GEOTECHNICAL

GEOTECHNICAL EXPLORATION REPORT
WHITERIVER INDIAN HOSPITAL
200 WEST HOSPITAL DRIVE
WHITERIVER, ARIZONA

Prepared for:
Mabbet and Associates, Inc.
105 Central Street, Suite 4100
Stoneham, Massachusetts

atek
ENGINEERING CONSULTANTS

Prepared by:
ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, Arizona 85226

ATEK Project # 230211

April 4, 2025

atek
ENGINEERING CONSULTANTS

April 4, 2025
ATEK Project #230211

Stephen A. Vetere, P.E., LSP, LEP
Mabbet and Associates, Inc.
105 Central Street, Suite 4100
Stoneham, Massachusetts

Regarding: Geotechnical Exploration Report

Project: Whiteriver Indian Hospital
200 West Hospital Drive
Whiteriver, Arizona

Dear Mr. Vetere:

ATEK Engineering Consultants, LLC is pleased to present the attached Geotechnical Exploration Report for the Whiteriver Indian Hospital located in Whiteriver, Arizona within the Fort Apache Indian Reservation. The purpose of our study was to explore and evaluate the subsurface conditions at the proposed site to develop geotechnical engineering recommendations for project design and construction.

Based on our findings, the site is considered suitable for the proposed construction, provided geotechnical recommendations presented in the attached report are followed. Specific recommendations regarding the geotechnical aspects of the project design and construction are presented in the attached report. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,
ATEK Engineering Consultants, LLC

Registered Professional Engineer (Civil) CERTIFICATE NO. 71358 ANTONIO LOPEZ ESQUEDA DATE SIGNED 04-04-25 ARIZONA U.S.A.

Registered Professional Engineer (Civil) CERTIFICATE NO. ARMANDO ORTEGA Date Signed 04/04/25 ARIZONA, U.S.A.

Antonio Lopez, P.E.
Geotechnical Group Manager

Armando Ortega, P.E.
Principal Geotechnical Engineer

Distribution: (1) Addresses (Electronic Copy)

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1. Project Description 1
1.2. Purpose 1
1.3. Scope of Services 1

2. SUBSURFACE EXPLORATION 2
2.1. Phase 1 – Soil Test Borings 2
2.1.1. Soil Sampling 2
2.1.2. Percolation Test Boring 3
2.2. Phase 2 – Rock Coring 4
2.3. Seismic Refraction survey 4
2.4. Refraction Microtremor 5

3. LABORATORY TESTING 5

4. GENERAL SITE CONDITIONS 6
4.1. Surface Conditions 6
4.2. Subsurface Conditions 6
4.2.1. Soils 6
4.2.2. Rock 7
4.3. Groundwater Conditions 7
4.4. Geologic Hazards 7
4.4.1. Liquefaction Potential 7
4.4.2. Collapsible Soils 8
4.4.3. Expansive Soils 8
4.5. Site-Specific Ground Motion Hazard Analysis 8
4.6. Seismic Considerations 8
4.7. Earth Fissures and Land Subsidence 9

5. ENGINEERING ANALYSES AND RECOMMENDATIONS 9
5.1. Earthwork 9
5.1.1. Frost Depth 10
5.1.2. Frost Consideration 10
5.1.3. Rock Socketed Drilled, Cast-in-Place, Concrete Shafts 11
5.1.3.1. Grade Beam 12
5.1.3.1. Structural Slab 12
5.1.4. Spread Footings – EMS and Facility Maintenance 13
5.1.5. Concrete Flatwork 13
5.1.6. Pavement Site Preparation and Grading 14
5.1.7. Aggregate Base Course 14
5.1.8. Engineered Fill 15
5.2. Excavation 17
5.2.1. Trench Backfill 18
5.2.2. Temporary Excavations 19
5.2.1. Permanent Excavations and Slopes 21

atek
ENGINEERING CONSULTANTS

5.3. Structures 21
5.3.1. Rock Socket Axial Capacities 21
5.3.1.1. Factor of Safety 22
5.3.1.2. Settlement 22
5.3.1.3. Allowable Uplift Capacities 23
5.3.1.4. Shaft Group Resistance 23
5.3.3. Shallow Spread Footings - EMS and Facility Maintenance 27
5.3.3.1. Continuous and Isolated Footings - EMS and Facility Maintenance 28
5.3.3.2. Structural Slab - EMS and Facility Maintenance 29
5.3.4. Resistance to Lateral Loads 29
5.3.4.1. Wall Drainage 30
5.3.4.2. Backfill Placement 31
5.4. Moisture Protection 31
5.5. Corrosion Potential 32
5.5.1. Electrical Resistivity 32
5.5.2. Sulfate and Chloride Content 33
5.6. Pavement Areas 33

6. CLOSURE 34
6.1. Limitations 34
6.2. Recommended Additional Services 36

APPENDIX A – Site Location Map
APPENDIX B – Sample Location Plan
APPENDIX C – Field Study and Boring Logs
APPENDIX D – Laboratory Test
APPENDIX E – Seismic Refraction Survey
APPENDIX F – Refraction Microtremor
APPENDIX G – Allowable Rock Socket Capacities
APPENDIX H – Geology Cross Section Profile

atek
ENGINEERING CONSULTANTS

1. INTRODUCTION

This report presents the results of our geotechnical exploration for the Whiteriver Indian Hospital located in Whiteriver, Arizona within the Fort Apache Indian Reservation. A Site Location Map is presented in **Appendix A** of this report. The following sections of this report describe our understanding of the project and our scope of services.

1.1. Project Description

The proposed project is a new four-story Hospital facility within the premises of the existing Whiteriver Indian Hospital in Whiteriver, Arizona. The building footprint will be approximately 103,500 square feet and a gross total square footage of approximately 406,000 square feet. The building construction will be a Type IA with concrete and steel components. The building will be supported on deep foundations embedded in rock sockets. The improvements include a free-standing Emergency Medical Services building with an approximate footprint of 4,600 square feet. Additional improvements include approximately 1,335 parking spaces.

1.2. Purpose

The purpose of this geotechnical study was to evaluate the general surface and subsurface conditions at the site, and to present recommendations related to geotechnical aspects of design and construction of the proposed project.

1.3. Scope of Services

Our study included a site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. This report presents geotechnical recommendations for design and construction of proposed structures. The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the “Limitations” section of this report.

2. SUBSURFACE EXPLORATION

The subsurface exploration was completed in two which included several drilling techniques and geophysical surveys. Prior to the start of drilling, the Arizona 811, the Tribal Utility Authority and Indian Health Service Facilities were contacted to locate existing utilities at the boring locations.

2.1. Phase 1 – Soil Test Borings

Phase 1 consisted of drilling fourteen borings using the Hallow Stem Auger (HSA) method. This field exploration was performed from August 18, 2024, to August 21, 2024. Fourteen soil borings were drilled to depths ranging between ten (10) and fifty (50) feet below existing grade, one percolation soil boring was drilled to a depth of five (5) feet below existing grade. Auger refusal was encountered at borings designated B-1, B-4, B-5, B-6, B-7, and B-9. The drilling method was changed from HSA to Overburden Drilling Excentric (ODEX) which uses a percussive air-hammer for boring designated as B-3 to gather information on depth of bedrock to plan and facilitate phase 2. The soil test borings were drilled using a truck mounted CME-75 power drill rig equipped with 7 and ¼-inch outside diameter hollow stem augers for the soil borings and a 15-inch solid stem auger for the percolation test boring. Due to rig accessibility, boring designated as B-15 was advanced using a hand auger, to a depth on two and a half (2.5) feet below existing grade. The percolation test and boreholes were located in the field at the approximate locations shown on the Sample Location Plan included in **Appendix B** of this report. Upon completion of the borings and percolation test, the boreholes were backfilled with excavated materials.

2.1.1. Soil Sampling

Disturbed and relatively undisturbed samples were taken at the direction of the field engineer during drilling operations. Relatively undisturbed samples of the subsurface materials were obtained using a California sampler with a 2.5-inch inside diameter and a 3.0-inch outside diameter. Disturbed samples were obtained using a Standard

Penetration/Split Spoon Sampler (SPT) with a 1.5-inch inside diameter and 2.0-inch outside diameter. The California and the SPT samplers were driven 12 and 18 inches, respectively, using a 140-pound hammer falling 30 inches, and blow counts for successive 6-inch penetration intervals were recorded. After the sampler was withdrawn from the borehole, the samples were removed, sealed to minimize moisture loss, and submitted to the laboratory.

Soil classifications made in the field from auger cuttings and samples were re-evaluated in the laboratory after further examination and testing. The soils were classified in accordance with the Unified Soil Classification System presented in **Appendix C**.

Sample classifications, blow counts recorded during sampling, and other related information, were recorded on the soil boring logs. The boring logs are presented in **Appendix C**. The information presented on the logs are a combination of factual and interpretive information. Lines delineating subsurface strata and group symbols are based on field observations made at the time of the field study. Actual subsurface lines delineating subsurface strata may be gradual and vary.

2.1.2. Percolation Test Boring

Percolation testing was completed in general accordance with the Arizona Administrative Code Title 18, Chapter 9, A 310 Section F and the sides of the test hole were sleeved with a permeable surface. The percolation depths and recorded rates are presented in the following table.

Percolation Test Location	Percolation Depth Below Existing Grade (feet)	Percolation Rate (min/inch)
P-1	5.0	33.0

Since percolation rates tend to slow with time as the basins "silt in", we recommend an appropriate factor of safety be used in conjunction with these percolation rates when designing the basins.

The excavation of the retention basin should be accomplished with light weight excavation equipment to avoid compaction of the exposed native soils. No traffic should be allowed within the retention basin after construction. It should be noted that compaction of the basin will reduce the infiltration rates. If compaction within the basin floor occurs, the exposed surface should be scarified to a minimum depth of 8-inches and left uncompacted.

2.2. Phase 2 – Rock Coring

Based on the findings in Phase 1 a rock coring subcontracted was brought in to gather additional samples and explore the rock formation. Four borings were completed between October 21, 2024, to October 23, 2024 using a double tube core barrel drilling method. The four borings were advanced to depths ranging between thirty-five (35) and sixty-five (65) feet below existing grade. The borings were advanced through the overburden soils with truck mounted CME-75 power drill rig equipped with an 8-inch outside diameter HSA. The drilling method was changed to rock coring once the rock formation was encountered. The coring equipment used was an HQ3 wireline with an outside diameter 3 and 3/8-inch outside diameter (2 and 3/8-inch inner diameter). The borings were located in the field at the approximate locations shown on the Sample Location Plan included in **Appendix B** of this report. Upon completion of the drilling, the boreholes were backfilled with excavated materials.

2.3. Seismic Refraction survey

The subsurface soil conditions were also evaluated using seismic refraction methods. The seismic refraction method uses the principle in which the velocity of the seismic refraction wave passes through a material, is directly related to the stiffness of the

subsurface material. As the velocity of this wave increases, the stiffness of the material increases. The waves used in this study consist of seismic compressive waves (p-waves). P-wave velocities of the subsurface strata are often correlated to the amount of effort required to excavate or rip through a subsurface soil material.

Four seismic refraction survey lines were completed on July 26, 2024. Seismic velocities, calculated zone thickness and depth to velocity zone boundaries for each interpreted bedrock or soil types are depicted in Figures 3 through 10 presented in **Appendix E**. The results of the seismic refraction survey should be used with caution and only used as guidelines.

2.4. Refraction Microtremor

One refraction microtremor (ReMI) survey line was performed on the project site as part of the subsurface study. The purpose of the ReMI survey was to provide a calculated average shear waver velocity (Vs) of the subsurface materials to a depth of 100 feet for use in establishing a site class in accordance with the 2018 International Building Code. Results of the ReMI survey are presented in **Appendix F**.

3. LABORATORY TESTING

Selected soil samples from the borings were tested in the laboratory for classification purposes and to evaluate their engineering properties. The laboratory tests included:

- Gradation;
- Atterberg limits;
- Moisture content;
- Hydrometer;
- One-dimensional consolidation;
- Standard Proctor;
- Swell potential of soil;
- Undisturbed ring density;
- pH tests;
- Resistivity tests;

- Sulfate content;
- Chloride content;
- Direct shear;
- Unconfined compressive strength.

A brief description of each test performed on the soil samples and the results are presented in **Appendix D** of this report.

4. GENERAL SITE CONDITIONS

4.1. Surface Conditions

The project is located south of the existing Whiteriver Indian Hospital in Whiteriver, Arizona within the Fort Apache Indian Reservation. The project site is bound to the south by Arizona State Route 73, 402 Old Sawmill Road to the east, Apache Behavioral Health Services to the west, and the Whiteriver Hospital to the north. The surface south of Apache Circle was covered with dense vegetation and an oval parking lot was located south of the eastern half of the existing hospital. A few pedestrian paths were observed on the southern portion of the project site. The topography of the site generally slopes down towards State Route 73. A sudden change in elevation of 20 to 30 feet was observed just south of Apache Circle.

4.2. Subsurface Conditions

Subsurface conditions at the site generally consist of fine-grained soils overlying basalt. A discussion of the subsurface materials encountered is presented in the following sections. Detailed description of the deposits are provided in our boring logs presented in **Appendix C**.

4.2.1. Soils

The overburden soils primarily consist of fine grain soils with a mixture of Clay, Silts and Sands. These soils had a low to medium plasticity and were found to have a relative

firmness ranging from moderately firm to very firm. In addition, these fine-grained soils had varying amounts of interbedded layers of gravel. Based on our exploratory borings the thickness of the residual soils ranged from 10 feet on the eastern side and 45 feet on the western side of the project site.

4.2.2. Rock

Rock was encountered at various boring locations completed for this project. The bedrock encountered was vesicular basalt and basalt with varying degrees of weathering. Core recovery was generally greater than 90 percent and RQD values were generally greater than 85 percent. The basalt was found to be weak to strong. Based on the rock recoveries, it is presumed that a younger basalt flow overlays and older basalt flow. This rock formation is mapped as Quaternary Basalt (Qb). For additional information see logs in **Appendix C** and Geology Cross Section Profile in **Appendix H**.

4.3. Groundwater Conditions

Groundwater was not encountered within the soil test borings, and it is anticipated that groundwater will not be a factor in design or construction of the planned improvements. It should be noted that soil moisture conditions within the area may vary depending on rainfall and/or runoff conditions not apparent at the time of our field study.

4.4. Geologic Hazards

4.4.1. Liquefaction Potential

Based on the site soils, rock formation and groundwater conditions encountered at the project site during this study, the potential for soil liquefaction is considered to be negligible.

4.4.2. Collapsible Soils

Collapsible soils are soils with the potential for a decrease in volume with an increase in external load or moisture content. These soils are typically found in areas of alluvial deposits with semi-arid to arid climates. Based on the information collected during our field study and subsequent laboratory testing, we anticipate collapse-susceptible soils will be encountered during construction. Based on ASTM D 5333, a calculated collapse potential, I_C, of the tested undisturbed ring samples collected during our field study resulted in a 11.7 percent indicating a severe collapse potential.

4.4.3. Expansive Soils

Expansive soils are soils with the potential for an increase in volume with an increase in moisture content. Based on the information collected during our field study and subsequent laboratory testing, we anticipate expansive-susceptible soils will be encountered during construction. Based on ASTM 4546, the expansive potential of the remolded sample collected during our field study, in the upper 5 feet, indicated an expansive potential.

4.5. Site-Specific Ground Motion Hazard Analysis

At the request of the client a site-specific ground motion hazard analysis was conducted by Kleinfelder, Inc. and is presented in the letter report titled *Site-Specific Ground Motion Hazard Analysis, Proposed Whiteriver Indian Hospital Addition, 200 W. Hospital Drive, Whiteriver, Arizona 85941,* Kleinfelder Project Number 25004546.001A, dated April 4, 2025. This letter report is presented under separate cover.

4.6. Seismic Considerations

The project site is located in eastern Arizona which is an area of low seismic activity. The following values were developed using the Seismic Design Maps by Structural Engineers Association by Location, the ASCE 7-16 Reference and are based on knowledge of local geologic conditions, and subsurface soils encountered during our study. A 100-

foot soil test boring was not advanced during our field study. The geographic coordinates listed below were used in developing the seismic design factors.

Central Latitude.....33.8753423˚
Central Longitude.....-109.9605721˚

Seismic Design Factors	Value
Site Class	C
F_a, Site Coefficient	1.3
F_v, Site Coefficient	1.5
S_s, Mapped Spectral Acceleration at 0.2-second Period	0.261 g
S_1, Mapped Spectral Acceleration at 1.0-second Period	0.082 g
S_{MS}, Spectral Acceleration at 0.2-second Period Adjusted for Site Class	0.339 g
S_{M1}, Spectral Acceleration at 1.0-second Period Adjusted for Site Class	0.123 g
S_{DS}, Design Spectral Response Acceleration at 0.2-second Period	0.226 g
S_{D1}, Design Spectral Response Acceleration at 1.0-second Period	0.082 g

4.7. Earth Fissures and Land Subsidence

The project site is located in an area with no documented earth fissures (Natural Hazards in Arizona by Arizona Geological Survey) and in an area without a measured land subsidence (Arizona Land Subsidence Areas by Arizona Department of Water Resources).

5. ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1. Earthwork

All existing structural remnants, fill, pavement, topsoil, vegetation and organic soils should be removed from below structural areas. The following sections present earthwork recommendations based on our understanding of the project, the finding of

our field exploration, results of the laboratory tests and engineering analysis. Based on the finding of our field exploration, laboratory test results and engineering analysis, it is our opinion that the proposed construction can be supported on a footing system as presented in the following sections.

5.1.1. Frost Depth

Based on review of the building codes and standards of the neighboring town of Pinetop-Lakeside the frost depth is 18-inches. To protect against frost heave, the use of fine-grained soils should be avoided in and around structural areas. The potential for snowpack adjacent to the structural areas may allow significant moisture to increase into fills around the outer edge of foundations therefore the exterior should be graded for positive drainage away from the structural areas. Also, to reduce the potential for moisture migration through earthwork operations, refer to section 5.4 of this report.

5.1.2. Frost Consideration

The site soils are frost susceptible, and small amounts of water can affect the performance of the relatively lightly loaded slab-on-grade and concrete flatwork. Exterior slabs and flatwork should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible engineered fill per section 5.1.8. Placement of non-frost susceptible material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from structures and flatwork and toward the site storm drainage system;
- Install drain tiles around the perimeter of the building, stoops, below exterior slabs and pavements, and connect them to the storm drainage system;

- Grade clayey subgrades such that groundwater, potentially perched, in overlying more permeable subgrades, such as sand or aggregate base, drain toward the site drainage system;
- Place non-frost susceptible fill as backfill beneath slabs and flatwork that are critical to the project;
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between non-frost susceptible soils and other soils.

5.1.3. Rock Socketed Drilled, Cast-in-Place, Concrete Shafts

Rock socketed drilled, cast-in-place, concrete shaft (deep foundations) should be utilized to support the four-story hospital building, including roof mechanical equipment, and rooftop helipad. The deep foundation excavation should be advanced with single-flight auger, rock auger, or bucket auger bits to the design tip elevation. The depth of excavation should be verified by measurement and inspection. The bottom of the hole should be cleaned such that no more than three inches of loose material remains. Depending on the type of auger used and the depth of the shaft excavation, alternative cleaning techniques, including hand cleaning or vacuuming, may be required. Due to the variability of the rock formation, we recommend verification predrilling to insure at a minimum of 5-feet of competent rock below drilled shaft bottom elevation. Rock socketed shafts may require additional excavation if competent rock is not encountered within 5-feet of first bedrock contact elevation. Cohesionless soils were encountered at varying depths which may cave during drilling operations, see Boring Logs in **Appendix C** for additional information.

A minimum shaft diameter of 36-inches should be drilled to allow for proper cleaning, bottom preparation and inspection. Provisions should be made for removal of groundwater from the drilled shafts excavations. While groundwater is not anticipated, the drilled pier contractor should have pumps on hand to remove water in the event seepage into the drilled pier is encountered. Concrete slumps ranging between 6 and

8 inches should be specified to fill irregularities along the sides and bottom of the drilled hole, displace water as it is placed (if encountered), and permit placement of reinforcing cages into the fluid concrete. Temporary protective steel casing may be used to prevent side wall collapse, water intrusion, and to allow worker to safely enter, clean and inspect the drilled shaft. The protective casing many be extracted as the concrete is placed in the drill shaft, providing that a sufficient head of concrete is maintained inside the steel casing to prevent soil or water intrusion in the shaft. The concrete should be placed into the drilled shaft though a chute to reduce side flow or segregation. The socket face should be cleaned prior to concrete placement. Cleaning will require hand cleaning or washing of a mud smear forms on the face of the rock. The geotechnical engineer or his representative should approve the rock socket surface prior to concrete placement.

5.1.3.1. Grade Beam

The site soils exhibit a swell potential and poses the risk of post construction movement. The grade beam should be supported on one foot of aggregate base course in areas not in contact with deep foundations, or void forms should be used. The aggregate base course should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density.

5.1.3.1. Structural Slab

A structural slab may be used to transfer the warehouse loads to the grade beam/deep foundations. Void boxes may be used under the structural slab to reduce vertical movements of the structural slab due to expansive soils. The void boxes should have a height of at least 6 inches. The void boxes may consist of carboard carton.

5.1.4. Spread Footings – EMS and Facility Maintenance

The EMS, Facility Maintenance building and ancillary buildings can be supported on shallow spread footings. The existing surface soils should be removed to a minimum depth of three (3) feet below bottom of proposed spread footing elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the structure and extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure. The exposed subsurface soils should be scarified to a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Any oversized material (larger than 3-inches) should not be used in backfill. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to within one (1) foot of finished pad elevation. Optimum moisture content and maximum dry density should be determined by American Society for Testing and Materials (ASTM) D 698.

Engineered Fill material meeting the recommendations for Imported Soils and low-susceptible soils presented in section 5.1.8 of this report should be placed within one (1) foot of the finished pad elevation. These soils should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

5.1.5. Concrete Flatwork

The site soil tested as part of this project exhibit swelling potential and should not be used within eight (8) inches of the finished subgrade elevation. The existing surface soils should be removed to a minimum depth of one (1) foot below bottom of proposed concrete flatwork. Concrete flatwork includes sidewalks, exterior concrete slabs or concrete flatwork not subjected to loads. In addition, the exposed subsurface soils

should be scarified to a depth of six (6) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Engineered Fill material meeting the recommendations for Imported Soils and low-susceptible soils presented in section 5.1.8 of this report should be placed within eight (8) inches of the finished subgrade elevation. These soils should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

5.1.6. Pavement Site Preparation and Grading

The pavement section presented in this report is based on the site soils encountered during our field exploration. Any material with a diameter larger than three (3) inches within the pavement area should be removed prior to base course placement. The native soils should be scarified to a depth of twelve (12) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of ninety-five (95) percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.7. Aggregate Base Course

Aggregate base used in support of Portland cement concrete and asphaltic concrete pavements should conform to the local governing agency and/or Maricopa Association of Governments (MAG) Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40 when exposed to a maximum of 500 revolutions.

A minimum of four (4) inch layer of clean, granular material should be placed beneath concrete slabs to serve as a leveling base, and to aid in concrete curing. The material should conform to the gradation requirements set by the local governing agency and/or

MAG section 702 specifications for Aggregate Base Course (ABC). The use of moisture barriers beneath the floor slabs may be helpful, but is not a geotechnical requirement; however, the architect or the slab designer should evaluate their need.

All aggregate base material should be placed in lifts not greater than eight (8) inches and compacted to a minimum of 95 percent of maximum dry density below Portland cement concrete and one hundred percent of maximum dry density below asphaltic concrete pavements as determined by ASTM Test Method D 698 or as specified by local specification. The moisture content during compaction should be maintained within two percent of optimum moisture content.

5.1.8. Engineered Fill

Engineered fill may consist of native soils and/or imported soils. Pea gravel and poorly-graded materials should not be used as engineered fill unless approved by the geotechnical engineer. All engineered fills should be compacted as noted in section 5.

1. Native soils can be used as fill material for the following:
    - general site grading
    - below foundation
    - pavement areas
    - up to 1-foot within finished pad

2. Imported soils with low expansive potentials could be used as fill material for the following:
    - general site grading
    - foundation areas
    - interior floor slab areas
    - foundation backfill
    - exterior slab areas
    - pavement areas

3. Imported soils (if required) should conform to the following:

Gradation	Percent finer by weight (ASTM C136)
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	50 (max)
Liquid Limit	30 (max)
Plasticity Index	15 (max)

Swell Test

Maximum Swell Potential ..... 1.5 %*

*Measured on a sample compacted to approximately 95 percent of the ASTM D 698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 144 psf surcharge and submerged.

Corrosion Potential	(PPM)
Sulfate Content (ARIZ 733)	1,000(max)
Chloride Content (ARIZ 736)	500(max)

4. In addition to the above, imported low-frost susceptible soils should conform to the following:

Gradation	Percent finer by weight (ASTM C136)
3"	100
No. 4 Sieve	25-60
No. 200 Sieve	15 (max)

5. Aggregate base should conform to MAG and/or local governing specifications.

6. The following are intended to guide in establishing adequate support for the conventional foundation elements:
    - Any natural washes, depressions or new excavations which are to be filled, should be widened as necessary to accommodate compaction equipment and provide a level base for placing fill.
    - Any engineered fill (backfill) materials placed beneath the foundations should meet the requirements for Engineered Fill Materials.
    - All footing excavations should be relatively level and free of loose or disturbed material and inspected by a qualified representative of the Geotechnical Engineer.

7. All fill soils to be used beneath the foundations; slabs and pavements should be approved by the Geotechnical Engineer. The fill should be placed in eight (8) inch loose lifts, moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Fill materials placed at depth greater than five (5) feet should be compacted to 100 percent of maximum dry density to finished grade elevation. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.2. Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 7 and ¼-inch outside diameter hollow stem augers and core barrels. We present the following general comments regarding ease of excavation with the understanding that they are opinions based on the test borings. The project consultant and contractor should become familiar with this report including boring logs to evaluate potential hard dig conditions. **Please note that excavation characteristics are best evaluated by performing test excavations with the size and type of equipment the contractor plans on using at the site, which was not conducted as part of this study.**

It is anticipated that shallow excavations in the site soils can most likely be accomplished by conventional earth moving equipment in good operating condition. Bedrock was encountered at various depths ten (10) to forty (40) feet below existing surface elevation. In general, bedrock elevation is shallower at the eastern portion of the project and deeper on the western side. Auger refusal was encountered at these depths and the drilling method was changed to rock coring see core logs in **Appendix C** and Geology Cross Section Profile in **Appendix H.** Excavations in bedrock may require specialized excavation equipment. Based on geophysical surveys completed for this project the qualitative excavatability can be moderate to severe for unweathered to slightly weathered basalt and severe for unweathered basalt. Please refer to Section 4 and the boring logs, and seismic refraction survey presented in **Appendix C and E** of this report for more information.

5.2.1. Trench Backfill

Materials

Pipe zone backfill (i.e., material beneath and in the immediate vicinity of the pipe) should consist of soil with a maximum particle size less than one inch. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of soil that meets the requirements for structural fill provided above.

If import material is used for pipe or trench zone backfill, we recommend it consist of fine-grained sand. In general, poorly graded coarse-grained sand and gravel should not be used for pipe or trench zone backfill due to the potential for site soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipes. We recommend the project

Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Compaction Criteria

Backfill of trenches should utilize site soils with particle diameter less than 3-inches, in order to aid compaction and reduce potential differential settlement problems. Backfilling of utility trenches should be in 12-inch maximum loose lifts, and compacted to a minimum of 90 percent and 95 percent of ASTM D-698 (standard Proctor), in non-structural areas and structural areas, respectively. Please note that the local governing agency specifications may surpass these trench backfill requirements. Jetting, flooding, or puddling of cohesive backfill soils should not be utilized under any circumstances.

Care must be used during compaction of backfill against stem walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated in close proximity to the below ground structures or earth retaining structures.

5.2.2. Temporary Excavations

General

All excavations must comply with applicable local, state, and federal safety regulations including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Generally, Construction site safety is solely the responsibility of the Contractor, who shall also be responsible for the means, methods, and sequencing of construction operations. We are providing the information below strictly as a service to our client. **Under no circumstances should the information be interpreted that ATEK is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.**

Excavations and Slopes

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced; and, if not followed, could result in substantial penalties to the Owner, Contractor, and/or earthwork subcontractor and/or utility subcontractors.

Near-surface soils encountered during our field study consisted predominantly of Sandy Clays. In our opinion, these soils would be considered a Type B soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1(h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than five (5) feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within one-third the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Arizona.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water should be collected and disposed of outside the construction limits.

5.2.1. Permanent Excavations and Slopes

We recommend all permanent cut and fill slopes in soil be constructed at a gradient no steeper than 3(h):1(v). During wet weather, erosion could become a problem. Proper drainage and maintenance is recommended. To reduce the potential for surface erosion, a berm or "V" ditch may be located at the top of slopes subject to significant overland water flows in order to intercept and redirect surface runoff.

Fill placed on slopes steeper than 5(h):1(v) should be benched into the existing slope. It is recommended that the slope face be compacted as presented in the earthwork section of this report.

5.3. Structures

5.3.1. Rock Socket Axial Capacities

Drilled concrete foundation axial capacities were calculated using the methods presented in AASHTTO (Edition 2002) Section 4.6.5.3. The side resistance (4.6.5.3.2-1) and tip capacities (4.6.5.3.1-1) were calculated based on Unconfined Compressive Strength (UCS) of the rock (basalt). The drilled shaft resistance was computed assuming a rock socket depth of at least 2.0D, where D is the shaft diameter.

The following table provides rock design parameters used in our analysis. Design Charts in **Appendix G** present the recommended allowable downward and uplift capacities of various diameters of straight, drilled, cast-in-place concrete rock sockets.

Parameter	Symbol	Estimated Value	Reference
Unit Weight	γ	150 pcf	Appendix D
Unconfined Compressive Strength	q_u	3,500 psi	Appendix D
Rock Quality Designation	RQD	80%	Appendix D
Geologic Strength Index	GSI	60%	Hoek & Diederichs (2006)
Elastic Modulus of Intact Rock	E_i	4,200 ksi	Table 4.4.8.2.2B
Elastic Modulus of Rock	E_m	2,100 ksi	Hoek & Diederichs (2006)
Modulus Ratio (Open Joints)	E_m/E_i	0.5	Table 4.4.8.2.2-3
Reduction Factor	α_E	0.528	Table 4.4.8.2.2-4

Drilled shafts for the building foundations should be rock socketed into the basalt rock which is approximately 10 to 40 feet below existing elevation grade, refer to boring logs in **Appendix C** and geology profiles in **Appendix H**. Note that the underlying rock is composed of two distinct flows/layers and a minimum of 5-feet of competent rock is required below bottom drilled shaft which may require penetration into the lower layer. This should be verified with a pilot hole before shaft construction. The site topography and geology profile vary which may result in different length drilled shafts. A minimum drilled shaft diameter of three (3) feet is recommended for the proposed building to allow for proper cleaning, bottom preparation and inspection.

5.3.1.1. Factor of Safety

Due to the variability of the rock formation encountered during our field study a factor of safety of 3.0 was used for both side resistance and tip resistance.

5.3.1.2. Settlement

For drilled shaft socketed into rock, settlement of ½ inch or less can be expected. Settlement would occur rapidly during construction of the foundation system.

5.3.1.3. Allowable Uplift Capacities

The allowable uplift axial capacities presented in the capacity chart presented in **APPENDIX G.** The allowable uplift capacity provided in the chart in **APPEDIX G** has an approximate factor of safety of 3.0.

5.3.1.4. Shaft Group Resistance

The minimum recommended center-to-center pier spacing is 2.5 times the pier diameter (2.5D). No group axial reduction is required for drilled shafts with center-to-center spacing equal to or greater than 2.5D.

5.3.2. Drilled Shaft Lateral Analyses

Computer software is available which models the lateral behavior of a pile or drilled shaft using estimated non-linear response of the soil. For a given pile loading, an iterative solution is employed to determine the deflection of the pile vs. depth, from which stresses within the pile are determined. Recommendations are provided in the following sections for the use of the computer programs LPILE.

5.3.2.1. Lateral Analyses Using LPILE

Recommended soil parameters for use in LPILE to analyze lateral soil interaction are presented in the tables below. For drilled shafts adjacent to slopes and for the direction of loading toward the slope face, it is recommended that lateral support be neglected in the upper part of the slope where the slope face is closer to the shaft than three shaft diameters (or 10 feet minimum).

Recommended Soil Type to Model	Approximate Elevation Range (ft)	Unit Weight (pcf)	Elastic Modulus (ksi)	Unconfined Compressive Strength (psi)	RQD	Soil Strain Ratio, ε_{50}
Weak Rock	Varies	150	2,100	3,500	80	0.005

pcf = pounds per cubic foot

psf = pounds per square foot

ksi= Kips per square inch

5.3.2.2. Lateral Drilled Shaft Group Effects

According to AASHTO (2002) Section 4.6.5.6.1.4, drilled shafts in a group may be considered to act individually under lateral load when the center-to-center (CTC) spacing is greater than 2.5 diameters in the direction normal to loading.

Pile Cap Configuration	CTC Spacing of 3D	CTC Spacing of 8D
pile cap in intimate contact with soil	0.8	1.0
pile cap not in intimate contact with soil	0.6	1.0

For intermediate spacing, the reduction value may be determined by linear interpolation. The above reduction factors apply to parallel loading only. Reduction factors should be applied to all shafts in a group regardless of shaft arrangement (i.e. end of row or middle of row), and all other portions of AASHTO Interim Bridge Specification 4.6.5.6 apply.

The recommended lateral reduction factors should be applied by reducing the p-values in the p-y curves by multiplying the internally generated p-values by the above reduction factors. There is a provision in LPILE for the user to input a p-multiplier to modify the internally generated p-y curves in this way. For COM624, it may be

necessary to have the program output the internally generated p-y curves, and then to manually re-enter the factored p-y curves.

5.3.2.3. Construction Considerations

The following paragraphs provide construction considerations for drilled shafts. As mentioned earlier, we recommend that the drilled shafts be installed according to ADOT Standard Specification 609, which includes submission of a detailed installation plan to the Engineer by the contractor.

Our evaluation of the excavation characteristics of the on-site materials is based on the results of our exploratory borings, site observations, and experience with similar materials.

The drilled shafts should be inspected and evaluated to check adequate bearing material has been reached and that the bearing surface has been suitably cleaned. The foundation concrete should be designed so that it satisfies the requirements of Sections 609 and 1006 of ADOT Standard Specifications. Due to the variability of the site rock formation a pilot hole will be needed to verify a minimum of 5 feet of competent rock below the bottom of the shaft.

Where possible, the drilled shafts should be constructed in the "dry" (i.e. no more than 3 inches of water covering the base of the drilled shaft excavation). Also, the bottom of the hole should be cleaned such that no more than 3 inches of loose material remains. Depending on the type of auger used and the depth of the pier excavation, alternative cleaning techniques, including hand cleaning or vacuuming, may be required. For drilled shafts constructed in the "dry", the concrete may be placed by the free-fall method. This method consists of using a vertical section of concrete chute to direct the concrete flow out of the truck in a vertical stream of concrete with a relatively small diameter. The stream should be directed to avoid hitting the sides of the drilled shaft or the reinforcing cage, which could cause concrete segregation. Adequate compaction will

be achieved by free-fall of the concrete up to the top 10 feet. The top 10 feet of concrete should be vibrated in order to achieve proper compaction. The concrete should be designed so that the slump during placement is in the range of 6 to 8 inches for dry, uncased conditions.

Where the drilled shaft are constructed in the "wet", a tremie pipe connected either to a hopper or concrete pump should be used to displace the water in the drilled shaft excavation upwards as the concrete is placed. If this method is used, detailed procedures should be submitted by the contractor for review and approval by the geotechnical engineer. The top 10 feet of concrete should be vibrated in order to achieve proper compaction. The concrete should be designed so that the slump during placement is in the range of 7 to 9 inches for conditions other than a dry, uncased hole. Where it is anticipated that drilled shafts may be constructed in the "wet", a minimum of 6-inches of concrete cover over reinforcing steel should be provided.

5.3.2.4. Casing

Permanent casing may be used to protect the drilled shaft from potential shaft wall collapse. Casing may be left in the ground after drilled-shaft concrete placement.

5.3.2.5. Excavation

Drilled shaft excavations should be advanced with single-flight auger, rock auger, or bucket auger bits to the design tip elevation. The depth of excavation should be verified by measurement and inspection. The bottom of the hole should be cleaned such that no more than three inches of loose material remains. Depending on the type of auger used and the depth of the shaft excavation, alternative cleaning techniques, including hand cleaning or vacuuming, may be required.

Cohesionless soils were encountered at varying depths which may cave during drilling operations, see Boring Logs in Appendix C for additional information.

5.3.2.6. Steel and Concrete Placement

We recommend steel reinforcement and concrete be placed immediately upon completion of each shaft excavation. Concrete used for shaft construction should be discharged vertically into the drilled hole to minimize aggregate segregation. Under no circumstances should concrete be allowed to free-fall against either the steel reinforcement or the sides of the excavation during shaft construction.

For construction in a dry hole, concrete should be placed through a suitable tube or tremie, so that it is channeled in such a manner to free-fall and clear the walls of the excavation and reinforcing steel until it strikes the bottom. Adequate compaction will be achieved by free-fall of the concrete up to the top 10 feet. The top 10 feet of concrete should be vibrated in order to achieve proper compaction. Placement of concrete and concrete mix design details should be in accordance with Section 609 of the ADOT Standard Specifications.

5.3.2.7. Quality Assurance

Observation of the drilled shaft construction should be performed by a representative of the Geotechnical Engineer to verify proper diameter, depth and cleaning, and to also verify the nature of the materials encountered in the shaft excavations. Concrete placement should be observed by the engineer's representative to ensure that it meets requirements. A quality control report should be submitted on each shaft, documenting compliance with design details and specifications.

5.3.3. Shallow Spread Footings - EMS and Facility Maintenance

The anticipated frost depth for the project area is 18 inches below existing site grade. Therefore, concrete footings and concrete slabs should have turn downs which extend below the anticipated frost depth.

5.3.3.1. Continuous and Isolated Footings - EMS and Facility Maintenance

Shallow spread footings bearing on engineered fill can be used to support the structures as recommended (See section 5.1). Recommended footing depths and allowable bearing pressures are presented below.

Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.0	2,500
2.5	3,000
3.0	3,500

***Note**: Footing depth is defined as the depth below the lowest adjacent finished grade elevation within 5-feet of the edge of the footing.

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

Continuous footings and isolated column footings should have a minimum width of 16-inches and 24 inches respectively. The minimum widths are recommended for ease of construction, and to provide a margin of safety against a local or punching shear failure of the foundation soils. All footings should be reinforced to reduce potential distress caused by differential foundation movement.

All the footing excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. If subsurface conditions are encountered that are different than indicated by the borings, revised recommendations may be required.

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements over, a horizontal distance of 50 feet between similarly loaded footings, are expected to be less than ½-inch and ¾-inch for wall and column footings, respectively. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.3.3.2. Structural Slab - EMS and Facility Maintenance

The subgrade in the structural slab area should be prepared as recommended in section 5.1.3 including the one foot of non-expansive fill.

For design of structural slabs on grade, a modulus of subgrade reaction, ks, of 150 pci is recommended for slabs bearing on competent soils prepared as recommended above. However, this ks value is based on a bearing area of one square foot. In order to account for size effects a reduction is recommended for larger areas. The following approximation of ks (based on Terzaghi's equation) can be used for mats of various dimensions.

ks (in pci) = 150 / B where B is the width of the mat (in feet)

Additionally, it is recommended that a thicken edge be constructed on the slab to minimize the potential for edge damage.

5.3.4. Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 40 Pounds

per Cubic Foot (PCF). Restrained walls should be designed to withstand a residual or long-term at-rest (Ko) earth pressure condition of 60 PCF.

A passive EFP of 300 PCF may be used for shallow spread footings. Allowable passive resistance values should not exceed 3,000 psf. A coefficient of friction of 0.36 is recommended for computing lateral resistance between the base of footing and soil in analyzing lateral loads. Friction and passive resistance may be combined without reduction. We recommend that the first foot of soil cover be neglected in the passive resistance calculations if the ground surface is not protected from erosion or disturbance by a slab, pavement, or in a similar manner. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

Only cohesionless, free-draining granular materials should be used as backfill, adjacent to earth-retaining structures. We recommend that backfill directly behind the walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 3 feet of the walls during backfilling, to avoid developing excessive temporary or long-term lateral soil pressures. Positive gravity drainage of the backfill should be provided.

5.3.4.1.Wall Drainage

The above-recommended values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose of excess water that may accumulate behind earth retaining structures. In cases where site soils become saturated an equivalent fluid pressure of 90 PCF should be used.

Wall drainage should be collected by continuous perforated drainpipes, filter fabric, and gravel connected to weep holes. The drainpipe must run parallel to the wall. We recommend drain rock consist of durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should have an

equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a permeability of at least 0.02 centimeters per second and minimum puncture strength of 50 pounds.

5.3.4.2. Backfill Placement

All backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Care must be used during compaction of backfill against the below ground tanks walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated next to the walls. See Section 5.1.8 for additional information.

5.4. Moisture Protection

Soil support values reduce with an increase of moisture content. Therefore, positive drainage is essential to the successful performance of any structure. Good surface and subsurface drainage should be established during and after construction to prevent the soils below or adjacent to the structural areas and utility trenches from becoming wet.

Infiltration of water into utility or foundation excavations must be prevented during construction. The drainage design must route all storm and sprinkler water away from the structural areas in a positive manner. All water should be diverted away from areas where it could penetrate the ground surface near the structural areas. Watering of plants should be avoided adjacent to the buildings. Desert-type landscaping is advisable near the structural areas. Plants, which require more water, should be located and drained away from the structural areas.

5.5. Corrosion Potential

5.5.1. Electrical Resistivity

Electrical Resistivity of a soil is a measure of resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. As a soil's resistivity decreases, its corrosivity increases.

A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is shown in the following table.

Resistivity (ohm-cm)	Corrosivity Classification
0 to 1,000	Severely corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately corrosive
Over 10,000	Mildly corrosive

Sample Location	pH	Resistivity (Ohm-cm)
Bulk Sample B-1 @ 1.0'-5.0'	9.0	2,500
Bulk Sample B-3 @ 1.0'-5.0'	8.9	2,460
Bulk Sample B-6 @ 1.0'-5.0'	9.0	1,560

Based on the laboratory tests as shown above, this soil would be considered "corrosive" to "moderately corrosive". It should be noted that these corrosion conditions are for the soils at submerged moisture conditions. Resistivities at drier moisture contents would be less corrosive than the results of the test.

The pH values of the samples tested were slightly basic. In most cases, pH is not a significant factor in corrosion in the near-neutral pH range (5<pH<9).

Estimated life for various gage galvanized CMP, based on Figure 6.7 of the Handbook of Steel Drainage & Highway Construction Products published by American Iron and Steel Institute Fourth Edition, 1993, is tabulated below. Details of the laboratory test results are presented in the **Appendix C** of this report.

Sample Location	Design Life (yrs)		
	16 Gage	14 Gage	12 Gage
Bulk Sample B-1 @ 1.0'-5.0'	94	122	169
Bulk Sample B-3 @ 1.0'-5.0'	93	121	168
Bulk Sample B-6 @ 1.0'-5.0'	77	101	139

5.5.2. Sulfate and Chloride Content

Selected samples of the near-surface soils encountered at the site were subjected to chemical analysis for the purpose of corrosion assessment. The samples were tested for soluble sulfates, and soluble chlorides. The samples were tested in general accordance with Arizona Test Methods 733, and 736 for soluble sulfates, and soluble chlorides, respectively. The test results are provided in **Appendix C**.

Based on provisions of American Concrete Institute (ACI) 318 Section 4.3, Table 4.3.1, *Requirements for Concrete Exposed to Sulfate-Containing Solutions* a sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible. Based on the laboratory results, sulfate contents of the site soils tested indicate a negligible corrosion potential to concrete.

Based on the laboratory result of the sample collected for this project, chloride contents of the site soils tested indicate a negligible corrosion potential.

5.6. Pavement Areas

The on-site soils should be suitable as pavement subgrade soils provided all unsuitable debris, rubble, oversized cobbles, etc. are removed. A flexible and/or rigid pavement is recommended for the pavement areas. The recommended pavement sections are based on the assumption that the subgrade soils are prepared in accordance with section 5.1 of this report.

The flexible pavement section should consist of Central Plant Mix Asphaltic Concrete Pavement (AC) on compacted Aggregate Base Course (ABC) as recommended in the table below. Flexible pavement should be placed in accordance with MAG Section 321 and local municipality standards.

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)
Parking Areas (On-Site)	3.0	8.0
Heavy Traffic Areas (On-Site)	4.0	10.0

Aggregate Base Course (ABC), Asphalt concrete materials and mix design should conform to the local governing and/or MAG Specifications. All aggregate base material should be compacted to a minimum of 100 percent of maximum dry density below asphaltic concrete as determined by ASTM Test Method D 698 or as specified by local specification. The moisture content during compaction should be maintained within two percent of optimum moisture content.

Areas subject to sustained, heavy concentrated loads, such as dumpster areas should be paved with Portland Cement Concrete (PCC). A pavement section of 6 inches of PCC on 4 inches of aggregate base course is recommended in these areas. We should be contacted for additional recommendations if there will be any areas subjected to volumes of traffic heavier than those assumed for this report.

6. CLOSURE

6.1. Limitations

Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar localities. No warranty is expressed or implied.

The recommendations contained in this report are based on our field exploration, laboratory test results, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the test borings excavated during the field subsurface exploration. It is anticipated that some variations in the soil conditions will exist on-site. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractor, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on 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 ATEK of such intended use. Based on the intended use of this report, ATEK may require that additional work be performed and that an updated report be issued.

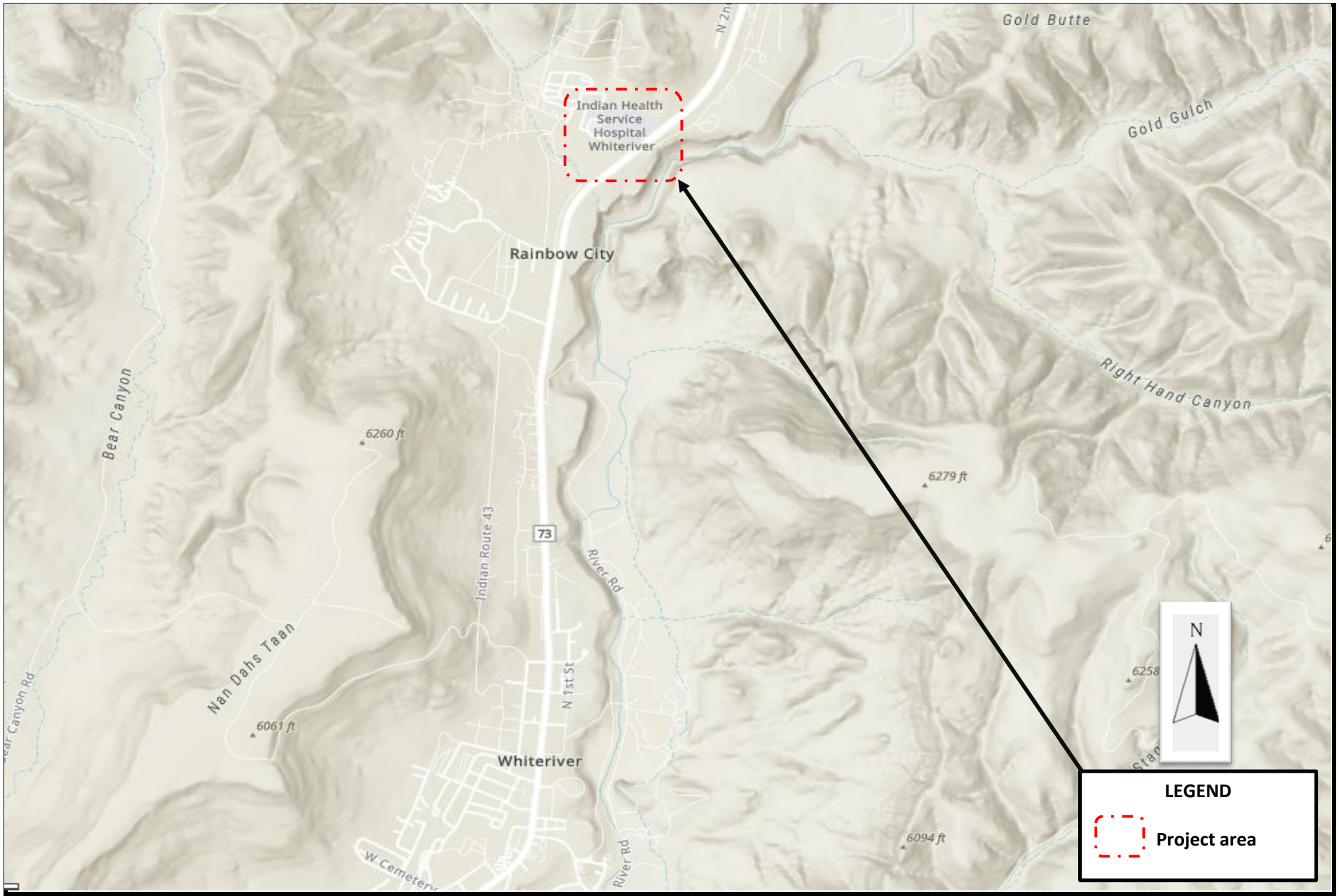
6.2. Recommended Additional Services

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction. These tests and observations should be performed by the Geotechnical Engineer's representative and should include, but not limited to the following:

- Observe and document that any existing surficial vegetation and other deleterious materials have been removed from the site as required in site preparation section.
- Approve any material used as import to document that it meets the requirements outlined above before placement.
- Monitor the backfill procedures.
- Perform field density tests, as needed, to verify compaction compliance. The representative should monitor the progress of compaction and filling operations.
- Keep records of on-site activities and progress.

Observation of footing excavations should be performed prior to placement of reinforcing and concrete to confirm that satisfactory bearing materials are present. Construction testing, including field and laboratory evaluation of fill and backfill materials, concrete and steel should be performed to determine whether applicable project requirements have been met.

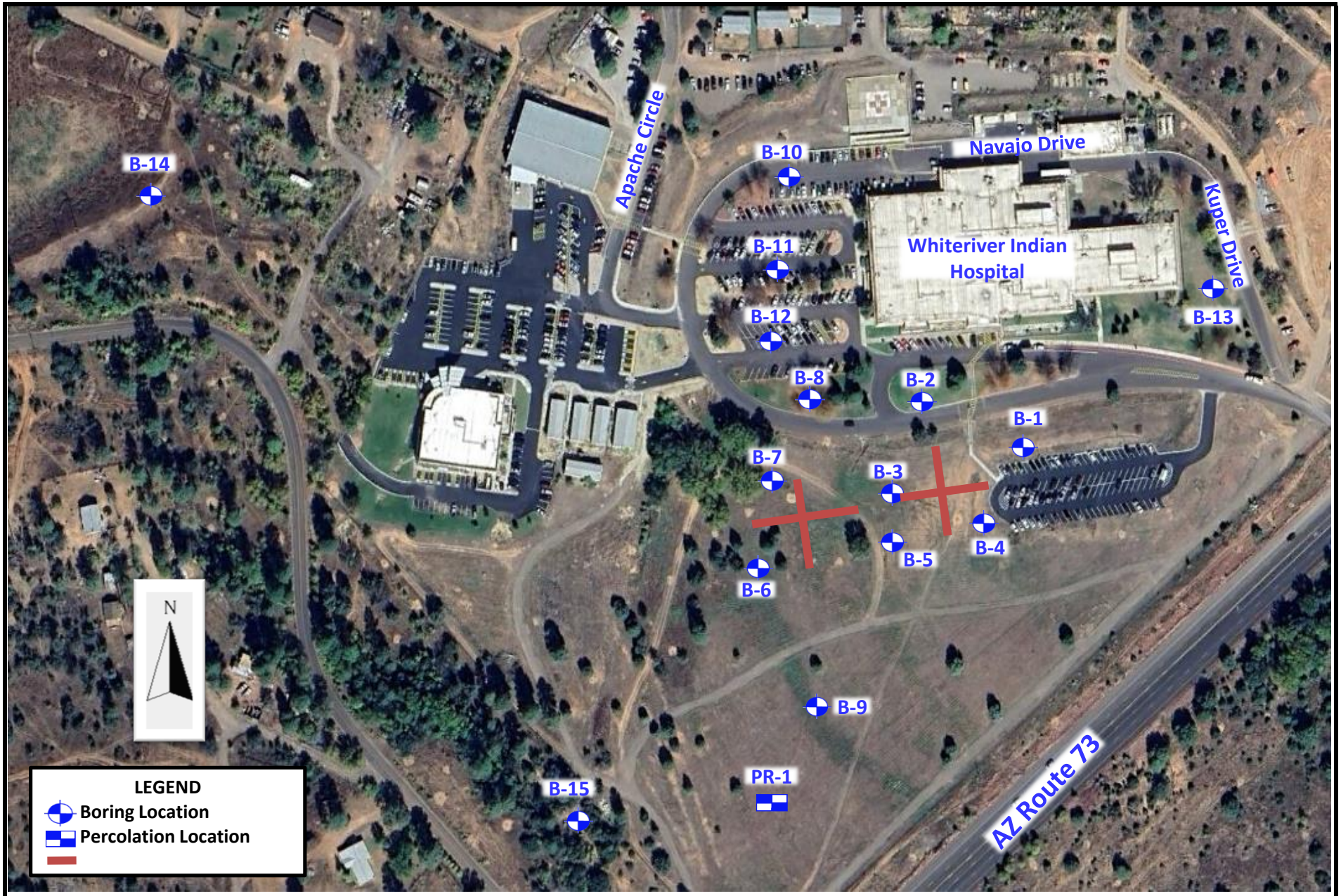
APPENDIX A
Site Location Map



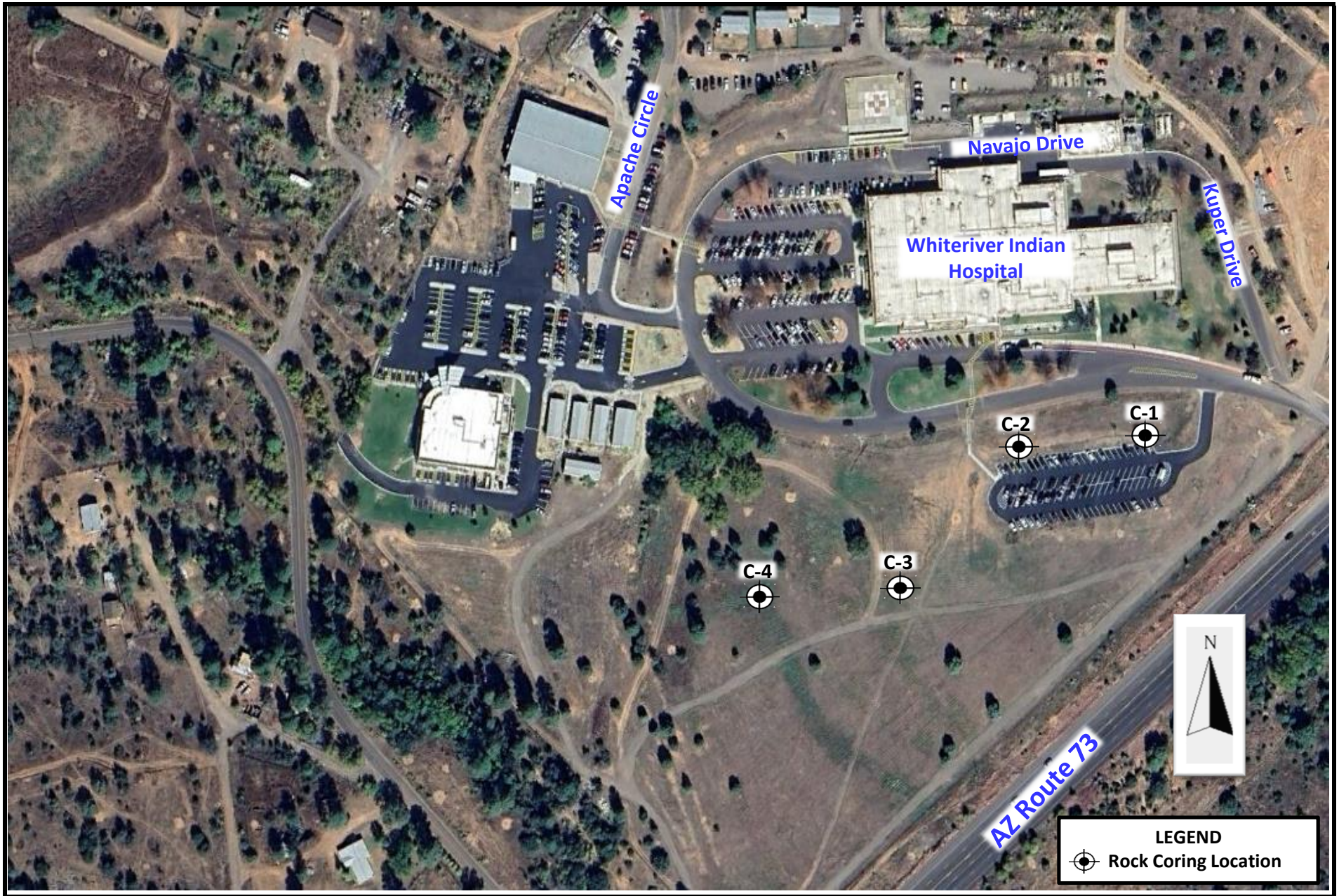
Basemap provided by ArcGIS	Project #: 230211 Date: 7/2/2024 Drawn by: GLR	**Site Location Map - Sheet 1 of 1** Whiteriver Indian Hospital Whiteriver, Arizona	atek ENGINEERING CONSULTANTS 111 South Weber Drive, Suite 1 Chandler, AZ 85226

APPENDIX B
Sample Location Plan

atek
ENGINEERING CONSULTANTS



Basemap provided by Google Earth	Project #: 230211 Date: 10/29/2024 Drawn by: MM	**Boring Location Plan - Sheet 1 of 1** Whiteriver Indian Hospital Whiteriver, Arizona	atek ENGINEERING CONSULTANTS 111 South Weber Drive, Suite 1 Chandler, AZ 85226



Basemap provided by Google Earth	Project #: 230211 Date: 10/18/2024 Drawn by: MM	**Coring Location Plan - Sheet 1 of 1** Whiteriver Indian Hospital Whiteriver, Arizona	atek ENGINEERING CONSULTANTS 111 South Weber Drive, Suite 1 Chandler, AZ 85226

APPENDIX C
FIELD STUDY AND BORING LOGS

APPENDIX C
FIELD STUDY

BORINGS

The subsurface conditions at the site were explored on August 19 2024 to August 21 2024, by drilling soil borings using a truck mounted CME drill rig with 7 and a ¼-inch outside diameter hollow stem auger. The locations of soil test borings performed for this study are shown in **Appendix B** of this report.

The locations of borings were located by visual sighting and pacing from existing site features and, therefore, should be considered approximate. Actual boring locations may vary from those indicated in **Appendix B**.

Our field engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table); and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System – C1
Log Key – C2
Charts and Definitions – C3
Terminology Used to Describe Soils – C4
Logs of Soil Borings

APPENDIX C
FIELD STUDY

BORINGS

The subsurface conditions at the site were explored on August 19 2024 to August 21 2024, by drilling soil borings using a truck mounted CME drill rig with 7 and a ¼-inch outside diameter hollow stem auger. The locations of soil test borings performed for this study are shown in **Appendix B** of this report.

The locations of borings were located by visual sighting and pacing from existing site features and, therefore, should be considered approximate. Actual boring locations may vary from those indicated in **Appendix B**.

Our field engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table); and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System – C1
Log Key – C2
Charts and Definitions – C3
Terminology Used to Describe Soils – C4
Logs of Soil Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LESS THAN 5% PASSING NO. 200 SIEVE	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% PASSING NO. 200 SIEVE	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LESS THAN 5% PASSING NO. 200 SIEVE	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% PASSING NO. 200 SIEVE	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

Note: Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing No. 200 sieve require dual USCS symbols. (See KEY A-3 if provided)

atek ENGINEERING CONSULTANTS

Drafted By: AM

Date: October, 2024

Project Number: 230211

UNIFIED SOIL CLASSIFICATION SYSTEM

Whiteriver Indian Hospital
Mabbet and Associates, Inc.
Whiteriver, Arizona

KEY

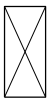
C-1

LOG SYMBOLS

BULK / GRAB SAMPLE

MODIFIED CALIFORNIA SAMPLER
(2 inch inside diameter)

GRAB SAMPLE



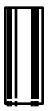
STANDARD PENETRATION
SPLIT SPOON SAMPLER
(2.0-inch O.D. X 1.4-inch I.D.)

SHELBY TUBE
(3 inch outside diameter)

NON-STANDARD PENETRATION
SPLIT SPOON SAMPLER
(1.5-inch O.D. X 0.9-inch I.D.)

BDBGM SIZE CORE BARREL
(1.65-inch I.D.)

BW44 SIZE CORE BARREL
(1.75-inch I.D.)



HQ-3 SIZE CORE BARREL
(2.4-inch I.D.)

WATER LEVEL
(level after completion)

WATER LEVEL
(level where first encountered)

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.

2. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

3. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.

4. In general, the Unified Soil Classification designations presented on the logs were based on visual classification in the field, modified where appropriate by visual classifications in the office, and/or laboratory gradation and index testing.

5. NA = Not Analyzed

atek ENGINEERING CONSULTANTS

Drafted By: AM
Date: October, 2024

Project Number: 230211

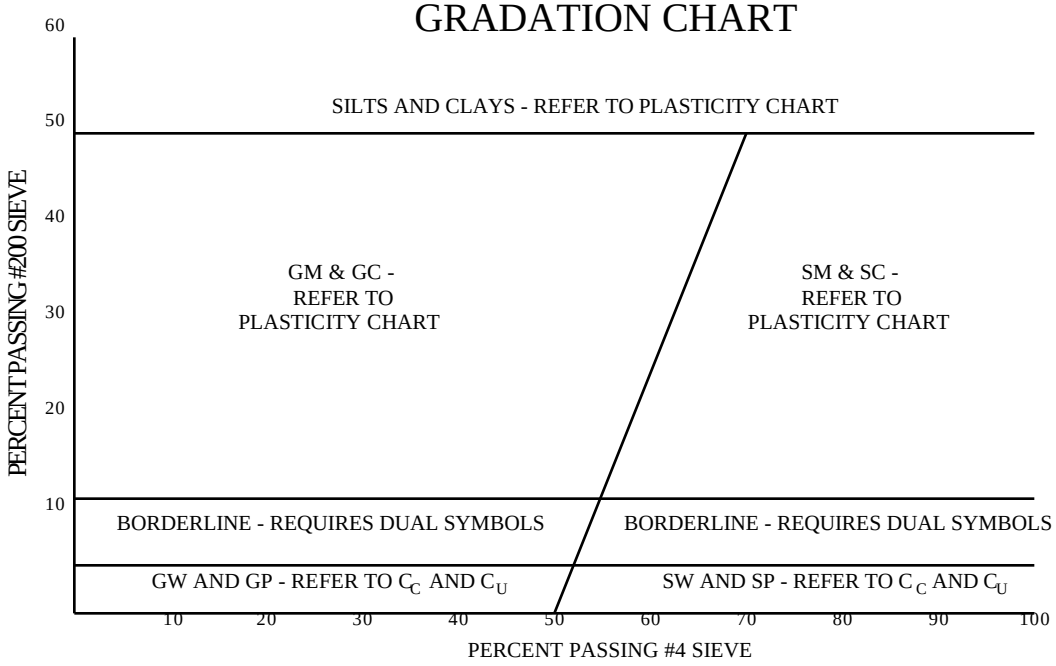
LOG KEY

Whiteriver Indian Hospital
Mabbet and Associates, Inc.
Whiteriver, Arizona

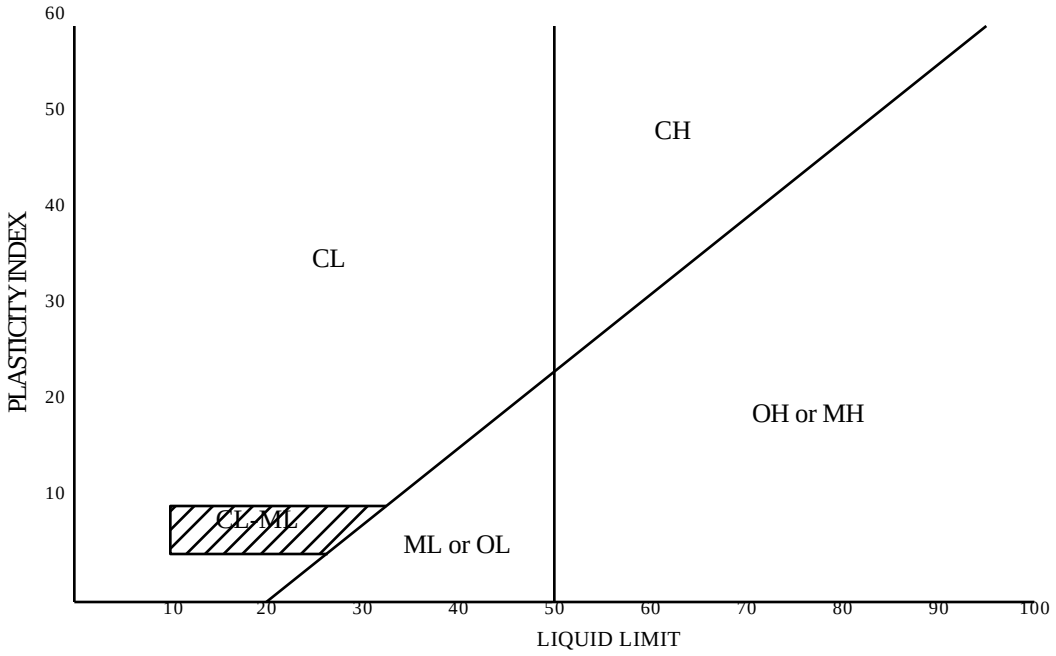
KEY

C-2

GRADATION CHART



PLASTICITY CHART



DEFINITIONS OF SOIL FRACTIONS

SOIL FRACTION	PARTICLE SIZE RANGE
Boulders	Greater than 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Coarse Gravel	75mm to 19mm (3in. to 3/4in.)
Fine Gravel	19mm (3/4in.) to No. 4 sieve
Coarse Sand	No. 4 sieve to No. 10 sieve
Medium Sand	No. 10 sieve to No. 40 sieve
Fine Sand	No. 40 sieve to No. 200 sieve
Fines	less than No. 200 sieve

atek ENGINEERING CONSULTANTS

Drafted By: AM

Date: October, 2024

Project Number: 230211

CHARTS & DEFINITIONS

Whiteriver Indian Hospital
Mabbet and Associates, Inc.
Whiteriver, Arizona

KEY

C-3

TERMINOLOGY USED ON THE BORING LOGS TO DESCRIBE
THE FIRMNESS, DENSITY, OR CONSISTENCY OF SOILS

The standard penetration resistance (**N**) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1 3/8" I.D. samplers.

1. Terms for description of partially saturated and/or cemented soils including clays, cemented granular materials, silts and silty and clayey granular soils.

N	Relative Firmness
0 - 4	Very soft
5 - 8	soft
9 - 15	Moderately firm
16 - 30	Firm
31 - 50	Very firm
51+	Hard

2. Terms for description of cohesionless, uncemented sands and sand-gravel mixtures.

N	Relative Density
0 - 4	Very loose
5 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
51+	Very dense

3. Terms for description of clays which are saturated or near saturation.

N	Relative Consistency
0 - 2	Very soft
3 - 4	soft
5 - 8	Moderately stiff
9 - 15	Stiff
16 - 30	Very Stiff
31+	Hard

atek ENGINEERING CONSULTANTS

Drafted By: AM
Date: October, 2024

Project Number: 230211

TERMINOLOGY USED TO DESCRIBE SOILS

Whiteriver Indian Hospital
Mabbet and Associates, Inc.
Whiteriver, Arizona

KEY

C-4

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-01		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/20/2024	Date Finished: 08/20/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			10-12			25	6	91	CL-ML		SILTY CLAY (CL-ML), 1% coarse graded gravel, 8% fine to medium grained sand, 91% fines, firm, low plasticity, reddish brown, slightly moist, weakly cemented, weak reaction to HCl		Resistivity 2,500 ohm-cm pH = 9.0
5			12-14										
10			10-10	17.6	100.3						Moist, no cementation, no reaction to HCl		
15			50/2"								Hard Auger grinding @ 15.0 feet	17	

Auger refusal @ 17.0 feet bgs.
Bottom of sampler @ 17.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-01

Fig. 1

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-02		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									AC		Asphaltic Concrete (approx. thickness of 5.5-inches)	0.45	
				2.8		37	13	52	ABC		Aggregate Base Course (approx. thickness of 4.0-inches)	0.8	
									CL		GRAVELY LEAN CLAY WITH SAND (CL), 27% fine graded gravel, 21% fine to coarse grained sand, 52% fines, firm, low plasticity, dark brown, moist, no cementation, weak reaction to HCl		
			4-8-8										
5			5-4-7								Subangular-angular gravel, moderately firm, medium plasticity		
10			2-2-2						CH		FAT CLAY WITH SAND (CH), very soft, high plasticity, dark brown, moist, no cementation, no reaction to HCl	10	
15			6-9	17.0	109.2						Moderately firm		
20			8-10-9								Firm		
25			2-3-3						CL		LEAN CLAY WITH SAND (CL), soft, medium plasticity, red, moist, no cementation, no reaction to HCl	25	
30													

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-02

Fig. 2

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-02		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			4-5-5								Moderately firm		
35			11-15-50/3"						BASALT		Hard	36	
											BASALT, highly weathered, dark gray, decomposed, dry, soft rock		
40			50/1"									40.1	

Bottom of auger @ 40.0 feet bgs.
Bottom of sampler @ 40.1 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-02

Fig. 2

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-03		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/20/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				9.2		31	7	81	CL-ML		SILTY CLAY WITH SAND (CL-ML), 6% fine graded gravel, 13% fine to coarse grained sand, 81% fines, moderately firm, low plasticity, dark brown, slightly moist, no cementation, weak reaction to HCl		Swell Potential of Soil = 5.3% Resistivity 2,460 ohm-mc pH = 8.9
			5-4-6										
5			22-26								Very firm, strongly cemented		
											Andesite gravel layer @ 8.0 feet		
10			16-17-50/5"						BASALT		Hard, pink	10.5	
											BASALT, highly weathered, dark gray, decomposed, dry, soft rock		
15			17-12-15										
											Auger grinding @ 18.5 feet		
20			50/1"								Auger refusal @ 20.0 feet Auger refusal on rock, drilling method switched from auger to ODEX on 8/20		
											Brown		
25			50/2"								Dark gray		
30													

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California

Operation Types: Hand Auger; ODEX; Auger Hollow Stem; Bullnose; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-03

Fig. 3

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-03		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/20/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
35			50/0"										
			50/0"										
40			50/0"										
45			50/0"										
50			50/0"									50	

Bottom of auger @ 50.0 feet bgs.
Bottom of sampler @ 50.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-03

Fig. 3

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-04		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									CL		SANDY LEAN CLAY (CL), moderately firm, medium plasticity, dark brown, slightly moist, no cementation, no reaction to HCl		
			3-5-6								Weakly cemented, strong reaction to HCl		
5			12-19	8.6	100						Very firm, red, moist, no cementation, no reaction to HCl		
10			12-12	4.0		50	32	97	CH		FAT CLAY (CH), 3% fine grained sand, 97% fines, firm, high plasticity, red, moist, no cementation, no reaction to HCl	10	
15			50/2"						BASALT		BASALT, highly weathered, dark gray, decomposed, dry, soft rock	15 15.2	

Bottom of auger @ 15.0 feet bgs.
Bottom of sampler @ 15.2 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Hand Auger; Auger Hollow Stem; ODEX; Bullnose; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-04

Fig. 4

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-05		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/20/2024	Date Finished: 08/20/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
0									CL		SANDY LEAN CLAY (CL), firm, medium plasticity, brown, slightly moist, weakly cemented, moderate reaction to HCl		
			11-10-6										
5			15-13										
10			39-42-50/3"						SC		Auger grinding @ 10.0 feet CLAYEY SAND WITH GRAVEL (SC), subangular-angular gravel, hard, low plasticity, brown, slightly moist, strongly cemented, strong reaction to HCl	10	
15			50/3"						BASALT		BASALT, highly weathered, dark gray, decomposed, dry, soft rock	15.5	
			50/1"									17.5	

Auger refusal @ 17.5 feet bgs.
Bottom of sampler @ 17.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-05

Fig. 5

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-06		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/19/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									TOPSOIL		TOPSOIL/GRASS	1	
				9.9		38	20	94	CL		LEAN CLAY (CL), 1% fine graded gravel, 5% fine to coarse grained sand, 94% fines, firm, medium plasticity, red, moist, no cementation, no reaction to HCl		Swell Potential of Soil = 2.7% Resistivity 1,560 ohm-cm pH = 9.0
			11-10	10.3	102.2						Weakly cemented		
5			6-8-12										
											Andesite gravel layer @ 7.5 feet		
10											Auger grinding @ 9.5 feet	10	
			22-17-20						SM		SILTY SAND WITH GRAVEL (SM), subangular gravel, dense, no plasticity, pale red, slightly moist, strongly cemented, strong reaction to HCl		
15												15	
			6-7						CL		LEAN CLAY WITH SAND (CL), moderately firm, medium to high plasticity, red, moist, no cementation, no reaction to HCl		
20												20	
			6-7-11						CH		FAT CLAY (CH), firm, high plasticity, red, moist, no cementation, no reaction to HCl		
25			4-7-9										
30												30	

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-06

Fig. 6

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-06		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/19/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			7-10-8						CL		SANDY LEAN CLAY (CL), firm, low plasticity, red, moist, no cementation, weak reaction to HCl		
35			4-4-6						CL		LEAN CLAY WITH SAND (CL), moderately firm, medium plasticity, red, moist, no cementation, weak reaction to HCl	35	
40			5-5-5						CL		SANDY LEAN CLAY (CL), moderately firm, low to medium plasticity, red, moist, no cementation, weak reaction to HCl	40	
45			50/1"						BASALT		BASALT, highly weathered, dark gray, decomposed, dry, very soft rock	45	
			50/1"								Heavy auger grinding @ 48.0 feet	48.5	

Auger refusal @ 48.0 feet bgs. on basalt
Bottom of sampler @ 48.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Hand Auger; Auger Hollow Stem; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-06

Fig. 6

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-07		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/19/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									TOPSOIL		TOPSOIL/GRASS	1	
			6-7-7						CL		SANDY LEAN CLAY (CL), moderately firm, low to medium plasticity, dark brown, slightly moist, no cementation, weak reaction to HCl Weakly cemented		
5			3-4						SC		CLAYEY SAND (SC), soft, low palsticity, brown, slightly moist, no cementation, weak reaction to HCl	5	
10			11-10								Firm		
											Andesite gravel layer @ 13.0 feet		
15			7-6-8	5.2		33	14	88	CL		LEAN CLAY (CL), 1% fine graded gravel, 11% fine to coarse grained sand, 88% fines, moderately firm, low plasticity, red, moist, weakly cemented, strong reaction to HCl	15	
20			4-6-9										
25			7-7-11								Firm		
30												30	

Sampler Types: Split Spoon; Shelby; Bulk Sample; Grab Sample; Penetrometer; Vane Shear; California

Operation Types: Hand Auger; ODEX; Auger Hollow Stem; Bullnose; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-07

Fig. 7

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-07		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/19/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			5-7						ML		SANDY SILT (ML), moderately firm, low plasticity, red, moist, no cementation, weak reaction to HCl		
35			6-9-44								Hard		
									BASALT		BASALT, highly weathered, dark gray, fractured, dry, very soft rock	36	
40			50/2"										
45			50/0"									46	

Auger refusal @ 46.0 feet bgs. on basalt
Bottom of sampler @ 46.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-07

Fig. 7

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-08		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									AC		Asphaltic Concrete (approx. thickness of 5.0-inches)	0.4	
									ABC		Aggregate Base Course (approx. thickness of 6.0-inches)	0.9	
									SC		CLAYEY SAND WITH GRAVEL (SC), subangular-angular gravel, very firm, medium plasticity, dark brown, moist, weakly cemented, strong reaction to HCl		
			13-15-21										
5			6-9-10								Firm		
10			15-14-19								Very firm		
									CL		SANDY LEAN CLAY (CL), medium plasticity, red, moist, weakly cemented, moderate reaction to HCl	12	
15			10-10-18								Firm		
20			43-19-12						CL		SANDY LEAN CLAY WITH GRAVEL (CL), subangular-angular gravel, very firm, medium plasticity, red, moist, strongly cemented, strong reaction to HCl	20	
25			5-4-6						CL		SANDY LEAN CLAY (CL), moderately firm, medium plasticity, red, moist, weakly cemented, strong reaction to HCl	25	
30													

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-08

Fig. 8

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-08		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			7-9-14								Firm, low palsticity, no cementation		
35			8-8-11										
40			5-8-9								Medium plasticity	41.5	

Bottom of auger @ 40.0 feet bgs.
Bottom of sampler @ 41.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-08

Fig. 8

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-09		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				9.4		36	18	93	CL		LEAN CLAY (CL), 7% fine to coarse grained sand, 93% fines, firm, medium plasticity, dark brown, slightly moist, weakly cemented, strong reaction to HCl		
			14-11	9.1	94.5								
5			30-22								Hard, moderate reaction to HCl		
10			16-20						SC		CLAYEY SAND WITH GRAVEL (SC), subangular-angular gravel, very firm, low to medium plasticity, red, moist, moderate cementation, weak reaction to HCl Light auger grinding @ 12.5 feet on gravel	10	
15			10-12-18						CL		LEAN CLAY WITH SAND (CL), firm, medium plasticity, red, moist, no cementation, no reaction to HCl	15	
20			5-5-8								Moderately firm, trace of volcanic cynder		
25			50/2"						BASALT		BASALT, highly weathered, dark gray, decomposed, dry, soft rock	25 25.6	

Auger refusal @ 25.5 feet bgs. on basalt
Bottom of sampler @ 25.6 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-09

Fig. 9

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-10		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									AC		Asphaltic Concrete (approx. thickness of 3.0-inches)	0.3	
				5.3		29	16	43	ABC		Aggregate Base Course (approx. thickness of 10.0-inches)	1.1	
			7-11	18.0	97.2				GC		CLAYEY GRAVEL (GC), 43% fine to coarse graded gravel, 14% fine to coarse grained sand, 43% fines, firm, medium plasticity, red, moist, no cementation, weak reaction to HCl		
5			4-6-8								Moderately firm		
10			4-5-5									11.5	

Bottom of auger @ 10.0 feet bgs.
Bottom of sampler @ 11.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-10

Fig. 10

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-11		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									AC		Asphaltic Concrete (approx. thickness of 4.0-inches)	0.35	
									ABC		Aggregate Base Course (approx. thickness of 5.0-inches)	0.75	
									SC		CLAYEY SAND (SC), very firm, medium plasticity, brown, moist, no cementation, no reaction to HCl		
			30-19										
5												5	
			15-10-12						CL		SANDY LEAN CLAY (CL), firm, medium plasticity, brown, moist, weakly cemented, strong reaction to HCl		
10													
			3-4-5								Moderately firm	11.5	

Bottom of auger @ 10.0 feet bgs.
Bottom of sampler @ 11.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-11

Fig. 11

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-12		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									AC		Asphaltic Concrete (approx. thickness of 4.0-inches)	0.35	
									ABC		Aggregate Base Course (approx. thickness of 4.0-inches)	0.7	
				9.3				64	CL		GRAVELLY LEAN CLAY WITH SAND (CL), 21% fine to coarse graded gravel, subangular-angular, 15% fine to coarse grained sand, 64% fines, very firm, low to medium plasticity, brown, moist, weakly cemented, strong reaction to HCl		
			16-28	10.1	105.2								
5			7-5-7								Moderately firm		
												8.5	
									CL		SANDY LEAN CLAY (CL), firm, medium plasticity, brown, moist, weakly cemented, strong reaction to HCl		
10			11-11-17								Moderately firm		
												11.5	

Bottom of auger @ 10.0 feet bgs.
Bottom of sampler @ 11.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-12

Fig. 12

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-13		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			5-5-7						CL		SANDY LEAN CLAY (CL), moderately firm, medium plasticity, brown, slightly moist, no cementation, weak reaction to HCl		
5			5-9-20								Firm		
10			15-17-13						SM		SILTY SAND WITH GRAVEL (SM), medium dense, nonplastic, brown, slightly moist, weakly cemented, weak reaction to HCl	10 / 11.5	

Bottom of auger @ 10.0 feet bgs.
Bottom of sampler @ 11.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-13

Fig. 13

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-14		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			8-7-9						FILL		FILL, SILTY SAND (ML), medium dense, no plasticity, dark gray, slightly moist, no cementation, no reaction to HCl		
5			8-9	5.7	91.3				ML		NATIVE, SILTY SAND (ML), medium dense, no plasticity, red, slightly moist, no cementation, weak reaction to HCl	5	
10			5-5-6	6.6		30	6	80	ML		SILTY SAND (ML), 20% fine to coarse grained sand, 80% fines, moderately firm, low plasticity, dark brown, moist, no cementation, strong reaction to HCl	10	
15			6-6-5										
20			4-4-6										
25			38-24-22						SM		SILTY SAND WITH GRAVEL (SM), subangular-angular gravel, dense, no plasticity, brown, slightly moist, moderately cemented, strong reaction to HCl	25	
30											Auger grinding @ 28.0 feet LEAN CLAY WITH SAND (CL) layer @ 28.0 feet		

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-14

Fig. 14

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-14		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/21/2024	Date Finished: 08/21/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			4-10-11								Medium dense		
35			31-32-33								Very dense, strongly cemented	38	
									CL		SANDY LEAN CLAY (CL), moderately firm, medium plasticity, reddish yellow, moist, no cementation, no reaction to HCl		
40			6-6-5									41.5	

Bottom of auger @ 40.0 feet bgs.
Bottom of sampler @ 41.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-14

Fig. 14

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-15		Driller: Wildcat	Logger: Antonio Lopez
Drilling Equipment: Hand Auger	Borehole Diameter (in.): 7.25 HSA	Date Started: 08/19/2024	Date Finished: 08/19/2024

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST (SPT)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				6.2				23	GC		CLAYEY GRAVEL WITH SAND (GC), 61% fine to coarse gravel, 16% fine to coarse grained sand, 23% fines, low palsticity, moist, no cementation, weak reaction to HCl	2.5	

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California

Operation Types: Hand Auger, ODEX, Auger Hollow Stem, Bullnose, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 230211

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-15

Fig. 15

230211 FINAL LOGS MO 12.6.24.GPJ ` 12-6-24 ` G. Lopez ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Whiteriver Indian Hospital			
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: C-1		Driller: Resilient	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 2.5 HQ3	Date Started: 10/23/2024	Date Finished: 10/23/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
													SANDY LEAN CLAY (CL), firm, low to medium plasticity, dark brown, slightly moist, no cementation, strong reaction to HCl		
						2-5-12									
5						9-12-14							Reddish brown, weakly cemented		
10						9-11-16							LEAN CLAY WITH SAND (CL), firm, high plasticity, reddish brown, slightly moist, no cementation, no reaction to HCl	10	
													Auger refusal @ 15.0 feet, switched to rock coring	12	
15			96.7	72.5									VESICULAR BASALT, IGNEOUS, extremely weak, highly weathered, dark gray, fine to medium grained, highly vesicular Auger refusal at 15 feet on VESICULAR BASALT, Switched from HSA to Core Barrel	15	
													VESICULAR BASALT, igneous, dark gray, aphanitic, highly to moderately weathered, medium strong, joint, highly fractured, open aperture, clay infill, partially filled, JRC= 18-20, highly vesicular		
20			100	92.5									Aphanitic, slightly to moderately weathered, strong, moderately fractured, joint, clay and calcite infill, partially filled, JRC= 12-14, moderately vesicular		
25			100	84									BASALT, IGNEOUS, dark gray, aphanitic, slightly weathered to unweathered, very strong, joint, moderately fractured, open to tight aperture, clay infill, filled, JRC= 10-12		

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-1** | Fig. 16

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital			
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: C-1		Driller: Resilient	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 2.5 HQ3	Date Started: 10/23/2024	Date Finished: 10/23/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
30			100	100									Slightly weathered, very strong, joint, slightly fractured, tight aperture, clay infill, filled, JRC= 4-6		
35														35	

Bottom of core @ 35.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Continuous Core, Shelby, Vane Shear, Bulk Sample, California, Cone Penetrometer, Grab Sample, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Mud Rotary, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

230211	atek ENGINEERING CONSULTANTS	**LOG OF EXPLORATORY BORING C-1**	Fig. 16

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital

Borehole Location: See Location Plan | Sheet 1 of 2

Borehole Number: C-2 | Driller: Resilient | Logger: Antonio Lopez

Drilling Equipment: CME-75 | Borehole Diameter (in.): 2.5 HQ3 | Date Started: 10/22/2024 | Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
5													SILTY CLAY (CL-ML), firm, low plasticity, reddish brown, slightly moist, weakly cemented, weak reaction to HCl		
10													Moist, no cementation, no reaction to HCl	12	
15			97	75									VESICULAR BASALT, IGNEOUS, extremely weak, highly weathered, dark gray, fine to medium grained, highly vesicular Auger refusal at 15 feet on VESICULAR BASALT, Switched from HSA to Core Barrel	15	
20			100	100									VESICULAR BASALT, igneous, dark gray, aphanitic, moderately weathered, medium strong, joint, moderately fractured, open aperture, clay infill, filled, JRC= 14-16, moderately vesicular Aphanitic, slightly to moderately weathered, strong, joint, moderately fractured, tight aperture, clay and calcite infill, filled, JRC= 4-6, moderately vesicular		
25			100	100									BASALT, igneous, dark gray, aphanitic, slightly weathered, strong, joint, slightly fractured, tight aperture, unknown infill, JRC= 12-14		

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-2** | Fig. 17

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital

Borehole Location: See Location Plan | Sheet 2 of 2

Borehole Number: C-2 | Driller: Resilient | Logger: Antonio Lopez

Drilling Equipment: CME-75 | Borehole Diameter (in.): 2.5 HQ3 | Date Started: 10/22/2024 | Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
30			95	95									Clay and Calcite infill, partially filled, JRC= 12-14		
35			98	88									Moderately fractured, tight aperture, clay and calcite infill, partially filled JRC= 6-8		
40														40	

Bottom of core @ 40.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Continuous Core, Shelby, Vane Shear, Bulk Sample, California, Cone Penetrometer, Grab Sample, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Mud Rotary, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-2** | Fig. 17

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital			
Borehole Location: See Location Plan			Sheet 1 of 3
Borehole Number: C-3		Driller: Resilient	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 2.5 HQ3	Date Started: 10/22/2024	Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
													SANDY LEAN CLAY (CL), firm, medium plasticity, brown, slightly moist, weakly cemented, moderate reaction to HCl		
5															
10														10	
													Auger grinding @ 10.0 feet CLAYEY SAND WITH GRAVEL (SC), subangular-angular gravel, hard, low plasticity, brown, slightly moist, strongly cemented, strong reaction to HCl		
15														15	
													VESICULAR BASALT, IGNEOUS, extremely weak, highly weathered, dark gray, fine to medium grained, highly vesicular Heavy auger grinding @ 17.0 feet		
20			98	91.6									Auger refusal at 20 feet on VESICULAR BASALT, Switched from HSA to Core Barrel	20	
													VESICULAR BASALT, igneous, dark gray, aphanitic, slightly weathered, medium strong, joint, slightly fractured, open aperture, calcite and coarse sand infill, filled, JRC= 12-14, moderately to slightly vesicular		
25			95.8	95.8									BASALT, igneous, dark gray, aphanitic, slightly weathered to unweathered, strong, joint, slightly fractured, wide aperture, calcite infill, filled, JRC= 4-6		

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-3** | Fig. 18

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital

Borehole Location: See Location Plan | Sheet 2 of 3

Borehole Number: C-3 | Driller: Resilient | Logger: Antonio Lopez

Drilling Equipment: CME-75 | Borehole Diameter (in.): 2.5 HQ3 | Date Started: 10/22/2024 | Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
30			100	100									Unweathered, strong, joint, slightly fractured, tight aperture, calcite infill, filled, JRC= 4-6		
35			100	92									Very strong, unfractured, tight aperture, unknown infill filled, JRC= 12-14, moderately to slightly vesicular		
40			98.3	98.3											
45			100	92									VESICULAR BASALT, igneous, dark gray, aphanitic, moderately weathered, medium strong, joint, highly fractured, open aperture, clay infill, filled, JRC= 12-14, highly vesicular		
50			100	94									Unweathered to slightly weathered, very strong, joint, moderately fractured, open aperture, clay infill, filled, moderately vesicular		
55			100	100									BASALT, igneous, dark gray, aphanitic, slightly		

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-3** | Fig. 18

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital			
Borehole Location: See Location Plan			Sheet 3 of 3
Borehole Number: C-3		Driller: Resilient	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 2.5 HQ3	Date Started: 10/22/2024	Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
60													weathered to unweathered, very strong, joint, unfractured, tight aperture, clay infill, filled	60	

Bottom of core @ 60.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Continuous Core, Shelby, Vane Shear, Bulk Sample, California, Cone Penetrometer, Grab Sample, Test Pit

Operation Types: Auger, Air Rotary, Core Barrel, Mud Rotary, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211	atek ENGINEERING CONSULTANTS	**LOG OF EXPLORATORY BORING C-3**	Fig. 18

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital			
Borehole Location: See Location Plan			Sheet 1 of 3
Borehole Number: C-4		Driller: Resilient	Logger: Antonio Lopez
Drilling Equipment: CME-75	Borehole Diameter (in.): 2.5 HQ3	Date Started: 10/22/2024	Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
													SANDY LEAN CLAY (CL), 1% fine graded gravel, 5% fine to coarse grained sand, 94% fines, firm, medium plasticity, red, moist, no cementation, no reaction to HCl		
													Weakly cemented		
5															
													Andesite gravel layer @ 7.5 feet		
10													Auger grinding @ 9.5 feet	10	
													SILTY SAND WITH GRAVEL (SM), subangular gravel, dense, nonplastic, pale red, slightly moist, strongly cemented, strong reaction to HCl		
15														15	
													LEAN CLAY WITH SAND (CL), moderately firm, medium to high plasticity, red, moist, no cementation, no reaction to HCl		
20														20	
													FAT CLAY (CH), firm, high plasticity, red, moist, no cementation, no reaction to HCl		
25															

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

	While Drilling	Upon Completion of Drilling		
	▽ N/A ft	▼ N/A ft		
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-4** | Fig. 19

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital

Borehole Location: See Location Plan | Sheet 2 of 3

Borehole Number: C-4 | Driller: Resilient | Logger: Antonio Lopez

Drilling Equipment: CME-75 | Borehole Diameter (in.): 2.5 HQ3 | Date Started: 10/22/2024 | Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
30													SANDY LEAN CLAY (CL), firm, low plasticity, red, moist, no cementation, weak reaction to HCl	30	
													VESICULAR BASALT, igneous, dark gray, aphanitic, extremely weak, highly weathered, highly vesicular	32	
35			18	6									Auger refusal at 20 feet on VESICULAR BASALT, Switched from HSA to Core Barrel	35	
													VESICULAR BASALT, igneous, dark gray, aphanitic, highly weathered, extremely weak, highly vesicular		
40			100	91.7									Slightly weathered, strong, joint, slightly fractured, tight aperture, clay infill, partially filled, slightly vesicular		
45			95.8	95.8									BASALT, igneous, dark gray, aphanitic, slightly weathered to unweathered, strong, joint, slightly fractured, tight aperture, clay infill, filled		
50			92.5	85									Very strong		
55			90	70									Highly weathered, moderately vesicular VESICULAR BASALT, igneous, dark gray,		

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | LOG OF EXPLORATORY BORING C-4 | Fig. 19

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

Project Name: Whiteriver Indian Hospital

Borehole Location: See Location Plan | Sheet 3 of 3

Borehole Number: C-4 | Driller: Resilient | Logger: Antonio Lopez

Drilling Equipment: CME-75 | Borehole Diameter (in.): 2.5 HQ3 | Date Started: 10/22/2024 | Date Finished: 10/22/2024

Elevation and Datum: Ground:

Notes:

DEPTH (ft)	DRILL OPERATION	CORE RUN NUMBER	CORE RECOVERY (%)	ROCK QUALITY DESIGNATION (RQD)	SAMPLE	STANDARD PENETRATION TEST SPT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
60			100	100									aphanitic, weak, highly to moderately weathered, highly vesicular Strong, slightly weathered, highly vesicular, calcite infill, filled	65	
65															

Bottom of core @ 65.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Continuous Core; Shelby; Vane Shear; Bulk Sample; California; Cone Penetrometer; Grab Sample; Test Pit

Operation Types: Auger; Air Rotary; Core Barrel; Mud Rotary; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

230211 | atek ENGINEERING CONSULTANTS | **LOG OF EXPLORATORY BORING C-4** | Fig. 19

230211 FINAL CORE LOGS ALE.GPJ ` 12-5-24 ` M Mendoza ` ATEK CORE (W/REMARKS-SH# & SAME FIG#) `

Revised 7-10-12 (MAT)

APPENDIX D
Laboratory Test

atek
ENGINEERING CONSULTANTS

APPENDIX D
LABORATORY TESTING

LABORATORY TESTS
Laboratory tests were performed on selected samples to aid in soil classification and to evaluate physical properties of the soils, which may affect the Geotechnical aspects of project design and construction. A description of the laboratory testing program is presented below.

Sieve Analysis
Sieve analyses were performed to evaluate the gradation characteristics of the material and to aid in soil classification. Tests were performed in general accordance with ASTM Test Method C 136 and D 2487.

Atterberg Limits
Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Tests were performed in general accordance with ASTM Test Method D 4318.

Moisture Content
Moisture content tests were performed to evaluate moisture-conditioning requirements during site preparation and earthwork grading. Moisture content was evaluated in general accordance with ASTM Test Method D 2216.

Hydrometer
Hydrometer tests were performed to evaluate the gradation characteristics of the material and to aid in fine material content. Tests were performed in general accordance with ASTM Test Method D 422.

One-Dimensional Consolidation
A one-dimensional consolidation test was performed on a ring samples to evaluate consolidation potential of the site soil. Test procedure was in general accordance with ASTM Test Method D 2435.

Standard Proctor
Standard Proctor tests were performed on bulk soil samples to evaluate the maximum dry density and optimum moisture of the site soils. Test procedures were in general accordance with ASTM Test Method D 698A.

Swell Test
Swell test was performed on bulk soil samples to evaluate the expansion potential of the site soils. Test procedures were in general accordance with ASTM Test Method D 4829.

Undisturbed Ring Density
Undisturbed ring density tests were performed on ring samples to evaluate the in-situ density and moisture content of the site soils. Test procedures were in general accordance with ASTM Test Method D 2937.

pH and Resistivity
pH and resistivity tests were performed on the bulk soil sample to evaluate the site soil corrosion potential. Test procedure was in general accordance with Arizona Test Method 236.

Sulfate Content
Sulfate content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 733.

Chloride Content
Chloride content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 736.

atek
ENGINEERING CONSULTANTS

PROJECT:	Whiteriver Indian Hospital	**PROJECT NO:**	240211
LOCATION:	Whiteriver, AZ	**WORK ORDER NO:**	2400232
DATE SAMPLED:	8/21/2024	**REVIEWED BY:**	A Lopez

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

					COBBLES	GRAVEL									SAND								Silt or Clay	
							Coarse					Fine				Coarse		Medium			Fine				
Location & Depth	**USCS**	**LL**	**PL**	**PI**	**6"**	**4"**	**3"**	**2"**	**1 1/2"**	**1 1/4"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**1/4"**	**#4**	**#8**	**#10**	**#16**	**#30**	**#40**	**#50**	**#100**	**#200**	**Lab #**

PERCENT PASSING BY WEIGHT

Bulk, PR-1 @ 1.0'-5.0'	NT	NT	NT	NT	100	100	100	100	100	100	100	100	100	100	100	100	99	99	99	99	99	99	98	92	1
Bulk, B-1 @ 1.0'-5.0'	CL-ML	25	19	6	100	100	100	100	100	100	99	99	99	99	99	99	99	98	98	98	97	96	95	91	2
Bulk, B-2 @ 1.0'-5.0'	CL	37	24	13	100	100	100	100	100	100	100	99	97	94	84	73	69	68	66	62	60	58	54	52	7
Ring, B-4 @ 10.0'-11.0'	CH	50	18	32	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	97	31
SPT, B-7 @ 15.0'-16.5'	CL	33	19	14	100	100	100	100	100	100	100	100	100	99	99	99	98	98	97	96	96	95	93	88	53
Bulk, B-9 @ 1.0'-5.0'	CL	36	18	18	100	100	100	100	100	100	100	100	100	100	100	96	96	96	95	95	95	95	94	93	69
Bulk, B-10 @ 1.0'-5.0'	GC	29	13	16	100	100	100	100	100	100	99	96	92	87	68	57	55	54	54	53	52	50	47	43	76
Bulk, B-12 @ 1.0'-5.0'	CL	29	15	14	100	100	100	100	100	100	99	97	93	89	83	79	76	76	74	71	70	69	67	64	82
Hand, B-15 @ 0.0'-2.5'	NT	NT	NT	NT	100	100	100	87	81	75	67	58	49	46	41	39	35	34	32	29	28	27	25	23	98

This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

111 South Weber Drive, Suite1
Chandler, AZ 85226

www.atekec.com

p 480.659.8065
f 480.656.9658

atek ENGINEERING CONSULTANTS

PROJECT: Whiteriver Indian Hospital
LOCATION: Whiteriver, AZ
SAMPLE DATE: 8/21/2024

PROJECT: 230211
WORK ORDER: 2400232
REVIEWED BY: A Lopez

MOISTURE CONTENT OF SOIL -- ASTM D 2216

LAB #	SAMPLE SOURCE	MOISTURE		
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT
1	Bulk, PR-1 @ 1.0'-5.0'	464.2	399.1	16.3%
2	Bulk, B-1 @ 1.0'-5.0'	540.9	504.7	7.2%
7	Bulk, B-2 @ 1.0'-5.0'	333.6	324.6	2.8%
17	Bulk, B-3 @ 1.0'-5.0'	319.3	292.5	9.2%
31	Ring, B-4 @ 10.0'-11.0'	268.1	257.8	4.0%
38	Bulk, B-6 @ 1.0'-5.0'	301.3	274.2	9.9%
53	SPT, B-7 @ 15.0'-16.5'	247.0	234.7	5.2%
69	Bulk, B-9 @ 1.0'-5.0'	468.2	428.0	9.4%
76	Bulk, B-10 @ 1.0'-5.0'	410.0	389.3	5.3%
82	Bulk, B-12 @ 1.0'-5.0'	573.6	524.8	9.3%
91	Bulk, B-14 @ 10.0'-15.0'	332.0	311.3	6.6%
98	Hand, B-15 @ 0.0'-2.5'	540.5	509.0	6.2%

atek
ENGINEERING CONSULTANTS

PROJECT NAME:	Whiteriver Indian Hospital	**PROJECT:**	230211
LOCATION:	Whitriver, AZ	**WORK ORDER:**	2400232
SAMPLE DATE:	8/21/2024	**REVIEWED BY:**	A Lopez
SAMPLE SOURCE:	Hand, B-15 @ 0.0'-2.5'		

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D422)

WEIGHT OF SAMPLE DISPERSED	54.38
PERCENT PASSING #10 SIEVE	34.45
SPECIFIC GRAVITY OF SOLIDS	2.552

HYDROMETER RESULTS (% PASSING)

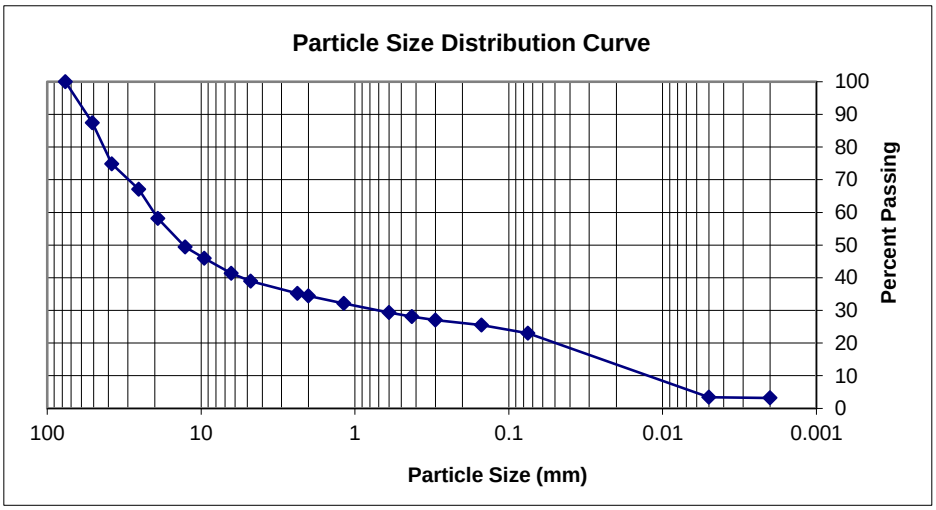
PARTICLE SIZE (DIA. mm)	0.0709	0.0515	0.0334	0.0201	0.0143	0.0102	0.0021	0.0015
PERCENT SAMPLE TESTED	43.0	35.5	28.0	14.9	13.0	11.1	9.2	9.3
PERCENT TOTAL SAMPLE	14.8	12.2	9.6	5.1	4.5	3.8	3.2	3.2

FULL SIEVE ANALYSIS
MECHANICAL SIEVE & HYDROMETER
(% PASSING)

3 IN	100.0
2 IN	87.4
1 1/2 IN	74.8
1 IN	67.1
3/4 IN	58.1
1/2 IN	49.4
3/8 IN	45.9
1/4 IN	41.4
# 4	38.9
# 8	35.2
# 10	34.5
# 16	32.2
# 30	29.3
# 40	28.1
# 50	27.1
# 100	25.5
# 200	23.0
0.005 mm	3.4
0.002 mm	3.2

MECHANICAL SIEVE ANALYSIS AFTER HYDROMETER (% PASSING)

#200	#100	#50	#40	#30	#16	#10
21.1	23.8	25.6	26.8	28.4	31.8	34.5



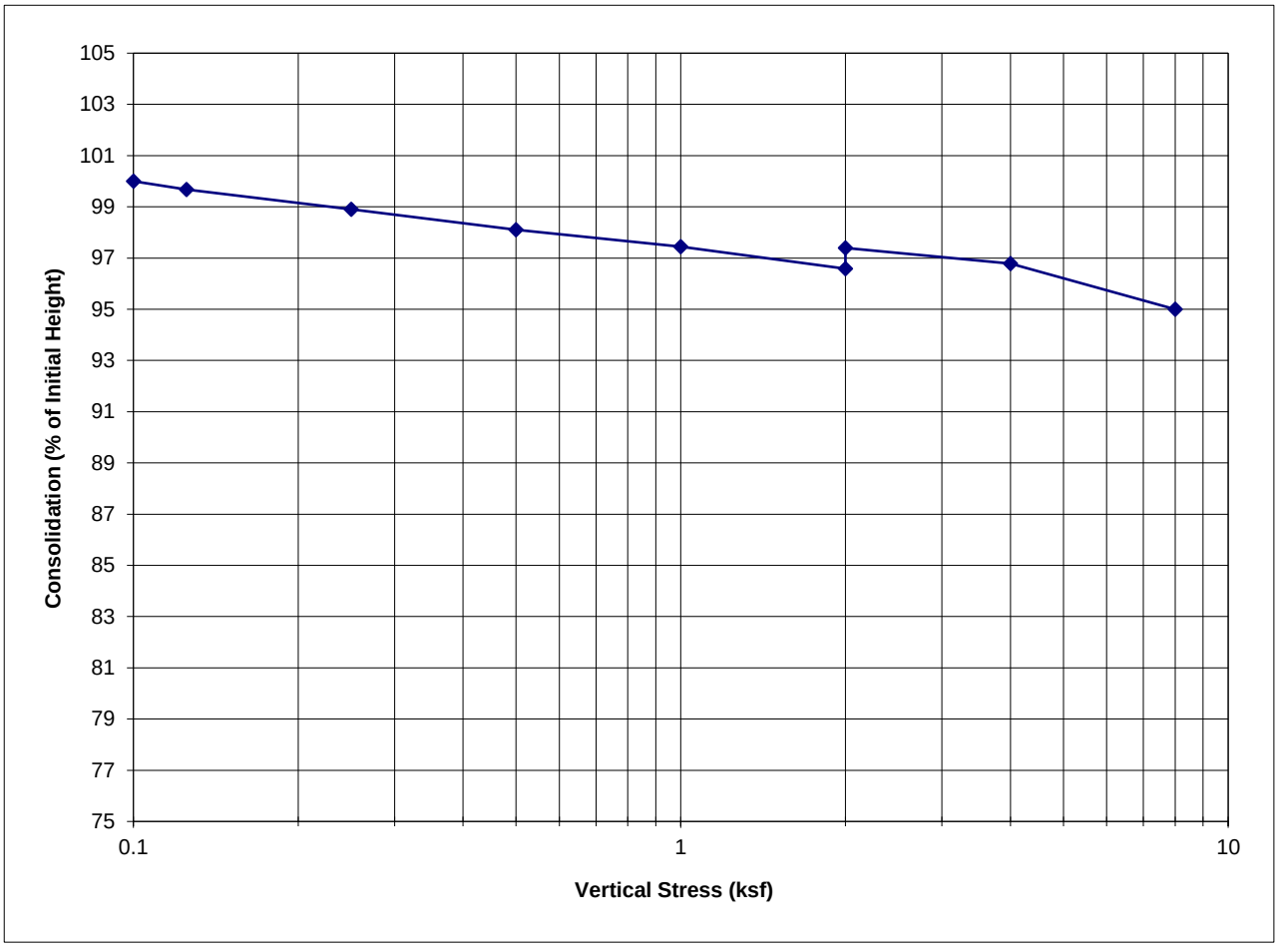
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Whiteriver Indian Hospital	**Project Number:**	230211
Project Location:	Whiteriver, AZ	**Work Order Number:**	2400232
Client:	Mabbet and Associates, Inc.	**Lab Number:**	4
Material:	Native	**Date Sampled:**	08/21/24
Sample Source:	Ring Sample B-1 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.37
Initial Moisture Content	15.0%	Final Moisture Content	19.2%
Initial Dry Density(pcf)	104.2	Final Dry Density(pcf)	109.6
Initial Degree of Saturation	68%	Final Degree of Saturation	100%
Initial Void Ratio	0.59	Final Void Ratio	0.51
Estimated Specific Gravity	2.65	Saturated at	2 ksf



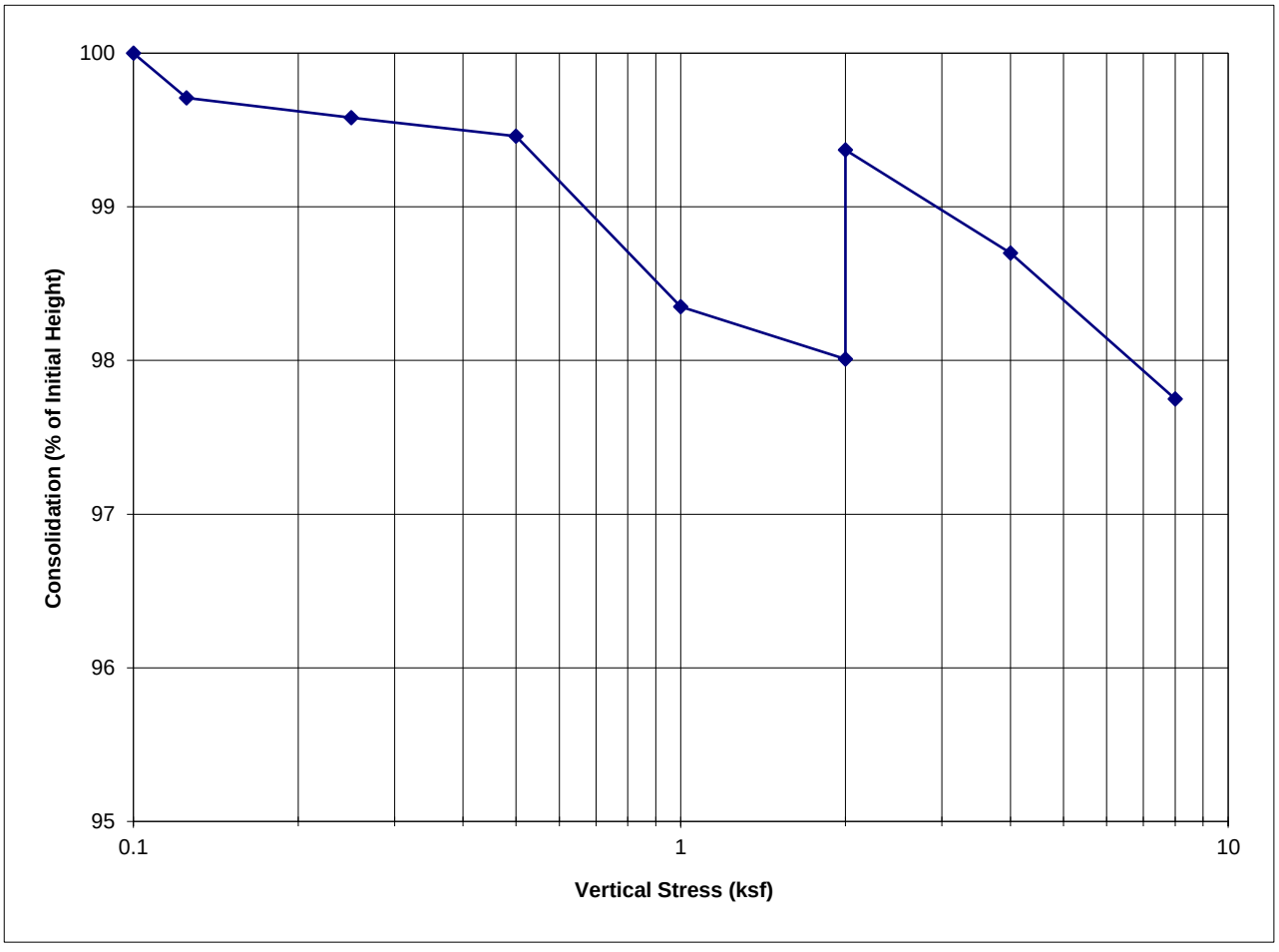
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Whiteriver Indian Hospital	**Project Number:**	230211
Project Location:	Whiteriver, AZ	**Work Order Number:**	2400232
Client:	Mabbet and Associates, Inc.	**Lab Number:**	19
Material:	Native	**Date Sampled:**	08/21/24
Sample Source:	Ring Sample B-3 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.50
Initial Moisture Content	12.0%	Final Moisture Content	16.4%
Initial Dry Density(pcf)	112.6	Final Dry Density(pcf)	115.1
Initial Degree of Saturation	68%	Final Degree of Saturation	100%
Initial Void Ratio	0.47	Final Void Ratio	0.44
Estimated Specific Gravity	2.65	Saturated at	2 ksf



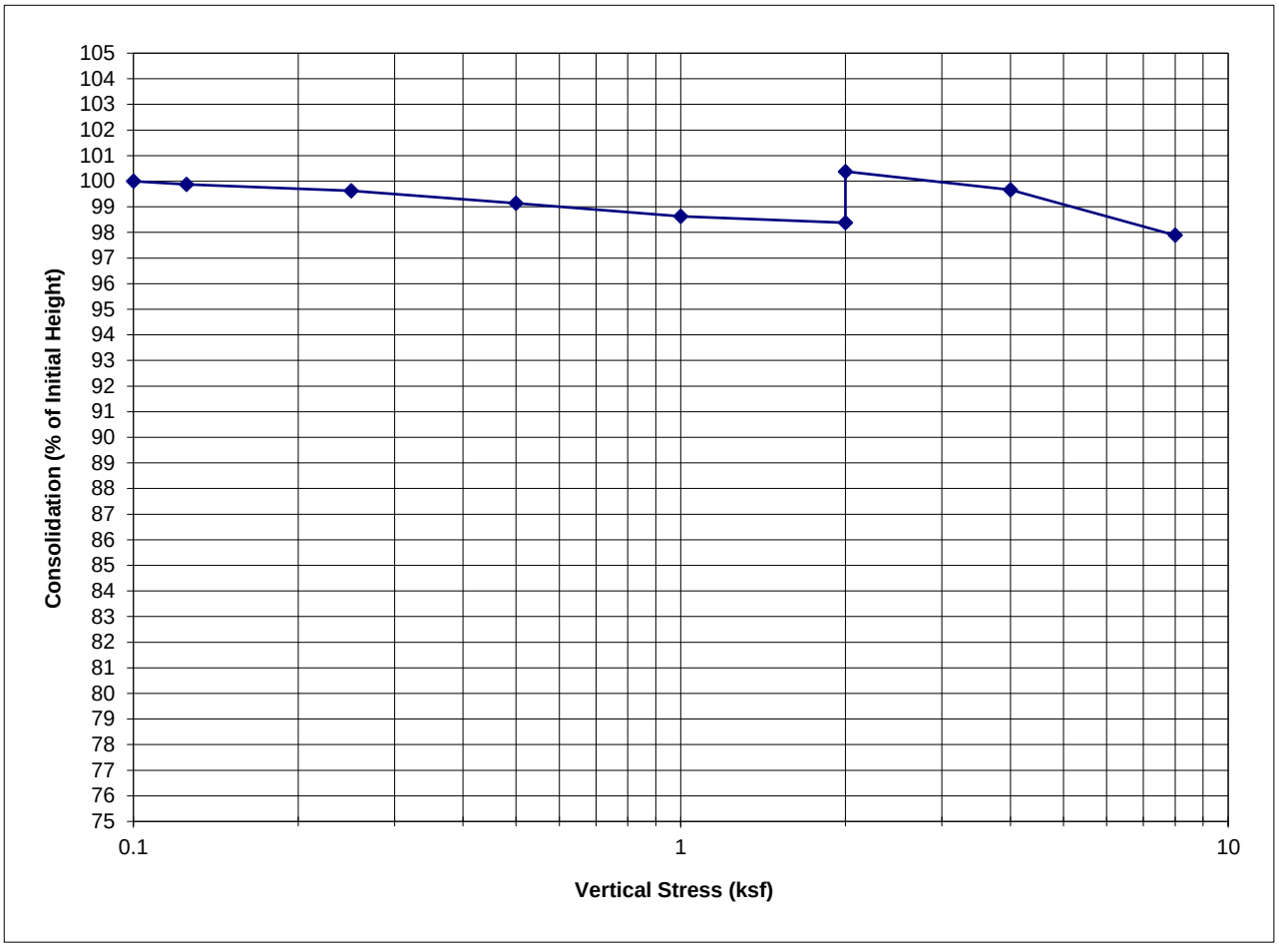
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Whiteriver Indian Hospital	**Project Number:**	230211
Project Location:	Whiteriver, AZ	**Work Order Number:**	2400232
Client:	Mabbet and Associates, Inc.	**Lab Number:**	34
Material:	Native	**Date Sampled:**	08/21/24
Sample Source:	Ring Sample B-5 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.51
Initial Moisture Content	14.0%	Final Moisture Content	23.1%
Initial Dry Density(pcf)	100.4	Final Dry Density(pcf)	102.6
Initial Degree of Saturation	57%	Final Degree of Saturation	100%
Initial Void Ratio	0.65	Final Void Ratio	0.61
Estimated Specific Gravity	2.65	Saturated at	2 ksf



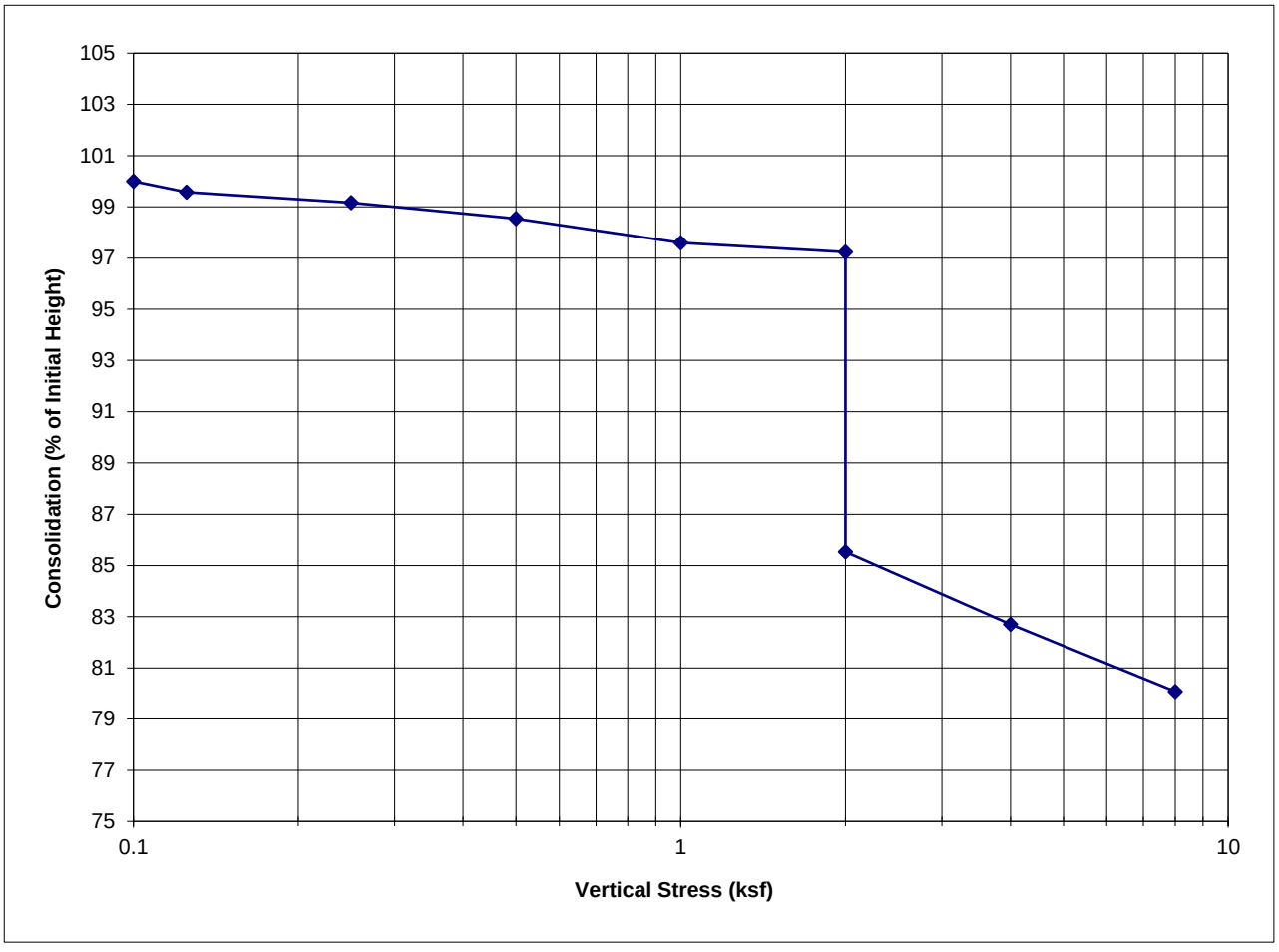
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Whiteriver Indian Hospital	**Project Number:**	230211
Project Location:	Whiteriver, AZ	**Work Order Number:**	2400232
Client:	Mabbet and Associates, Inc.	**Lab Number:**	51
Material:	Native	**Date Sampled:**	08/21/24
Sample Source:	Ring Sample B-7 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	3.69
Initial Moisture Content	13.2%	Final Moisture Content	27.0%
Initial Dry Density(pcf)	77.3	Final Dry Density(pcf)	96.5
Initial Degree of Saturation	31%	Final Degree of Saturation	100%
Initial Void Ratio	1.14	Final Void Ratio	0.71
Estimated Specific Gravity	2.65	Saturated at	2 ksf
		Hydro Collapse Potential	11.69%



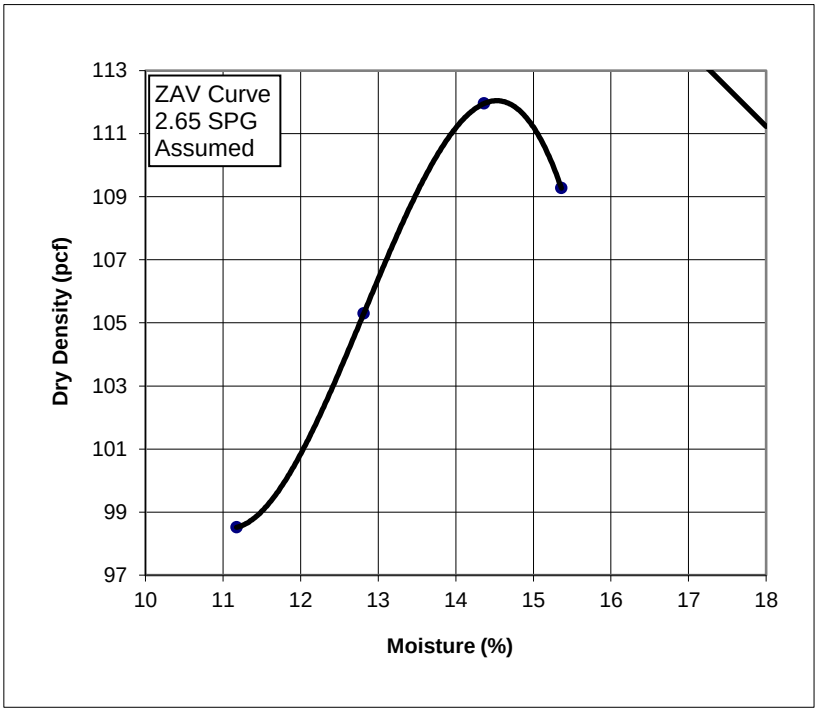
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek ENGINEERING CONSULTANTS

PROJECT:	Whiteriver Indian Hospital	**PROJECT NO:**	230211
LOCATION:	Whiteriver, AZ	**WORK ORDER NO:**	2400232
MATERIAL:	Native	**LAB NO:**	17
SAMPLE SOURCE:	Bulk, B-3 @ 1.0'-5.0'	**SAMPLE DATE:**	8/21/2024

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)
Maximum dry density:	112.0	1795
Optimum moisture (%):	14.5	14.5



SIEVE SIZE	PERCENT PASSING
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	98
3/8 in / 9.5 mm	98
1/4 in / 6.4 mm	96
#4, 4.75mm	94
#8, 2.36mm	93
#10, 2.00mm	93
#16, 1.18mm	92
#30, 0.60mm	90
#40, .425mm	90
#50, .300mm	89
#100, .150mm	85
#200, .075mm	81

LL:	39
PL:	15
PI:	24
USCS:	CL
AASHTO:	A-6(18)

NOTES:

AASHTO Description: Clayey soils

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.

Reviewed by: A Lopez

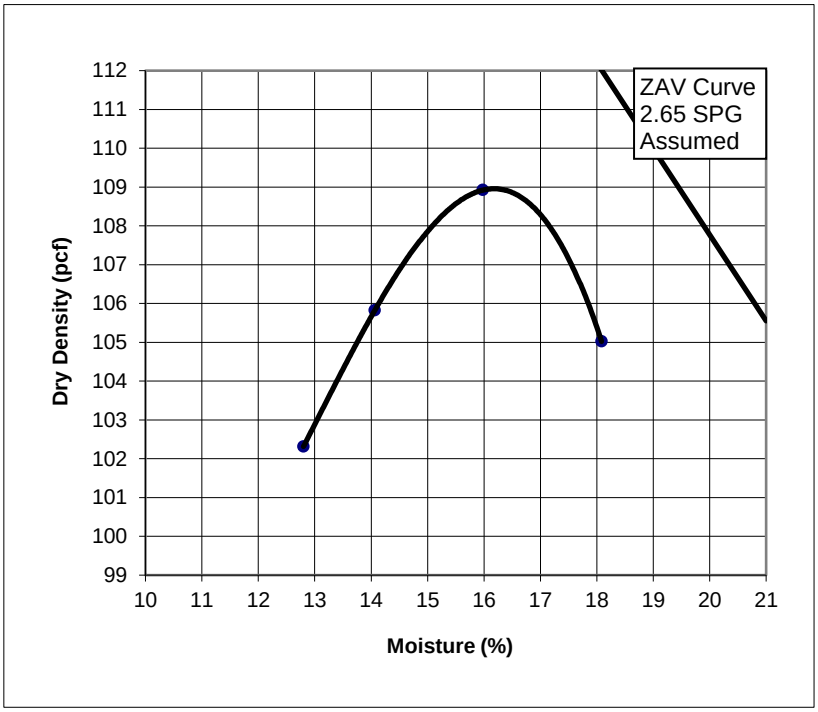
111 S. Weber Dr., Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek ENGINEERING CONSULTANTS

PROJECT:	Whiteriver Indian Hospital	**PROJECT NO:**	230211
LOCATION:	Whiteriver, AZ	**WORK ORDER NO:**	2400232
MATERIAL:	Native	**LAB NO:**	38
SAMPLE SOURCE:	Bulk, B-6 @ 1.0'-5.0'	**SAMPLE DATE:**	8/21/2024

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)
Maximum dry density:	109.0	1745
Optimum moisture (%):	16.2	16.2



SIEVE SIZE	PERCENT PASSING
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	100
1/2 in / 12.5 mm	100
3/8 in / 9.5 mm	100
1/4 in / 6.4 mm	100
#4, 4.75mm	99
#8, 2.36mm	98
#10, 2.00mm	98
#16, 1.18mm	98
#30, 0.60mm	98
#40, .425mm	97
#50, .300mm	97
#100, .150mm	97
#200, .075mm	94

LL:	36
PL:	15
PI:	21
USCS:	CL
AASHTO:	A-6(19)

NOTES:

AASHTO Description: Clayey soils

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.

Reviewed by: A Lopez

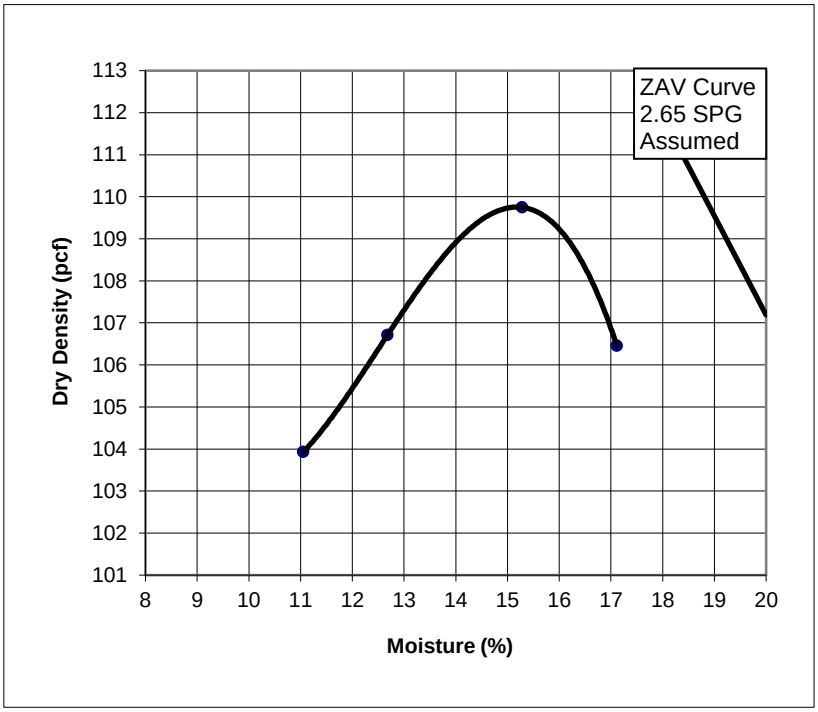
111 S. Weber Dr., Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek ENGINEERING CONSULTANTS

PROJECT:	Whiteriver Indian Hospital	**PROJECT NO:**	230211
LOCATION:	Whiteriver, AZ	**WORK ORDER NO:**	2400232
MATERIAL:	Native	**LAB NO:**	91
SAMPLE SOURCE:	Bulk, B-14 @ 1.0'-5.0'	**SAMPLE DATE:**	8/21/2024

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)
Maximum dry density:	109.8	1758
Optimum moisture (%):	15.2	15.2



SIEVE SIZE	PERCENT PASSING
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	100
1/2 in / 12.5 mm	100
3/8 in / 9.5 mm	100
1/4 in / 6.4 mm	100
#4, 4.75mm	100
#8, 2.36mm	99
#10, 2.00mm	99
#16, 1.18mm	99
#30, 0.60mm	97
#40, .425mm	95
#50, .300mm	94
#100, .150mm	89
#200, .075mm	80

LL:	30
PL:	24
PI:	6
USCS:	ML
AASHTO:	A-4(4)

NOTES:

AASHTO Description: Silty soils

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.

Reviewed by: A Lopez

111 S. Weber Dr., Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Whiteriver Indian Hospital	**Project Number:**	230211
Location:	Whiteriver, AZ	**Work Order Number:**	2400232
Client:	Mabbet and Assocaites, Inc.	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	08/21/24
Sample Source:	See Below		

Swell Potential of Soil ASTM D4546

Sample Number	Sample Source	Swell (%)	Target Compaction (%)	Actual Compaction (%)	Target Moisture (%)	Actual Moisture (%)
17	Bulk, B-3 @ 1.0'-5.0'	5.3	95.0	95.3	11.5	11.6
38	Bulk, B-6 @ 1.0'-5.0'	3.1	95.0	95.3	13.2	13.5

Note: Ring Samples were subjected to a 144 psf surcharge.

atek
ENGINEERING CONSULTANTS

PROJECT: Whiteriver Indian Hospital
LOCATION: Whiteriver, AZ
SAMPLE DATE: 8/21/2024

PROJECT: 230211
WORK ORDER: 2400232
REVIEWED BY: G. Lopez

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD -- ASTM D 2937

LAB #	SAMPLE SOURCE	MOISTURE			# OF RINGS	WET WEIGHT + RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT				
5	Ring, B-1 @ 10.0'-11.0'	854.2	726.6	17.6%	6	1126.6	272.4	100.3
11	Ring, B-2 @ 15.0'-16.0'	925.9	791.5	17.0%	6	1199.4	273.5	109.2
30	Ring, B-4 @ 5.0'-6.0'	786.9	724.5	8.6%	6	1054.5	267.6	100.0
39	Ring, B-6 @ 2.5'-3.5'	680.5	617.1	10.3%	5	901.1	220.6	102.2
70	Ring, B-9 @ 2.5'-3.5'	746.7	684.5	9.1%	6	1018.0	271.3	94.5
77	Ring, B-10 @ 2.5'-3.5'	692.3	586.8	18.0%	5	935.6	243.3	97.2
83	Ring, B-12 @ 2.5'-3.5'	839.1	761.9	10.1%	6	1095.8	256.7	105.2
90	Ring, B-14 @ 5.0'-6.0'	699.6	661.7	5.7%	6	966.4	266.8	91.3

atek
ENGINEERING CONSULTANTS

Project:	Whiteriver Indian Hospital	**Project Number:**	230211
Location:	Whiteriver, AZ	**Work Order Number:**	2400232
Client:	Mabbet and Associates, Inc.	**Lab Number:**	See Below
Material:	See Below	**Date Sampled:**	08/21/24
Sample Source:	See Below		

pH & Resistivity (AZ 236)

Sample Number	Sample Source	Resistivity (Ohm-cm)	pH
2	Bulk, B-1 @ 1.0'-5.0'	2,500	9.0
17	Bulk, B-3 @ 1.0'-5.0'	2,460	8.9
38	Bulk, B-6 @ 1.0'-5.0'	1,560	9.0

111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

MOTZZ LABORATORY, INC.

Report: 952476
Reported: 9/18/2024
Received: 9/13/2024
PO: 2400232

Laboratory Analysis Report

Atek Engineering Consultants
Antonio Lopez
111 South Weber Dr Suite 1
Chandler, AZ 85226

Project: 230211

Lab Number	Sample ID
952476-1	2) Bulk, B-1 (1.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	5	ppm
Chloride	ARIZ 736b	< 3	ppm

Lab Number	Sample ID
952476-2	17) Bulk, B-3 (1.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	6	ppm
Chloride	ARIZ 736b	18	ppm

Lab Number	Sample ID
952476-3	38) Bulk, B-6 (1.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	6	ppm
Chloride	ARIZ 736b	4	ppm

Lab Number	Sample ID
952476-4	69) Bulk, B-9 (1.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	5	ppm
Chloride	ARIZ 736b	< 3	ppm

Lab Number	Sample ID
952476-5	76) Bulk, B-10 (1.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	9	ppm
Chloride	ARIZ 736b	6	ppm

MOTZZ LABORATORY, INC.

Report: 952476
Reported: 9/18/2024
Received: 9/13/2024
PO: 2400232

Laboratory Analysis Report

Atek Engineering Consultants
Antonio Lopez
111 South Weber Dr Suite 1
Chandler, AZ 85226

Project: 230211

Lab Number	Sample ID	
952476-6	82) Bulk, B-12	(1.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	5	ppm
Chloride	ARIZ 736b	17	ppm

LABORATORY SERVICES REPORT

Report Number: 65191024.0031
Service Date: 09/24/24
Report Date: 09/24/24
Task:

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ 85282-6767
480-897-8200

Client

ATEK Engineering Consultants
Attn: Armando Ortega
111 S. Weber Dr., Ste. 1
Chandler, AZ 85226

Project

ATEK Engineering Consultants, LLC Annual Materials Testing
Terracon Tempe Lab
Tempe, AZ 85282

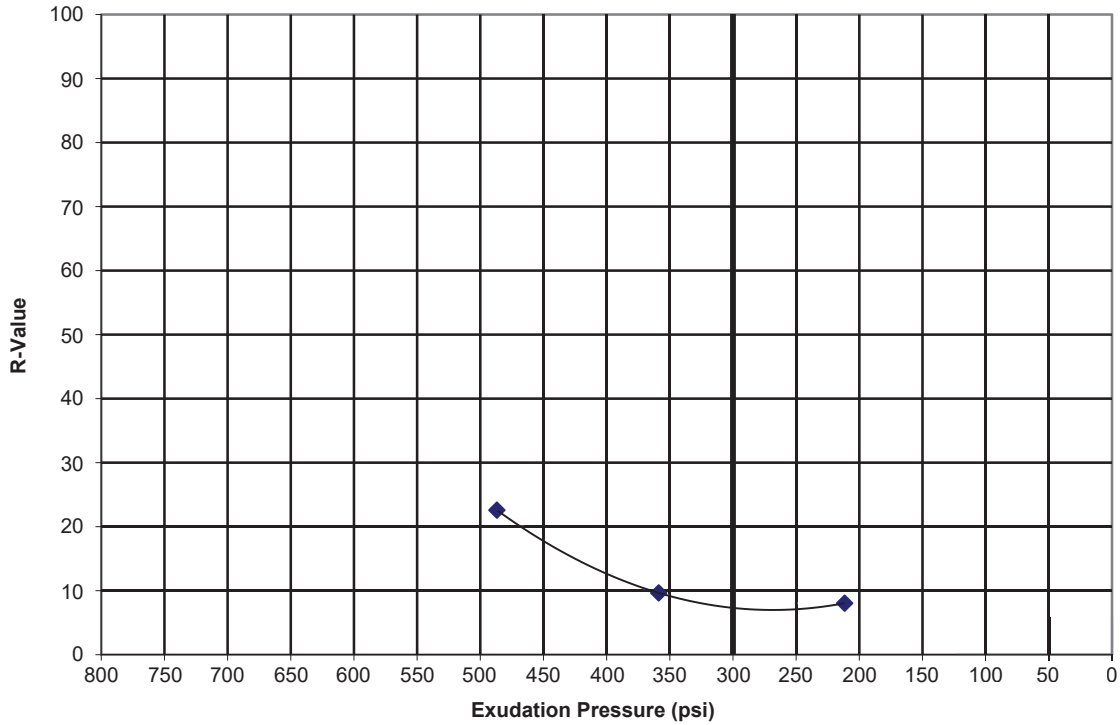
Project No. 65191024

Material Description: Silty Clay
Sample Location: B-12@1'-5'
Lab Number: 7239 Sample Source: Atek Project #230211

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	A	B	C
Moisture Content	18.3%	15.6%	14.2%
Compaction Pressure (psi)	*	75	125
Specimen Height (inches)	2.59	2.46	2.47
Dry Density (pcf)	110.9	116.2	120.6
Horiz. Pres. @ 1000lbs (psi)	63.0	59.0	47.0
Horiz. Pres. @ 2000lbs (psi)	140.0	138.0	117.0
Displacement	4.45	3.73	3.15
Expansion Pressure (psi)	0.0	0.0	0.1
Exudation Pressure (psi)	212	359	487
R Value	8.0	9.7	22.6

R-Value:
7



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

(1) ATEK Engineering Consultants, Lab

Reviewed By:

Iram Bencomo
Assistant Project Manager

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS AASHTO T236

PROJECT:	Atek On-Call Testing	**JOB NO:**	65191024
LOCATION:	Phoenix, AZ	**WORK ORDER NO:**	65191024.0031
MATERIAL:	Silty Clay	**LAB NO:**	B-4@10'-11'
SAMPLE SOURCE:	B-4 @10'-11'	**DATE SAMPLED:**	09/18/24

Sample Preparation: Insitu material, moisture and density. Specimens consolidated at normal load for 30 minutes prior to shear. Specimen Innundated

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**4000**
Dry mass (g):	124.23	120.97	122.17
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.42	2.42	2.42
Moisture, %:	18.0	19.8	18.6
Dry Density (pcf):	102.9	100.2	101.2
Saturation, %:	78	81	78
Void Ratio:	0.61	0.65	0.64

Pre- Shear Parameters of specimen:

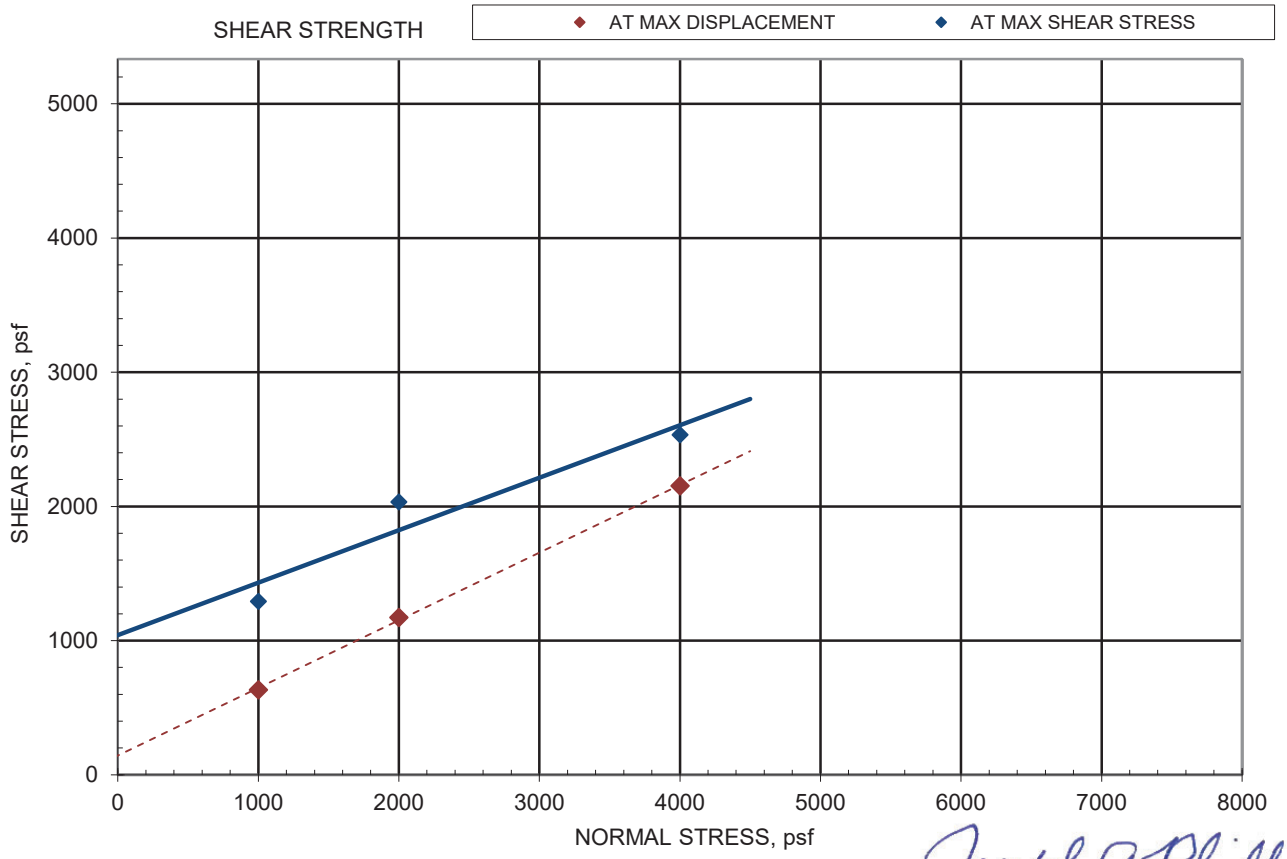
	Point 1	Point 2	Point 3
Normal Stress (psf):	**1000**	**2000**	**4000**
Dry mass (g):	124.23	120.97	122.17
Height (in):	0.941	0.9875	0.9744
Diameter (in):	2.42	2.42	2.42
Moisture, %:	19.4	23.8	22.4
Dry Density (pcf):	109.4	101.5	103.9
Saturation, %:	100	100	100
Void Ratio:	0.51	0.63	0.59

Normal Stress (psf):	1000	2000	4000
Maximum Shear Stress, (psf):	1292	2033	2535
Displacement at Maximum Shear, (in):	0.060	0.114	0.062
Shear Stress at Max Displacement, (psf)	634	1172	2153
Maximum Displacement, (in):	0.451	0.451	0.450
Rate of Deformation, in/min	0.003	0.003	0.003

	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**21**	**1041**
AT MAX DISPLACEMENT	27	144
Specs:		

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

SPECIFIC GRAVITY: Specific gravity assumed: 2.651

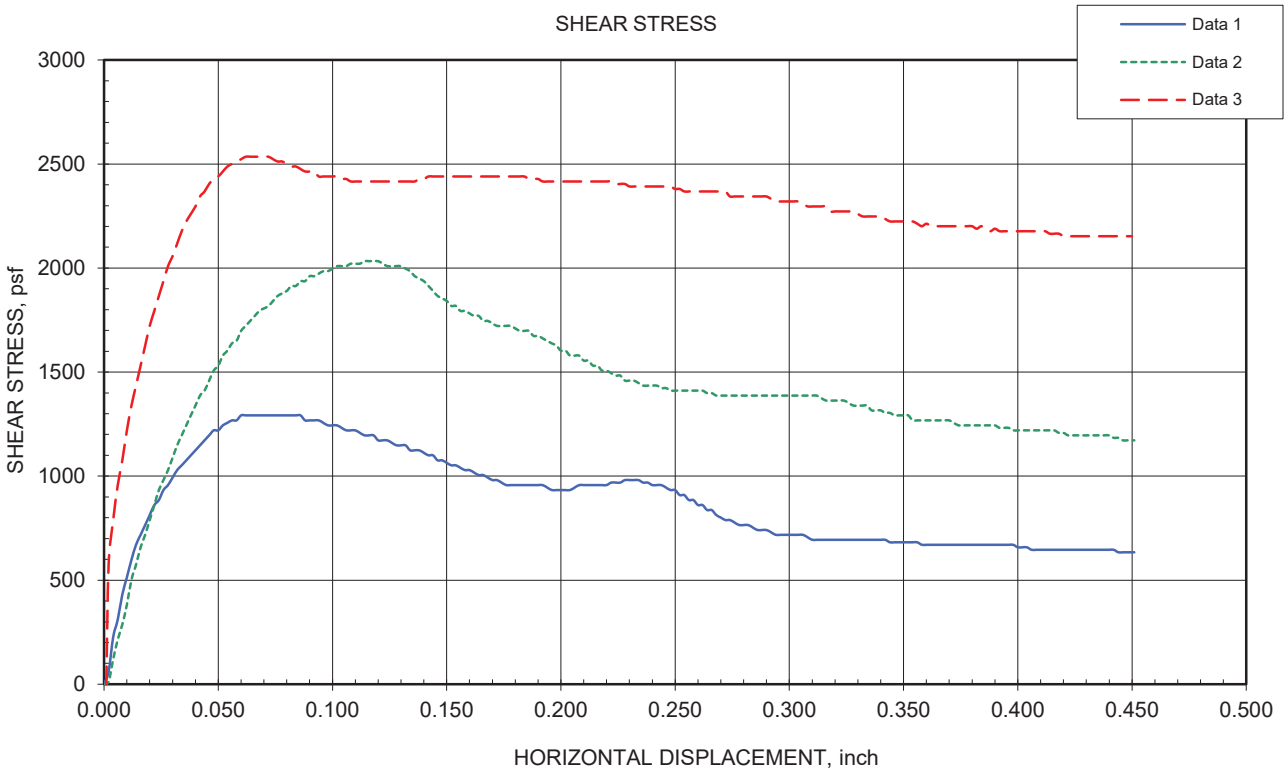


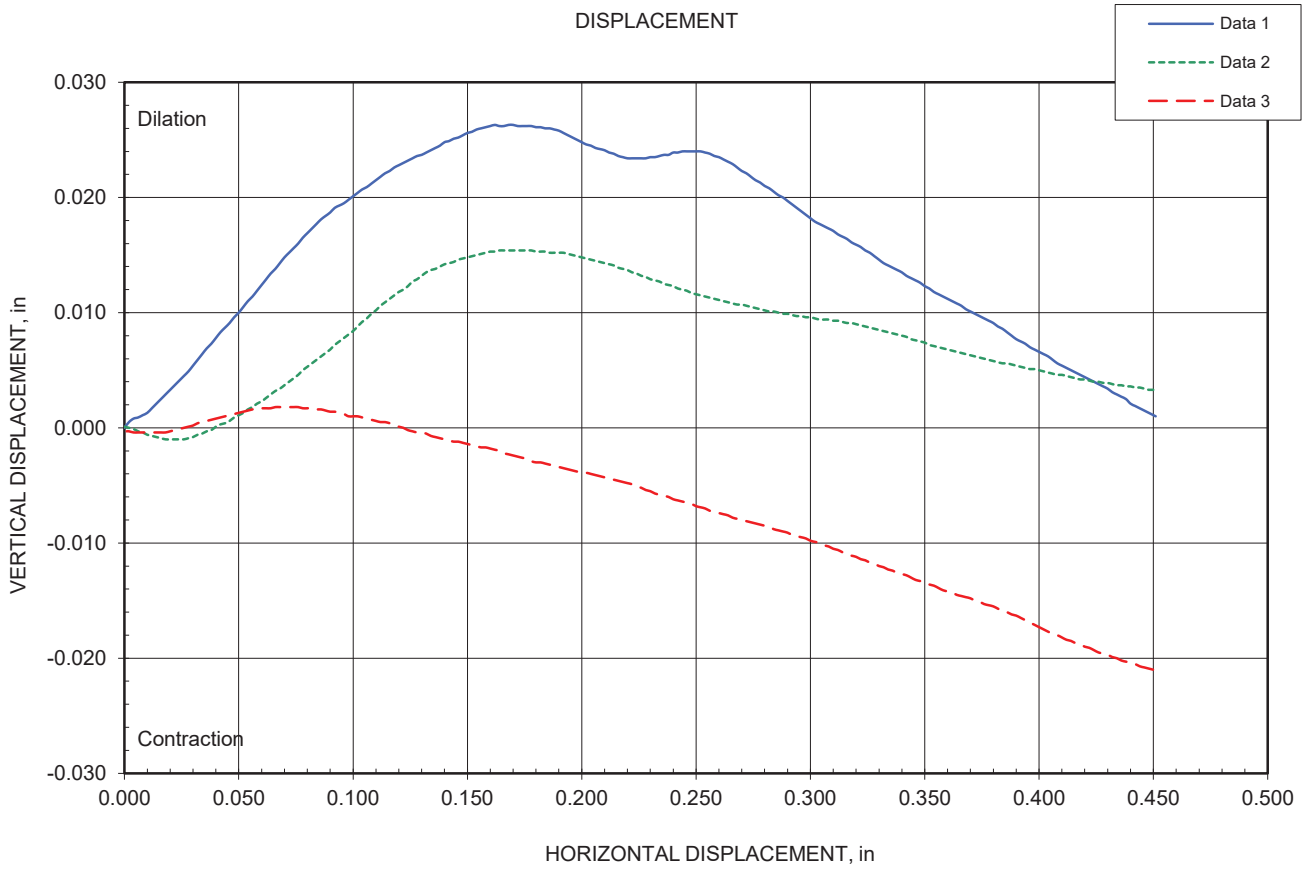
Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Reviewed By: Joseph A. Phillips

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS AASHTO T236

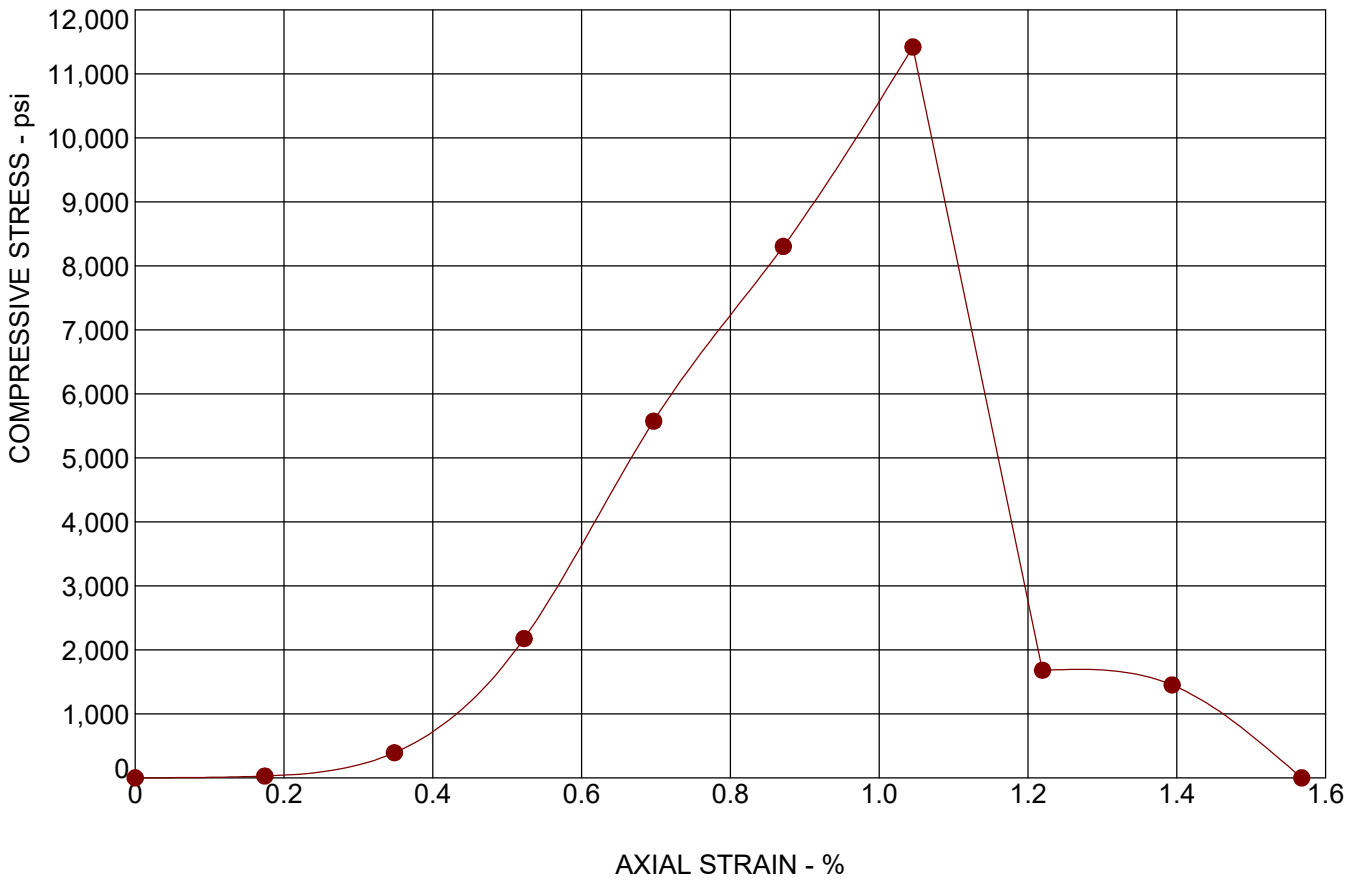
PROJECT:	Atek On-Call Testing	**JOB NO:**	65191024
LOCATION:	Phoenix, AZ	**WORK ORDER NO:**	65191024.0031
MATERIAL:	Silty Clay	**LAB NO:**	B-4@10'-11'
SAMPLE SOURCE:	B-4 @10'-11'	**DATE SAMPLED:**	9/18/24





UNCONFINED COMPRESSION TEST

ASTM D7012



SPECIMEN FAILURE PHOTOGRAPH

SPECIMEN TEST DATA

Moisture Content:	%	0.0
Dry Density:	pcf	165
Diameter:	in.	2.39
Height:	in.	5.74
Height / Diameter Ratio:		2.40
Calculated Saturation:	%	
Calculated Void Ratio:		
Assumed Specific Gravity:		
Failure Strain:	%	1.05
Unconfined Compressive Strength	(psi)	11420
Undrained Shear Strength:	(psi)	5710
Strain Rate:	in/min	
Remarks:		

SAMPLE TYPE: CORE

SAMPLE LOCATION: C-1 @ 25 - 26 feet

SAMPLE DESCRIPTION:

LL	PL	PI	Percent < #200 Sieve

PROJECT: ATEK Engineering Consultants

SITE: White River Indian Hospital
Whiteriver, Arizona

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

PROJECT NUMBER: 65191024

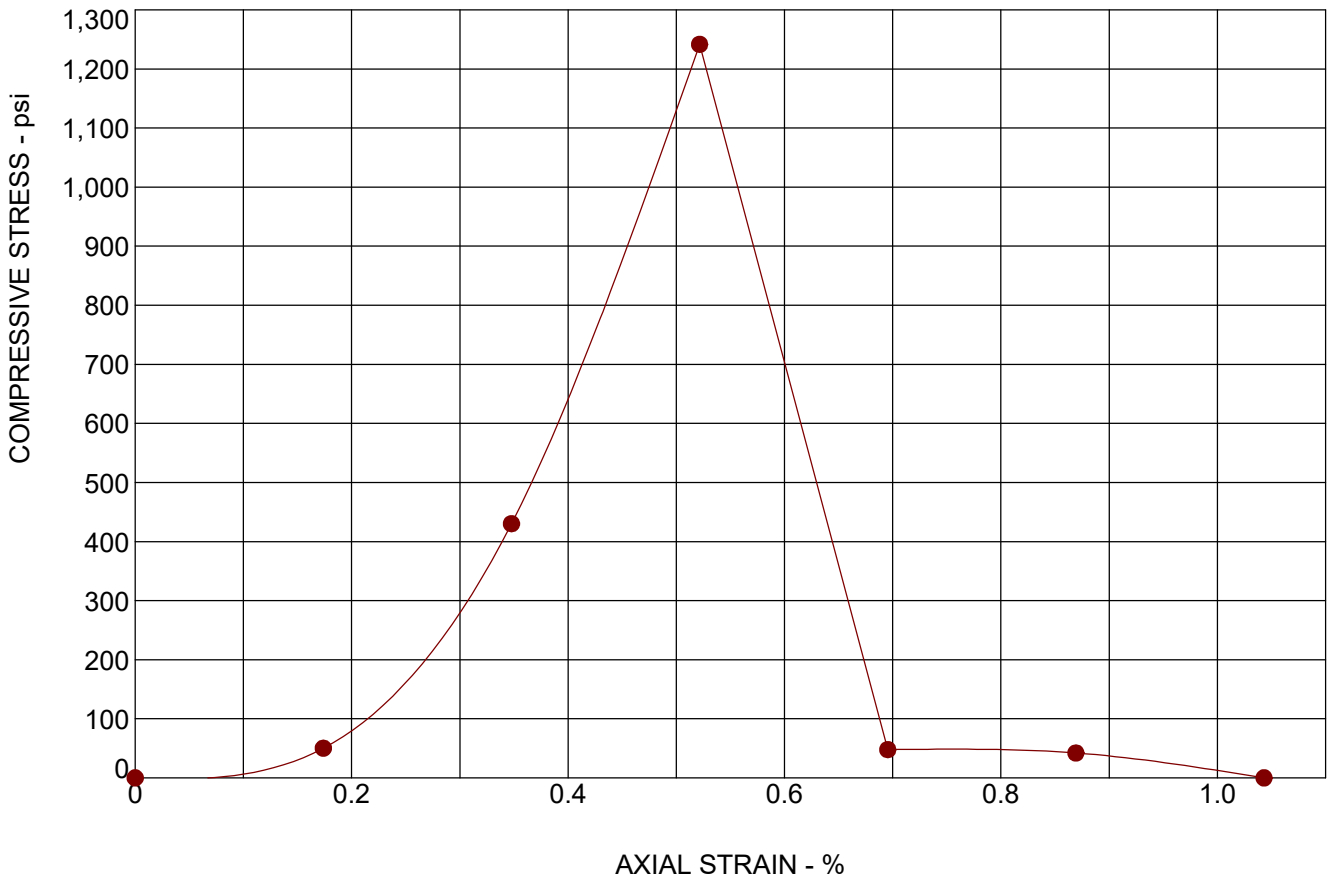
CLIENT:

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED WITH PHOTOS WHITE RIVER INDIAN HOSPITAL.GPJ TERRACON_DATATEMPLATE.GDT 12/6/24

UNCONFINED COMPRESSION TEST

ASTM D7012



SPECIMEN FAILURE PHOTOGRAPH

SPECIMEN TEST DATA

Moisture Content:	%	0.0
Dry Density:	pcf	145
Diameter:	in.	2.39
Height:	in.	5.75
Height / Diameter Ratio:		2.41
Calculated Saturation:	%	
Calculated Void Ratio:		
Assumed Specific Gravity:		
Failure Strain:	%	0.52
Unconfined Compressive Strength	(psi)	1242
Undrained Shear Strength:	(psi)	621
Strain Rate:	in/min	
Remarks:		

SAMPLE TYPE: CORE

SAMPLE LOCATION: C-2 @ 20 - 21 feet

SAMPLE DESCRIPTION:

LL	PL	PI	Percent < #200 Sieve

PROJECT: ATEK Engineering Consultants

SITE: White River Indian Hospital
Whiteriver, Arizona

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

PROJECT NUMBER: 65191024

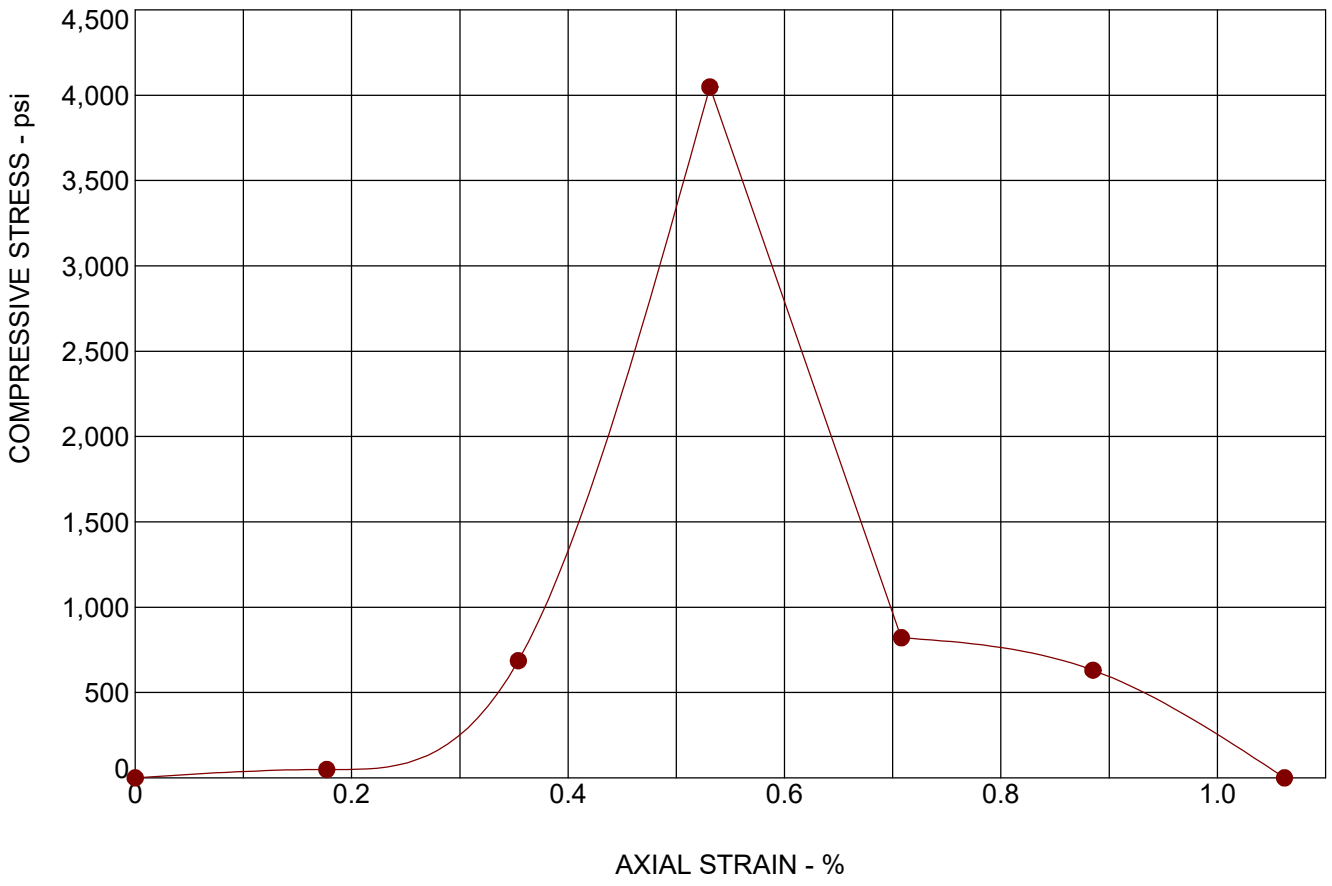
CLIENT:

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED WITH PHOTOS WHITE RIVER INDIAN HOSPITAL.GPJ TERRACON_DATATEMPLATE.GDT 12/6/24

UNCONFINED COMPRESSION TEST

ASTM D7012



SPECIMEN FAILURE PHOTOGRAPH	SPECIMEN TEST DATA		
	Moisture Content:	%	0.0
	Dry Density:	pcf	149
	Diameter:	in.	2.39
	Height:	in.	5.65
	Height / Diameter Ratio:		2.36
	Calculated Saturation:	%	
	Calculated Void Ratio:		
	Assumed Specific Gravity:		
	Failure Strain:	%	0.53
	Unconfined Compressive Strength	(psi)	4048
	Undrained Shear Strength:	(psi)	2024
	Strain Rate:	in/min	
	Remarks:		

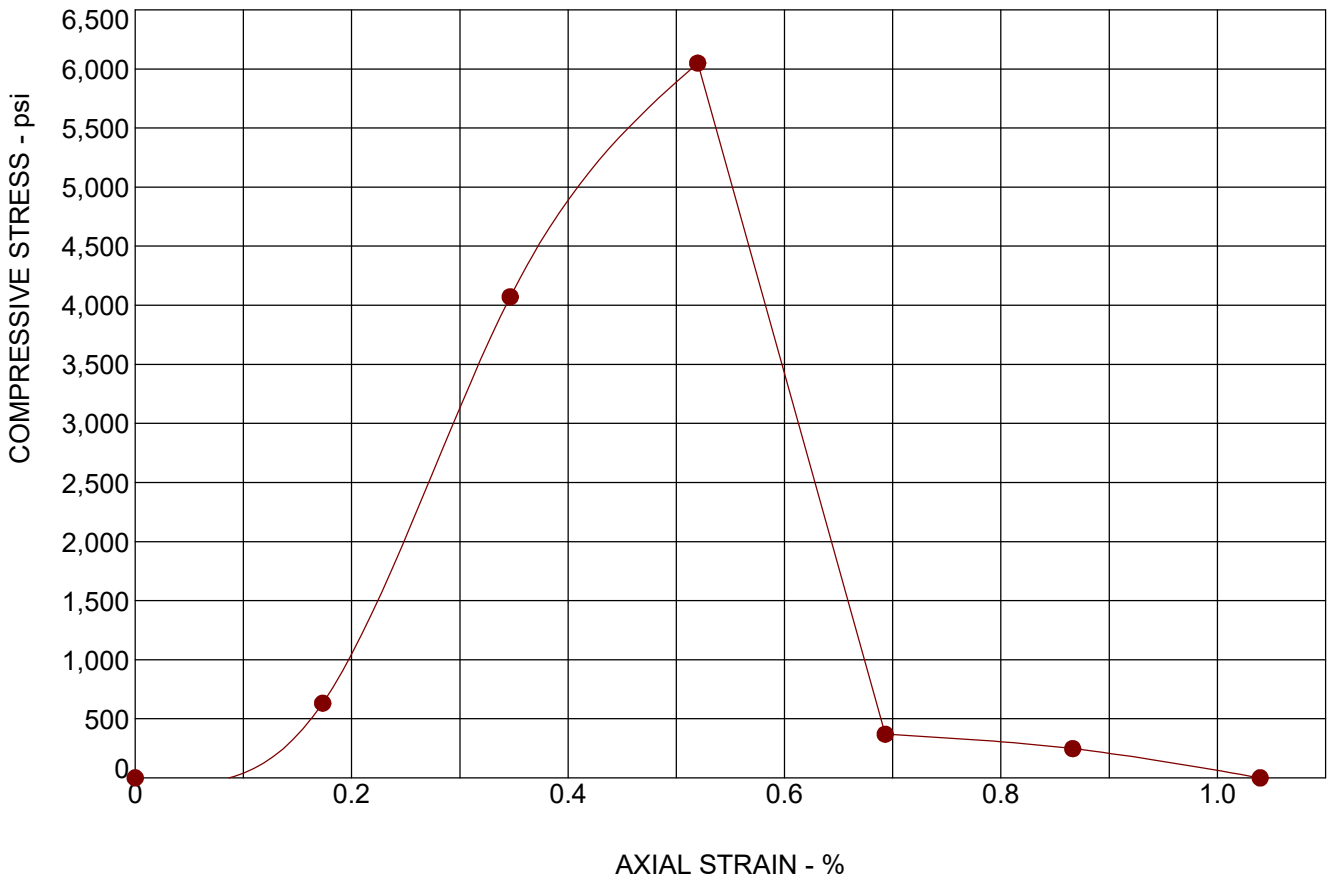
SAMPLE TYPE:	SAMPLE LOCATION: C-3 @ 59 feet			
SAMPLE DESCRIPTION:	LL	PL	PI	Percent < #200 Sieve

PROJECT: ATEK Engineering Consultants	Terracon 4685 S Ash Ave, Ste H-4 Tempe, AZ	PROJECT NUMBER: 65191024
SITE: White River Indian Hospital Whiteriver, Arizona		CLIENT:
		EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED WITH PHOTOS WHITE RIVER INDIAN HOSPITAL.GPJ TERRACON_DATATEMPLATE.GDT 12/6/24

UNCONFINED COMPRESSION TEST

ASTM D7012



SPECIMEN FAILURE PHOTOGRAPH

SPECIMEN TEST DATA

Moisture Content:	%	0.0
Dry Density:	pcf	162
Diameter:	in.	2.40
Height:	in.	5.77
Height / Diameter Ratio:		2.41
Calculated Saturation:	%	
Calculated Void Ratio:		
Assumed Specific Gravity:		
Failure Strain:	%	0.52
Unconfined Compressive Strength	(psi)	6049
Undrained Shear Strength:	(psi)	3025
Strain Rate:	in/min	
Remarks:		

SAMPLE TYPE: CORE

SAMPLE LOCATION: C-4 @ 45 - 46 feet

SAMPLE DESCRIPTION:

LL	PL	PI	Percent < #200 Sieve

PROJECT: ATEK Engineering Consultants

SITE: White River Indian Hospital
Whiteriver, Arizona

Terracon
4685 S Ash Ave, Ste H-4
Tempe, AZ

PROJECT NUMBER: 65191024

CLIENT:

EXHIBIT: B-4

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED WITH PHOTOS WHITE RIVER INDIAN HOSPITAL.GPJ TERRACON_DATATEMPLATE.GDT 12/6/24

APPENDIX E
Seismic Refraction Survey

Report Prepared for:

ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, AZ 85226

Prepared for: Mr. Antonio Lopez, P.E.,
Project Manager

ATEK Project No. 180035

Report Prepared by:

Geological Consultants Inc.
P.O. Box 39609
Phoenix, Arizona 85069

Prepared by:

Nicole L. Marin

Nicole Marin,
Associate Geoscientist

Reviewed by:

Mr. Kenneth M. Euge, R.G.
Principal Geologist

SEISMIC REFRACTION SURVEY

WHITERIVER INDIAN HOSPITAL ADDITION
WHITERIVER, ARIZONA

GCI Project No. 2024-122

September 7, 2024

TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 CONCLUSIONS AND RECOMMENDATIONS 3
- 2.1 Site Geology 3
- 2.2 Seismic Survey Results 4
- 2.3 Estimated Rock Strength 6
- 2.4 Qualitative Excavateability/Drill-ability 7
- 2.5 Excavation Constraints 7
- 2.6 Safety 8
- 2.7 Slope Stability Considerations 8

3.0 GEOPHYSICAL SITE INVESTIGATION 10
- 3.1 Site Specific Seismic Survey 10
- 3.2 Equipment 10
- 3.3 Results 11

4.0 GENERAL LIMITATIONS 12

TABLES

Table Number — Title

- 1a Seismic Survey Line Calculated Depth/Velocity Ranges Seismic Survey Line WRH-01 and WRH-02 5
- 1b Seismic Survey Line Calculated Depth/Velocity Ranges Seismic Survey Lines WRH-03 and WRH-04 6
- 2 Qualitative Excavateability & Drillability Relative to Soil/Bedrock Type & P-Wave Velocity 9

FIGURES

Figure Number — Title

- 1a General Location Map–Overview
- 1b Project Location Map
- 2 Seismic Refraction Survey Line Location Map
- 3 Seismic Refraction Survey Line WRH-01 Profile/Velocity Cross-Section & Time-Distance Data Plot
- 4 Seismic Line Photographs– WRH-01
- 5 Seismic Refraction Survey Line WRH-02 Profile/Velocity Cross-Section & Time-Distance Data Plot
- 6 Seismic Line Photographs– WRH-02

FIGURES - continued

Figure Number	Title
7	Seismic Refraction Survey Line WRH-03 Profile/Velocity Cross-Section & Time-Distance Data Plot
8	Seismic Line Photographs– WRH-03
9	Seismic Refraction Survey Line WRH-04 Profile/Velocity Cross-Section & Time-Distance Data Plot
10	Seismic Line Photographs– WRH-04

APPENDICES

APPENDIX A - SEISMIC REFRACTION SURVEY

A.1 GENERAL A-1
A.2 SEISMIC REFRACTION SURVEY LIMITATION A-2
A.3 DATA COLLECTION A-2
A.4 REFRACTION DATA PROCESSING A-2

APPENDIX B - EXCAVATEABILITY AND RIPPABILITY CHARTS

Table B-1 Rock Hardness and Excavation/Drillability Characteristics
Table B-2 Excavateability of Materials-Source: Caterpillar Rippability Charts & others

SEISMIC REFRACTION SURVEY

WHITERIVER INDIAN HOSPITAL ADDITION
WHITERIVER, ARIZONA

1.0 INTRODUCTION

This report presents results of a seismic refraction geophysical field investigation and analysis to assess general subsurface conditions at selected locations for the proposed new additions to the Whiteriver Indian Hospital. The project site is located south of the current hospital building, bounded by Apache Circle to the north, Arizona State Route 73 to the southeast, and 402 Old Sawmill Road to the southwest (Figures 1a and 1b). Four seismic refraction survey lines (WRH-01 through WRH-04) were laid out within the area of the proposed additions (Figure 2). The specific seismic survey line locations were selected by Mr. Antonio Lopez, P.E., Project Manager with ATEK Engineering Consultants (ATEK). This report is provided to supplement the geotechnical investigation conducted by ATEK.

Seismic survey line data are used to develop reasonable interpretations of subsurface conditions within specified areas of the project site. The objectives of the seismic refraction geophysical surveys are to provide, by indirect means, a higher level of confidence to:

- Indirectly characterize natural residual soil including decomposed basalt weathered to clay and or clay with gravel that is expected to be present within the proposed new addition footprint.

- Evaluate the thickness of the underlying decomposed basalt (clay) and the depths to the less weathered to unweathered basalt bedrock within the site area.

The general requirements for this project were defined by Mr. Lopez who authorized GCI to proceed on July 18, 2024 in an email notice to proceed. Seismic survey field work was completed by Mr. Kenneth M. Euge, R.G., Principal Geologist with Geological Consultants Inc. (GCI), assisted by Ms. Nicole Marin, Associate Geoscientist, on July 26, 2024.

The Scope of Work performed to accomplish the objectives of this study included:

- Mobilizing and demobilizing personnel and equipment to and from the job site.

- Four shallow seismic refraction surveys and preliminary field analysis of survey results. Figure 2 depicts the location of the seismic refraction survey lines.

- A rough position survey using a hand-held GPS receiver to locate the seismic lines relative to the site topography and cultural features observed at the site.

- Review of geologic mapping data for the project vicinity and performance of a cursory examination of the surficial soil in the vicinity of the seismic refraction survey lines.

- Computer analysis of field data and interpretation of results to complete the assessment of the materials present, their relative quality and their excavateability/drill-ability.

- Preparation of this report to document the seismic refraction survey, our findings, interpretations, conclusions, and recommendations.

The effective penetration depth for the seismic refraction survey lines is estimated to be at least 30 feet or greater below the ground surface. Velocity, thickness, and depth computations of different horizons, or zones, are provided to generally characterize site materials within the depth of interest expected at the project site. No direct subsurface explorations, such as test pits, were made by GCI as part of this seismic refraction survey. However, drill hole logging and sampling explorations were conducted by ATEK as part of their geotechnical investigation.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the cursory site reconnaissance, seismic surveys, and the data interpretations, the following conclusions and recommendations are provided:

2.1 **Site Geology**: The project site is located near the mapped surficial contact between the Quaternary basalt unit (Qb) and the older, Permian age Supai formation (PPs)[1] The basalt is related to the Springerville volcanic field which encompasses over 400 volcanic vents, located approximately 14.5 miles northeast of the site.

Although the basalt has been mapped on the southeast side of Arizona State Route 73, the surficial dark brown clay rich soil within the project area and at the seismic survey locations suggests the presence of residually weathered basalt. Likewise, the 2018 ATEK boring logs indicate relatively shallow refusal in borings BH-8, BH-9, BH-13, and BH-17 (ranging from 2.3 feet to 4.2 feet below the ground surface– bgs), possibly delineating the contact between the Supai formation to the northwest and the basalt to the southeast. Additionally, a more general geologic map of Arizona[2] displays Holocene to middle Pleistocene basalt mapped at the project location.

The boring logs provided by ATEK (conducted near the seismic survey lines) were used to describe the materials present at the subsurface. The borings near the seismic survey lines (BH-2 near survey lines WRH-03 and WRH-04, and BH-3 near survey lines WRH-01 and WRH-02) indicate an upper material characterized by dark brown clay (with some sand at BH-2) underlain by clay with gravel or clayey gravel. At BH-2, this material consists of 35% coarse to fine grained sand, 65% fines, and is very soft to soft, has low to medium plasticity, is moist, and has no cementation but a strong reaction to HCl. The underlying clay with gravel consists of 38% coarse to fine graded gravel, 6% coarse to fine grained sand, 56% fines, and is subrounded to subangular, very firm, has medium plasticity, is reddish brown, moist, and has no cementation but reacts strongly to HCl. While GCI interpreted the transition from a low velocity layer to a very high velocity layer at a depth ranging from 16.7 feet to 32.0 feet bgs at WRH-03 and from 23.6 feet to 31.2 feet bgs at WRH-04, BH-2 indicated a transition at around 9.0 feet from clay to clay with gravel, and auger refusal at 12.5 feet. It is likely that the auger refusal represented a transition from highly weathered basalt (clay and clay with gravel) to less weathered basalt and did not reach the very high velocity unweathered basalt in the lower layer interpreted by GCI.

[1]Wilson, E.D., Moore, R.T., and O'Haire, R.T.; 1960; Geologic map of Navajo and Apache counties, Arizona.

[2]Richard, S.M.; 2000; Geologic Map of Arizona; Arizona Geologic Survey Map-35, 1,000,000 map scale.

At BH-3, the upper material consists of dark brown clay with 10% coarse to fine grained sand and 90% fines, is firm to soft to moderately firm, has low to medium plasticity, is moist, and has no cementation but weakly reacts to HCl. Underlying this is reddish brown clayey gravel with 60% coarse to fine graded gravel, 5% coarse to fine grained sand, and 35% fines. This material is subangular, hard, has medium plasticity, is moist, and has no cementation and no reaction to HCl. While auger refusal in BH-3 was encountered at 19.1 feet bgs, GCI generally interpreted the high velocity layer at shallower depths– from 14.0 feet to 17.9 feet at WRH-01 and from 10.0 feet to 12.7 feet at WRH–02.

2.2 **Seismic Survey Results**: The interpreted stratigraphy derived from the seismic survey data is depicted in Figures 3, 5, 7, and 9. These figures include the average seismic velocities of the interpreted geologic units encountered along the seismic lines along with the calculated velocity zone boundaries, the ground surface profile, and a cross-section depicting the different velocity zones.

Based on our interpretations of the seismic data, the conclusions presented regarding the depth to various velocity zones are believed to be reasonable at the location of the seismic survey line. The conditions characterized by indirect seismic methods along the seismic survey lines probably represent subsurface conditions that could be found within the project site. The calculated depth/velocity ranges and our interpretations of the geologic materials represented by the measured seismic velocities are summarized in Tables 1a and 1b.

GCI was provided the preliminary ATEK soil boring logs that were finished in October of 2018. Boring BH-2 was approximately 68 feet northeast of the crossing of seismic survey lines WRH-03 and WRH-04, and boring BH-3 was at the crossing of seismic survey lines WRH-01 and WRH-02. GCI used the drill hole logs to describe the subsurface materials within the velocity zones presented in Tables 1a and 1b.

Table 1a
Seismic Survey Line Calculated Depth Ranges and Seismic Velocity
Whiteriver Indian Hospital
Seismic Survey Line WRH-01 and WRH-02

Survey Line No.	Depth Range at Shot Point (ft)			Average Seismic Velocity (ft/sec)	Interpreted Geologic Description	Qualitative Excavateability
	A	B	C			
WRH-01	0 - 3.0	0 - 3.4	0 - 2.5	870	Clay (CL) from residually weathered Basalt; consists of 10% coarse to fine grained sand and 90% fines; firm to soft to moderately firm, low to medium plasticity, dark brown, moist, no cementation, weak reaction to hydrochloric acid (HCl). Equivalent to Very Soft Rock.	Slight
	3.0 - 17.9	3.4 - 16.0	2.5 - 14.0	2,313	Clay (CL) from residually weathered Basalt; consists of 10% coarse to fine grained sand and 90% fines; firm to soft to moderately firm, low to medium plasticity, dark brown, moist, no cementation, weak reaction to hydrochloric acid (HCl). Equivalent to Very Soft Rock.	Slight
	17.9 - 30+	16.0 - 30+	14.0 - 30+	8,845	Unweathered Basalt Bedrock. Equivalent to Extremely Hard Rock.	Severe
WRH-02	0 - 2.0	0 - 3.0	0 - 5.2	1,031	Clay (CL) from residually weathered Basalt; consists of 10% coarse to fine grained sand and 90% fines; firm to soft to moderately firm, low to medium plasticity, dark brown, moist, no cementation, weak reaction to hydrochloric acid (HCl). Equivalent to Very Soft Rock.	Slight
	2.0 - 10.5	3.0 - 12.2	5.2 - 12.7	1,942	Clay (CL) from residually weathered Basalt; consists of 10% coarse to fine grained sand and 90% fines; firm to soft to moderately firm, low to medium plasticity, dark brown, moist, no cementation, weak reaction to hydrochloric acid (HCl). Equivalent to Very Soft Rock.	Slight
	10.5 - 30+	12.2 - 30+	12.7 - 30+	5,788	Unweathered to slightly weathered basalt. Equivalent to Hard Rock.	Moderate to Severe

Table 1b
Seismic Survey Line Calculated Depth Ranges and Seismic Velocity
Whiteriver Indian Hospital
Seismic Survey Lines WRH-03 and WRH-04

Survey Line No.	Depth Range at Shot Point (ft)			Average Seismic Velocity (ft/sec)	Interpreted Geologic Description	Qualitative Excavateability
	A	B	C			
WRH-03	0 - 32.0	0 - 31.0	0 - 16.7	1,513	Sandy Clay (CL) related to residually weathered Basalt; consists of 35% coarse to fine grained sand and 65% fines, very soft to soft, low to medium plasticity, dark brown, moist, no cementation, strong reaction to HCl, trace roots. Underlain by Clay with Gravel (CL) consisting of 38% coarse to fine graded gravel, 6% coarse to fined grained sand, 56% fines, subrounded to subangular, very firm, medium plasticity, reddish brown moist, no cementation, strong reaction to HCl. Nearby boring (BH-2) experienced auger refusal at 12.5 feet depth bgs, likely due to encountering less weathered basalt. Equivalent to Very Soft Rock.	Slight
	32.0+	31.0+	16.7 - 30+	5,581	Unweathered to slightly weathered basalt. Equivalent to Hard Rock.	Moderate to Severe
WRH-04	0 - 31.2	0 - 29.0	0 - 23.6	1,177	Sandy Clay (CL) related to residually weathered Basalt; consists of 35% coarse to fine grained sand and 65% fines, very soft to soft, low to medium plasticity, dark brown, moist, no cementation, strong reaction to HCl, trace roots. Underlain by Clay with Gravel (CL) consisting of 38% coarse to fine graded gravel, 6% coarse to fined grained sand, 56% fines, subrounded to subangular, very firm, medium plasticity, reddish brown moist, no cementation, strong reaction to HCl. Nearby boring (BH-2) experienced auger refusal at 12.5 feet depth bgs, likely due to encountering less weathered basalt. Equivalent to Very Soft Rock.	Slight
	31.2+	29.0 - 30+	23.6 - 30+	8,772	Unweathered basalt. Equivalent to Extremely Hard Rock.	Severe

2.3 **Estimated Rock Strength:** At seismic survey lines WRH-01 and WRH-02, the overlying very low velocity material consists of clay from residually weathered basalt. This layer had a velocity of 870 feet per second (fps) and extended to depths of 2.5 to 3.4 feet bgs at WRH-01, and a had a velocity of 1,031 fps and extended to depth of 2.0 to 5.2 feet bgs at WRH-02. The Intermediate velocity layer was interpreted to consist of similar clay from residually weathered basalt that was slightly less weathered than the overlying layer. This material ranged from 2,313 fps to depths of 14.0 to 17.9 feet bgs at WRH-01 to 1,942 fps to depths of 10.5 to 12.7 feet bgs at WRH-02. Both upper layers are equivalent to very soft rock with an unconfined compressive strength ranging from 246 to

435 pounds per square inch (psi). The underlying very high velocity layer is interpreted to consist of unweathered basalt bedrock equivalent to hard to extremely hard rock, with a velocities of 8,845 fps (unconfined compressive strength greater than 10,500 psi) and 5,788 fps (unconfined compressive strength of 1,490 to 2,900 psi) at WRH-01 and WRH-02, respectively. Notably, the ATEK boring BH–3 located at the intersection of the two survey lines indicate refusal at a depth of 19.1, slightly lower than the depth interpreted in the seismic surveys.

At seismic survey lines WRH-03 and WRH-04, the upper residually weathered basalt consisted of sandy lean clay (according to the ATEK boring logs) and was interpreted to extend to much deeper depths than at WRH-01 and WRH-02– extending to 16.7 feet to 32.0 feet bgs at WRH-03 and to 23.6 feet to 31.2 feet bgs at WRH-04, with velocities of 1,513 fps and 1,177 fps, respectively. This material has an unconfined compressive strength ranging from 246 to 435 psi. The underlying very high velocity layer had velocities of 5,581 fps (unconfined compressive strength of 1,450 to 2,900 psi) at WRH-03 and 8,772 fps (unconfined compressive strength greater than 10,500 psi) at WRH-04, equivalent to very hard to extremely hard rock. The nearby ATEK boring encountered much shallower refusal at 12.5 feet bgs, however, indicating that it may have encountered less weathered bedrock at this depth.

2.4 **Qualitative Excavateability/Drill-ability**: The estimated qualitative excavateability of the site materials is summarized in Table 2. The qualitative estimates are based on the interpretations of the seismic survey data, understanding of the site geological conditions, and our professional experience. There is no guarantee that the seismic refraction survey results or the qualitative excavateability can be duplicated by others. We recommend this information be used with caution and only as guidelines. Because the seismic velocities used to determine qualitative excavateability may vary from 10 to 20 percent, and due to the variability of the subsurface material, qualitative excavateability constraint categories listed in Table 2 may overlap at the transition from one constraint category to the next.

2.5 **Excavation Constraints:** The excavation constraints described in this report (Tables 1a, 1b, and 2) are, in our opinion, reasonable for the locations where the seismic refraction surveys were conducted. The ultimate excavateability/drillability is dependent on many factors (variably cemented soils, cemented gravel to boulder soil zones, presence of large boulders, presence of bedrock, degree of bedrock weathering, excavation methods, size and age of excavation equipment, level of effort applied by the contractor, etc.) and it may not be possible to correlate these factors with the results of the seismic refraction survey conducted for this investigation. The excavation contractor must exercise caution, and assume associated risks, when attempting to extrapolate these data to other areas where seismic surveys have not been conducted. There is no guarantee that the seismic refraction survey results (Tables 1a and 1b) or the qualitative excavateability (Table 2)

can be duplicated by others. We recommend this information be used with caution and only as guidelines.

Prospective contractors or others involved with grading and excavations at this site should review this report along with the excavateability performance charts and tables provided by manufacturers of rock and soil excavation and drilling equipment. This information can be used as part of their evaluation criteria for selecting equipment that may be used to advance excavation or fragment very hard to extremely hard, unweathered basalt bedrock expected to be encountered at this site. However, the contractors using these data or making interpretations of this information, for any reason, do so at their sole risk.

The qualitative excavateability summarized in Table 2, along with our interpretation of the subsurface materials including the surficial clay and clayey gravel related to residually weathered basalt and the underlying less weathered to unweathered basalt bedrock (Tables 1a and 1b) are provided so that a prospective contractor can relate seismic velocities to the subsurface materials they can expect to encounter where excavations may be proposed. Although a backhoe may be able to excavate low velocity material and heavy, hydraulic impact rock breakers attached to a large track-mounted excavator might be able to fragment moderate to high velocity material, and strongly cemented zones, there are no guarantees due to the wide range of variables summarized herein that effect equipment suitability and material excavateability or drill-ability.

No site-specific testing has been conducted at this site by GCI to verify the qualitative excavateability categories (Table 2), nor has any equipment performance evaluations been conducted relative to excavating site materials or to determine equipment suitability for this site. Therefore, as stated previously, the contractor must exercise caution and assume associated risks if the information provided herein is used by the contractor to assist with the determination of equipment suitability for fragmentation or excavation. For an indicator of the drill-ability of the site near surface soils and the deeper high velocity zone, refer to the test drill hole logs provided in the ATEK geotechnical report.

2.6 **Safety**: We recommend adequate “safety zones” be established and maintained around the proposed excavations during construction.

2.7 **Slope Stability Considerations**: If the vertical heights of any permanent or temporary slopes that exceed five feet are required for the proposed structures or appurtenances, or if any excavated slopes are in close proximity or adjacent to existing structures, exceed 5 feet and are steeper than 2:1 (horizontal to vertical) or are steeper than current building and grading code requirements, the contractor shall be required to evaluate the stability of the proposed slopes. Loose, poorly consolidated, uncemented soil could experience raveling and slumping.

The slope stability analysis shall demonstrate whether the cut slopes have an adequate factor of safety against failure (acceptable to the local regulatory authority). If the factor of safety is less than acceptable, shoring or a slope reinforcement/stabilization system shall be designed by registered professional civil engineer or engineering geologist according to the local building code standards, and according to the slope recommendations provided by a registered civil (geotechnical) engineers or engineering geologists.

Table 2
Qualitative Excavateability & Drillability
Relative to Soil/Bedrock Type & P-Wave Velocity
Whiteriver Indian Hospital Addition

Unit	Average Velocity (feet per second)	Excavateability Constraints
Residually Weathered Basalt Consisting of Clay or Clay with Gravel Equivalent to Very Soft Rock	< 3,000	**Slight**- Should be able to excavate with conventional low to moderate horsepower earth moving or drilling equipment. These soils should be relatively easy to excavate but less weathered basalt may be encountered. Excavation may become difficult if boulder-size fragments are encountered. Large basalt boulders could require secondary fragmentation along with special excavation methods to remove the material efficiently.
Weathered to Unweathered basalt bedrock Equivalent to Very Soft to Hard Rock Note: This Velocity Range Was Not Interpreted from the modeling of the seismic survey data	3,000 to 6,000	**Marginal**- Potentially difficult to excavate the intermediate velocity weathered to unweathered basalt with conventional earth moving or drilling equipment. These materials could require hard to very hard ripping to facilitate excavation. Large-size, basalt boulders could be encountered. Track-mounted backhoes with a heavy impact hammer (ram-hoe) could provide effective, but slow, fragmentation. Drilling could be slow. Using staggered tooth or v-shaped rock buckets could improve production.
Unweathered basalt bedrock Equivalent to Very Hard to Extremely Hard Rock	> 6,000	**Severe**- Excavation and drilling will be very difficult. Very hard and extremely hard rock fragmentation/excavation/drilling methods (such as rock augers and drilled piers) will be necessary. Low torque/horsepower excavation and drilling will likely experience shallow refusal. High horsepower tractors using single-shank rippers could be effective in large, open excavations. Large, basalt boulders could be generated that could require secondary fragmentation. Use of special excavation/ fragmentation methods such as blasting, could improve the efficiencies and advancement of excavations in large areas where very hard or extremely hard rocklike materials are encountered. Likewise, using staggered-tooth, v-shaped, or hydraulic rotary rock drum buckets could improve production. Hard rock drilling for piers in massive volcanic rock should consider down hole borings advanced with “Patriot” Type down hole hammers with “Super Jaw’ bits, or equal.

3.0 GEOPHYSICAL SITE INVESTIGATION

The seismic refraction survey was conducted to indirectly investigate subsurface conditions and to develop reasonable interpretations of subsurface conditions.

3.1 Site Specific Seismic Survey

Following the completion of a site reconnaissance to identify the seismic survey locations, four seismic survey lines were completed at the locations depicted in Figure 2. The seismic surveys were conducted to evaluate the residual soil overburden thickness and, where possible, identify and characterize the overburden soil and underlying weathered to unweathered basalt bedrock that may be present below existing grades within the project site, as well as to determine the qualitative excavateability of the material encountered along the seismic survey lines.

Three shot points were used along each seismic survey line to evaluate possible non-horizontal subsurface boundary conditions (buried sloping surfaces, cementation zones, soil-change boundaries, etc.) that could be expected in this type of geological terrain (refer to site photographs in Figures 4, 6, 8, and 10), and to improve the accuracy of the seismic wave velocity determinations. Each of the seismic refraction survey lines were run over a total length of 120-feet (including shot point offsets) sufficient to achieve adequate depth penetration (of at least 30 feet). The geometry of the seismic survey lines was set up to identify the subsurface layers or zones that could influence proposed site drilling, excavations, and improvements within the site area where auger drilling may experience refusal at relatively shallow depths below the existing ground surface.

As with any type of geophysical investigation method, there are limitations to its usefulness and application. Refer to Appendix A for additional information regarding seismic refraction surveys and their limitations.

3.2 Equipment

Travel-time data for the seismic survey was obtained using Geometrics Inc. Model S12 SmartSeis™ 12-Channel Exploration Seismograph. Seismic wave arrivals are detected with digital grade vertical geophones with a dual hum-bucking coil and a frequency response above 14 Hz natural frequency. Geophones were placed beginning at Station 0 and at 10-foot intervals thereafter to the end of the seismic survey line. The seismic shock wave was produced by repeated impacts of a 16-pound sledge hammer onto a soft steel striking plate. Hammer impacts (shots) were made at five-foot offsets from each end of the seismic line traverse and at a shot point located at the center of the survey line spread. The distance from the impact locations (shot points) to the geophones and the travel time recorded for each station is stored in the seismograph's onboard computer. If the field seismic data plot indicated the possible presence of

anomalous subsurface conditions or spurious noise coincident with the hammer impacts, repeated impacts are used to verify the initial data reading or to correct the data. Topographic features, outcrops, and other natural features found along the seismic survey line that might influence the data interpretations are annotated with the field data plot.

3.3 Results

Interpretations of the seismic survey data obtained at the project site suggest the presence of a distinctive subsurface stratigraphic profile (surficial soil consisting of clay related to residually weathered basalt and underlying less weathered to unweathered basalt bedrock along the seismic survey line). Seismic velocities, calculated zone thicknesses, and depth to velocity zone boundaries for the interpreted soil types are summarized in Tables 1a and 1b. The qualitative excavateability of the basalt bedrock (if encountered), and overlying clay interpreted along the seismic survey lines are summarized in Table 2. The seismic velocity profile and distance-travel time data plot are depicted in Figures 3, 5, 7, and 9. The depth scale depicted on the Y-axis of the velocity layer cross-section assumed an arbitrary datum elevation of 100.0 feet at the seismic survey site where surface grade changes were greater than two feet. These cross-sections may be used to measure the depths to different velocity layer boundaries below the ground surface at any point along the seismic survey line. The estimated accuracy of the velocity layer boundaries is approximately 20 percent. Figures 4, 6, 8, and 10 include photographs taken from each end shot point (A and C) of the seismic survey lines.

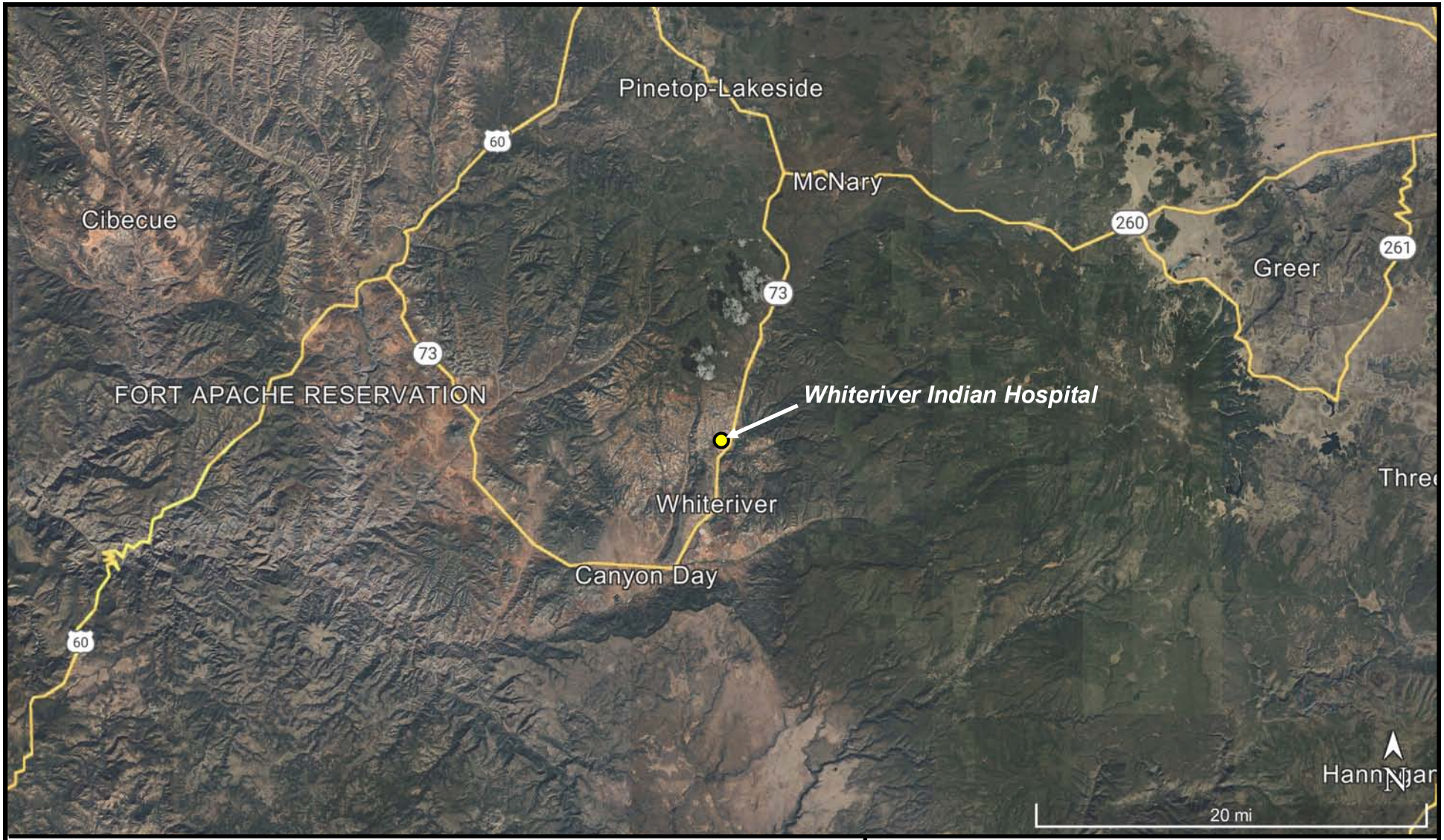
4.0 GENERAL LIMITATIONS

The geologic observations, findings, conclusions, and recommendations presented in this report are based on (1) cursory observations of surface conditions and geologic materials where exposed and (2) analysis of the seismic refraction data gathered at the site. The services provided by Geological Consultants Inc. were performed in accordance with generally accepted geological principals and standard practices used by members of the geological profession in this locale at the time of this study.

It must be recognized that subsurface geologic conditions may vary from place to place and from those found at locations where measurements or surveys are made by the investigator. Generalized geological and excavateability recommendations presented in this report are based on the interpretations of the results of this investigation and it may not be possible for others to accurately correlate the geology and excavateability results to test explorations or investigations conducted by others. No warranty or representation, either expressed or implied, is or should be construed regarding geological conditions at locations other than those evaluated as part of this study.

The professional opinions, conclusions and recommendations presented in this report relate only to the project and locations specified in this report. If any changes are made in the project, the conclusions and/or recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this study are modified and approved in writing by Geological Consultants Inc.

FIGURES



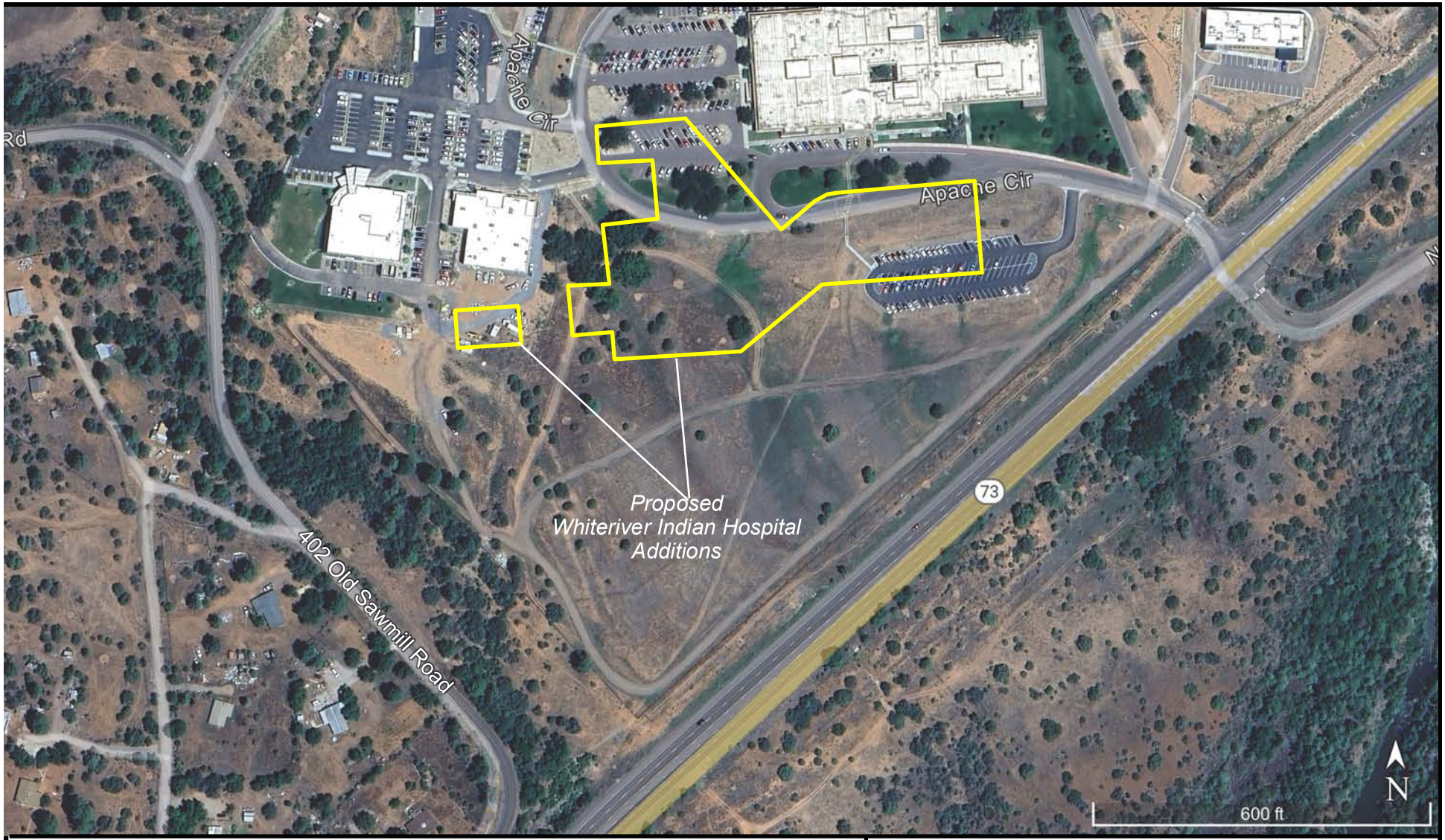
EXPLANATION:

Basemap modified by GCI (8/23/2024) from Google Maps (2024)

Whiteriver Indian Hospital Addition
Whiteriver, Arizona
Seismic Refraction Survey
General Location Map—Overview
Figure 1a

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899



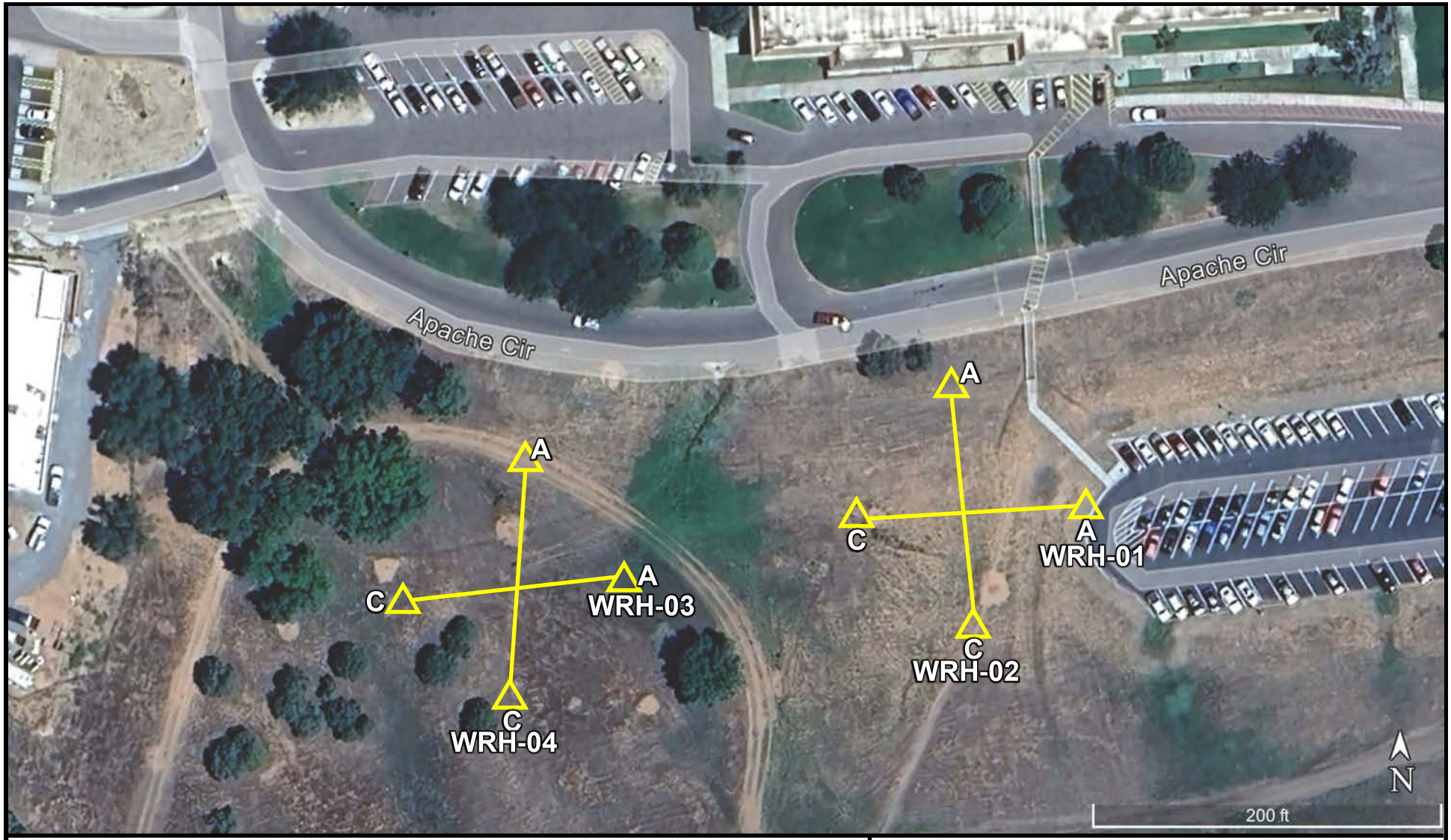
EXPLANATION:

Basemap modified by GCI (8/30/2024) from Google Maps (2024)

Whiteriver Indian Hospital Addition
Whiteriver, Arizona
Seismic Refraction Survey
Project Location Map
Figure 1b

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899



EXPLANATION:

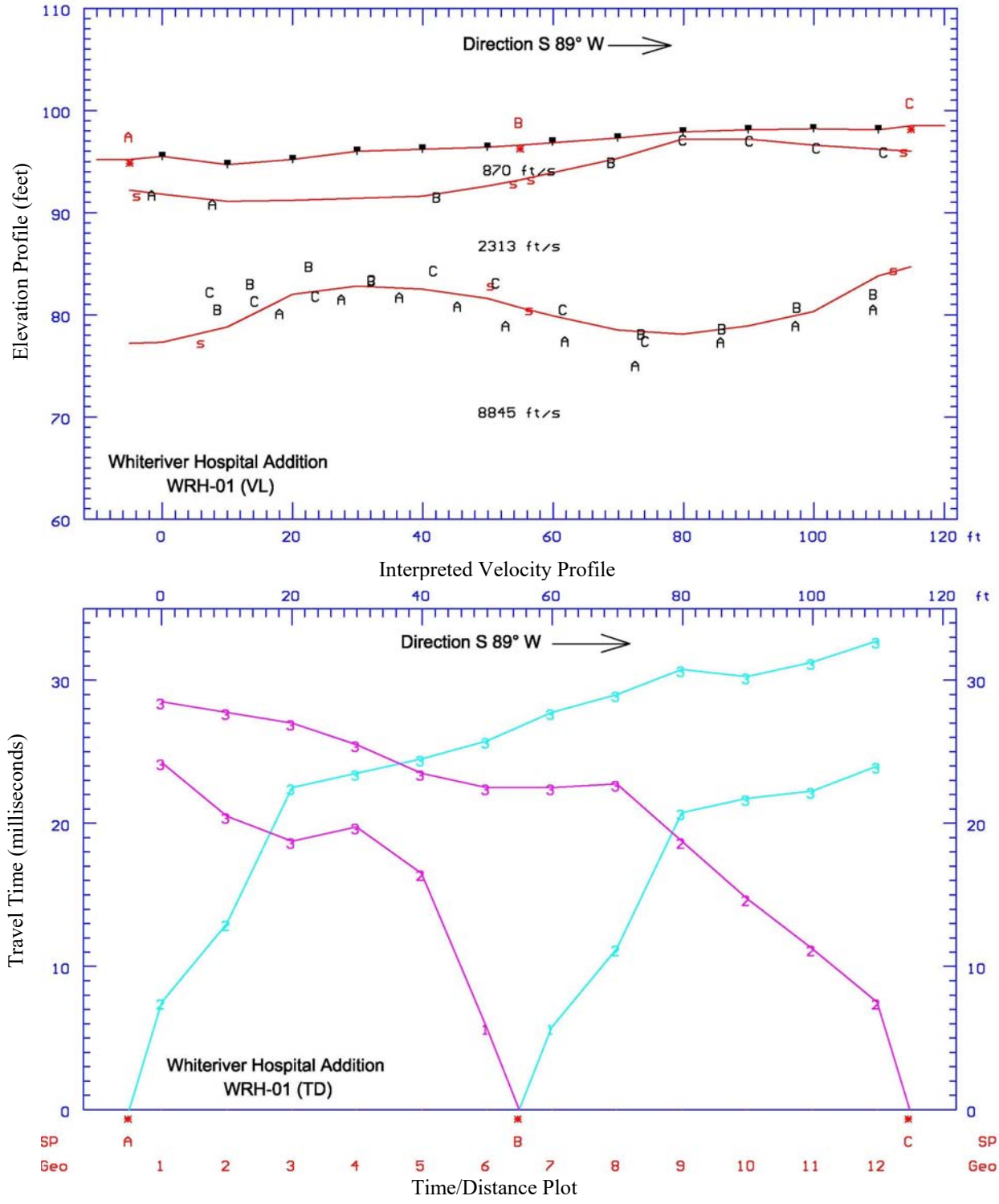
C A WRH-01 — Seismic Survey Line Location (approximate) and Designation

Basemap modified by GCI(8/23/2024) from Google Maps (2024)

Whiteriver Indian Hospital
Whiteriver, Arizona
Seismic Refraction Survey
Seismic Survey Line Location Map
Figure 2

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899



Refer to Figure 2 for seismic survey line location and Figure 4 for photographs of the seismic survey line layout

Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey WRH-01
Velocity Profile & Time-Distance Plot
Figure 3

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899

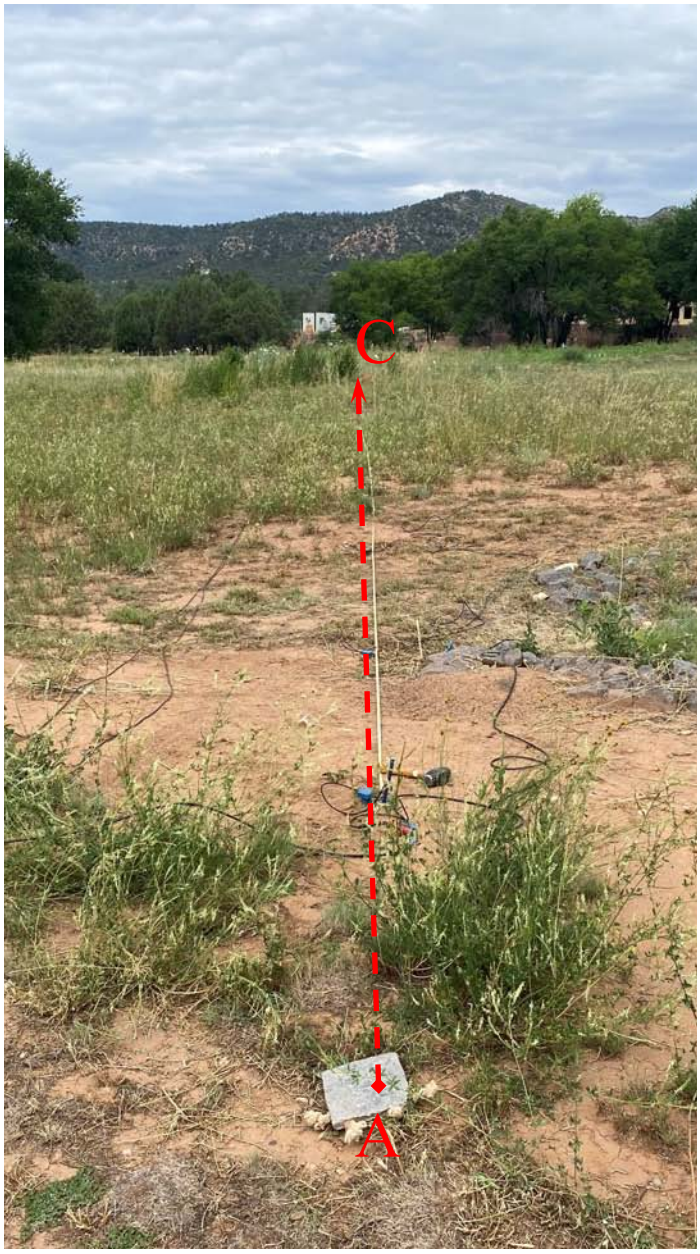


Figure 4; Photo 1: Seismic Survey Line WRH-01 view looking west from Shot Point A toward Shot Point C.

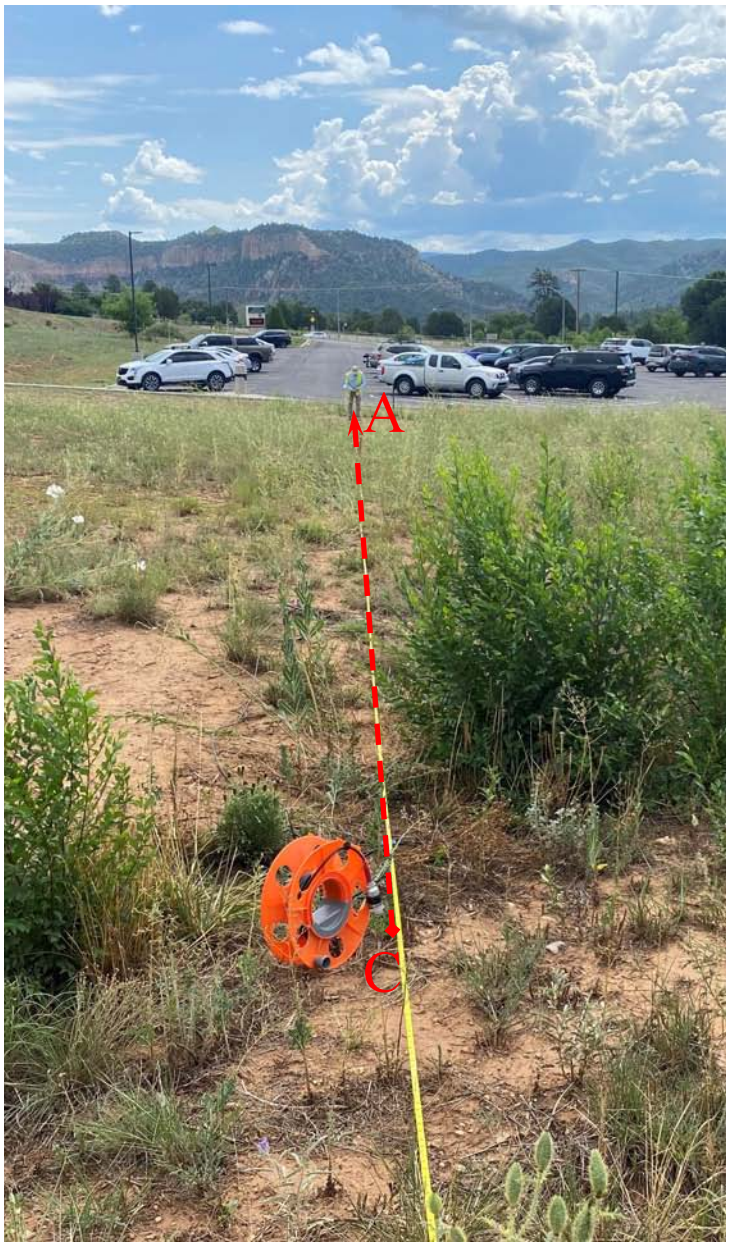


Figure 4; Photo 2: Seismic Survey Line WRH-01 view looking east from Shot Point C toward Shot Point A.

Photographs of seismic survey line WRH-01 taken July 26, 2024 by N. Marin, Geoscientist; Geological Consultants Inc. Project No. 2024-122.

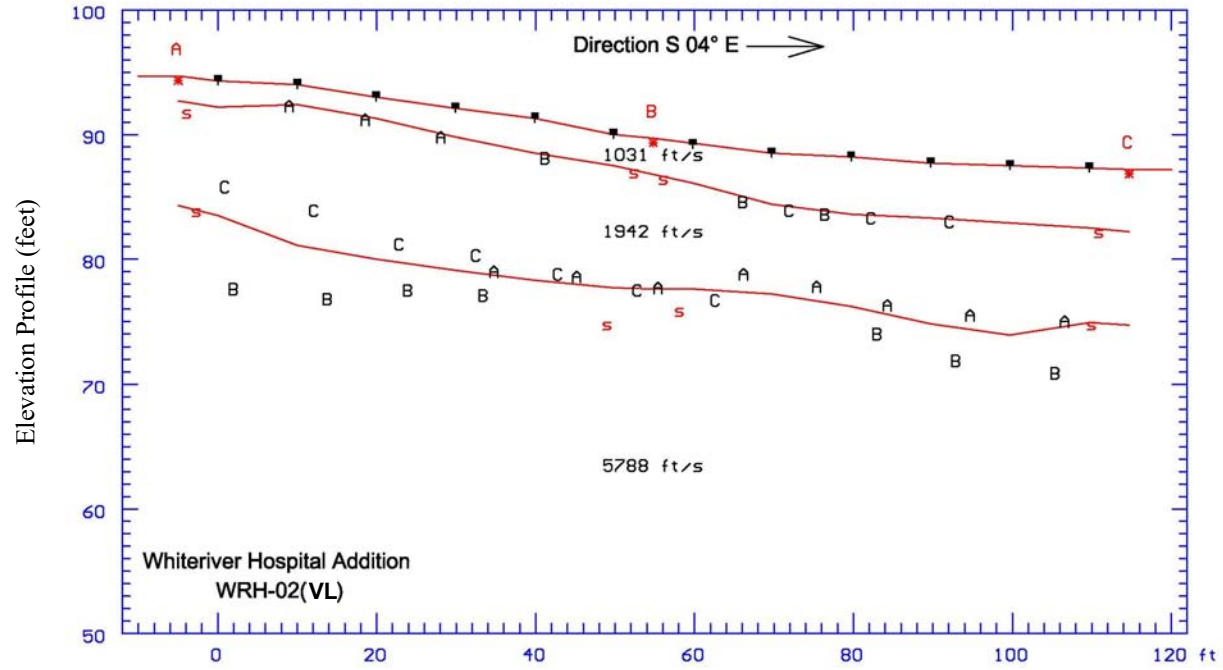
Explanation:

Seismic survey line location: A-shot point start; C-shot point end. Refer to Figure 3 for interpreted seismic line velocity zone cross-section and travel time-distance plot.

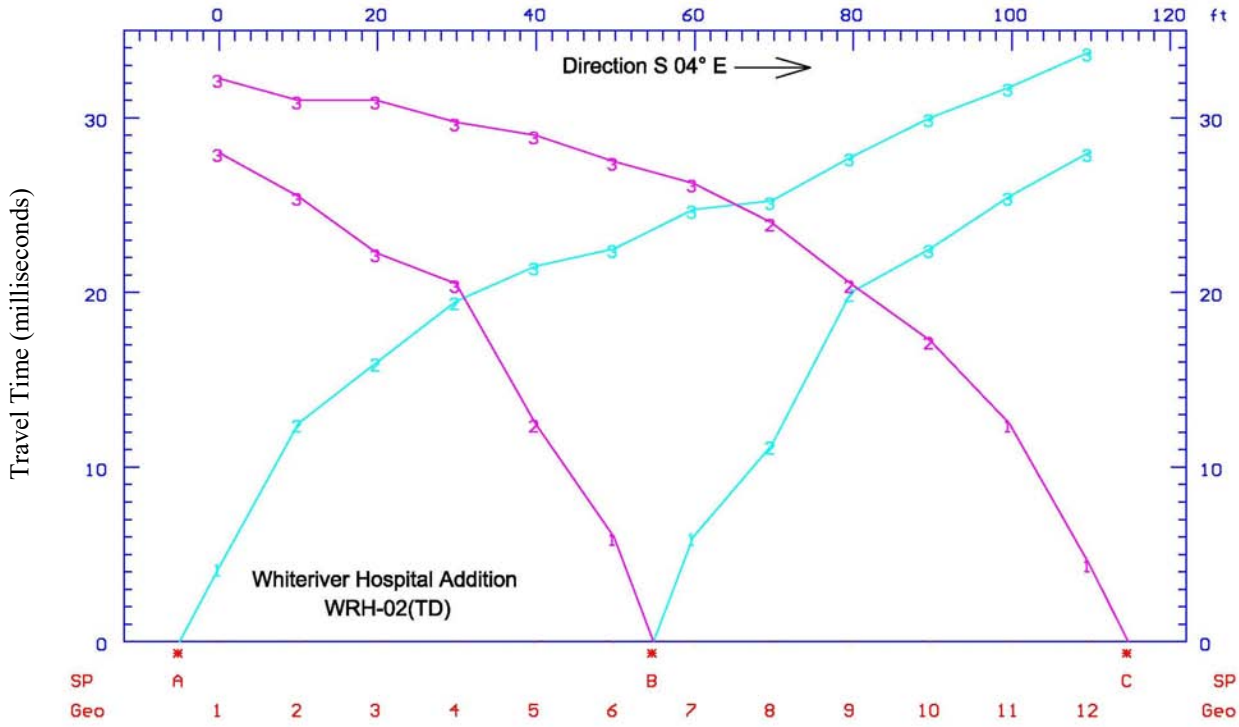
Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey
Seismic Line Photographs—WRH-01
Figure 4

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899



Interpreted Velocity Profile



Time/Distance Plot

Refer to Figure 2 for seismic survey line location and Figure 6 for photographs of the seismic survey line layout

Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey WRH-02
Velocity Profile & Time-Distance Plot
Figure 5

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899

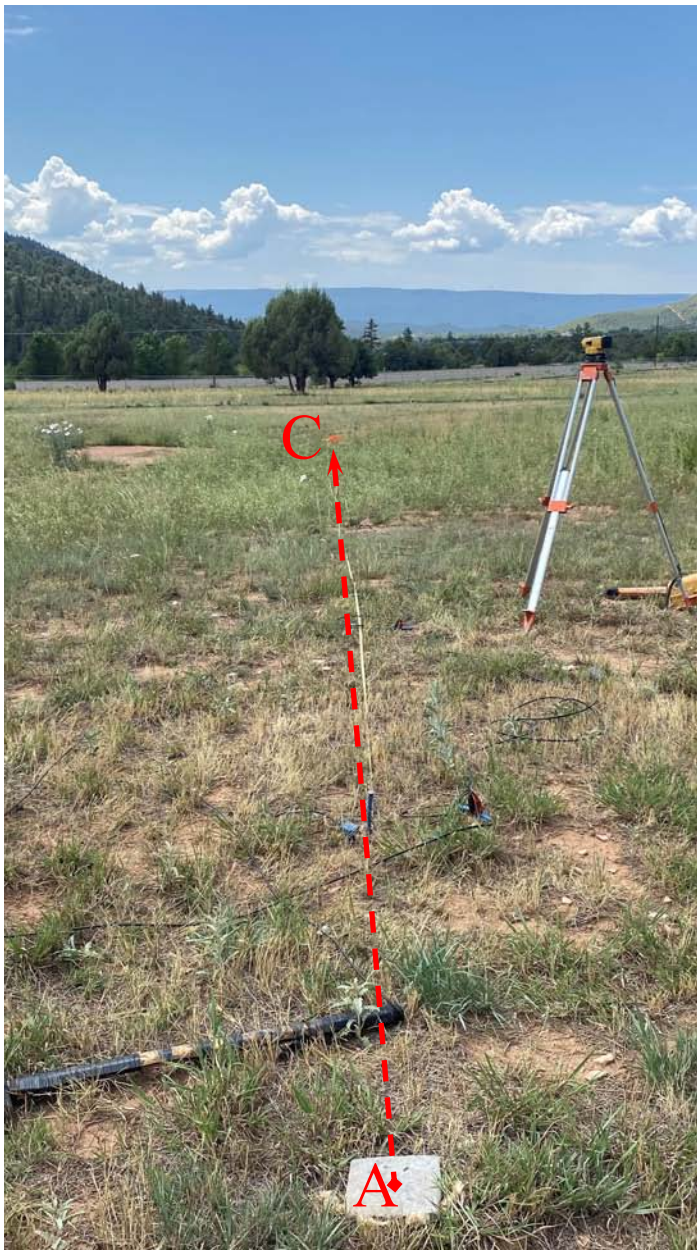
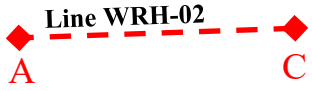


Figure 6; Photo 1: Seismic Survey Line WRH-02 view looking south from Shot Point A toward Shot Point C.

Figure 6; Photo 2: Seismic Survey Line WRH-02 view looking north from Shot Point C toward Shot Point A.

Photographs of seismic survey line WRH-02 taken July 26, 2024 by N. Marin, Geoscientist; Geological Consultants Inc. Project No. 2024-122.

Explanation:

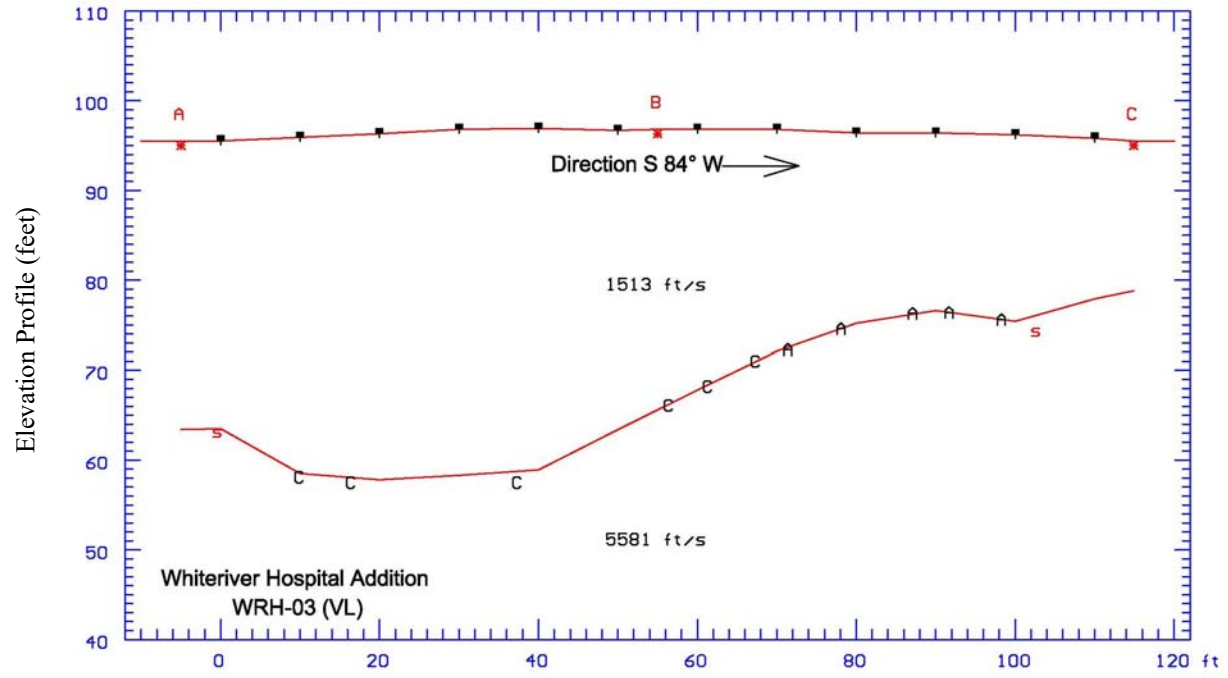


Seismic survey line location: A-shot point start; C-shot point end. Refer to Figure 5 for interpreted seismic line velocity zone cross-section and travel time-distance plot.

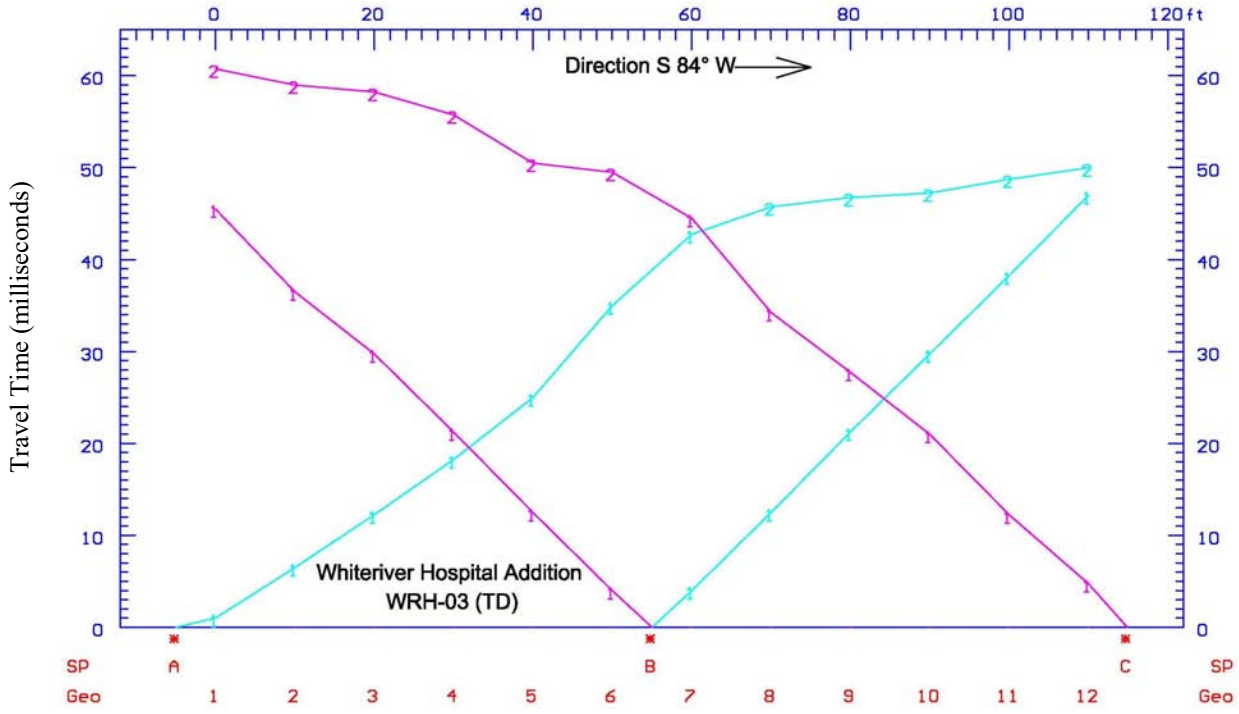
Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey
Seismic Line Photographs—WRH-02
Figure 6

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899



Interpreted Velocity Profile



Time/Distance Plot

Refer to Figure 2 for seismic survey line location and Figure 8 for photographs of the seismic survey line layout

Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey WRH-03
Velocity Profile & Time-Distance Plot
Figure 7

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899

Figure 8; Photo 1: Seismic Survey Line WRH-03 view looking west from Shot Point A toward Shot Point C.

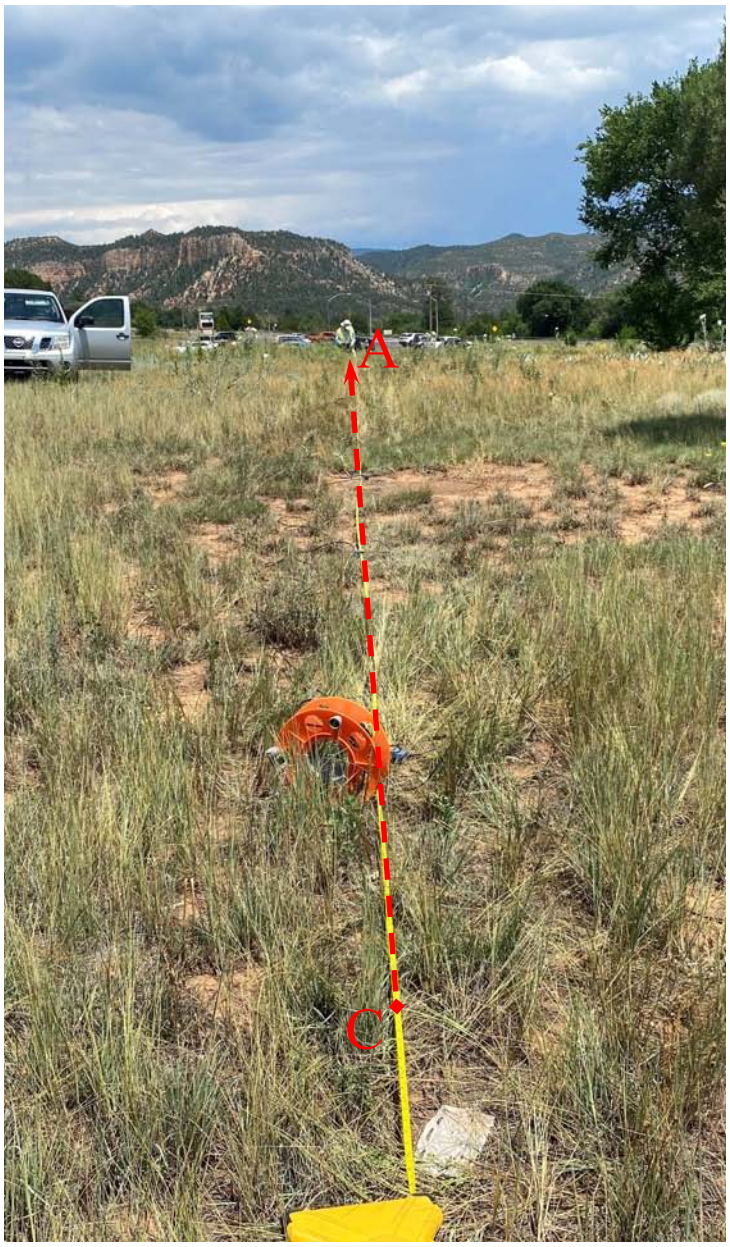
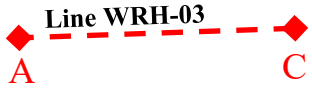


Figure 8; Photo 2: Seismic Survey Line WRH-03 view looking east from Shot Point C toward Shot Point A.

Photographs of seismic survey line WRH-03 taken July 26, 2024 by N. Marin, Geoscientist; Geological Consultants Inc. Project No. 2024-122.

Explanation:

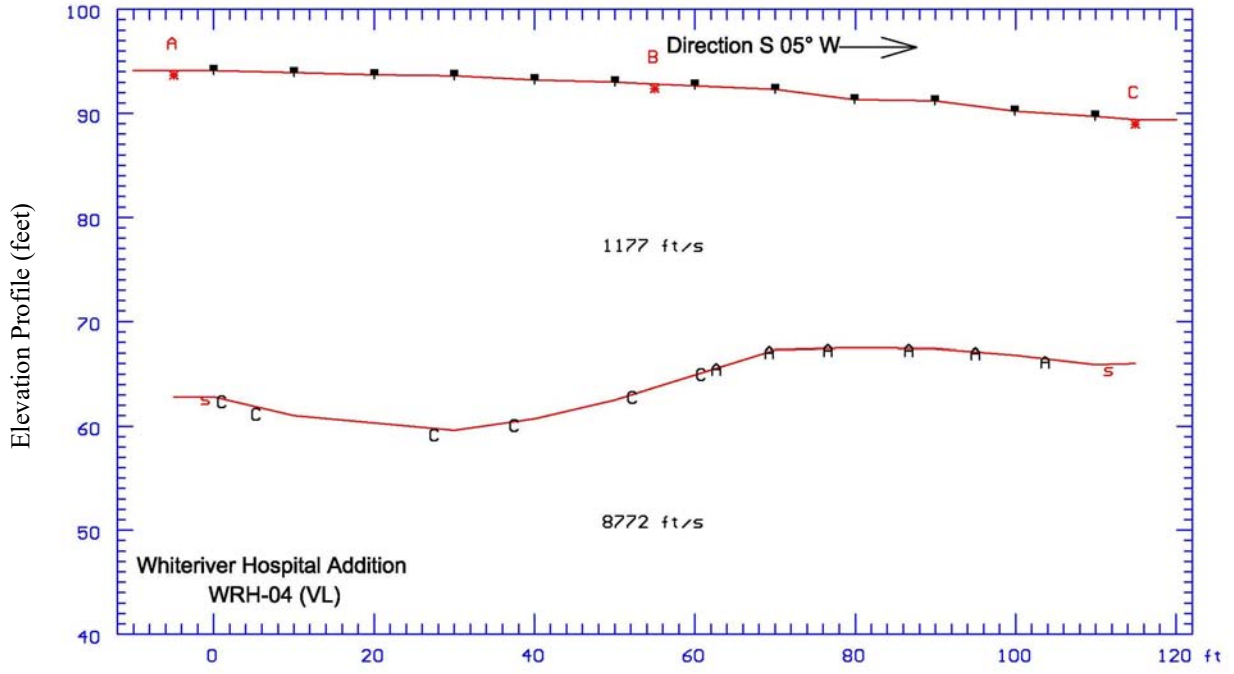


Seismic survey line location: A-shot point start; C-shot point end. Refer to Figure 7 for interpreted seismic line velocity zone cross-section and travel time-distance plot.

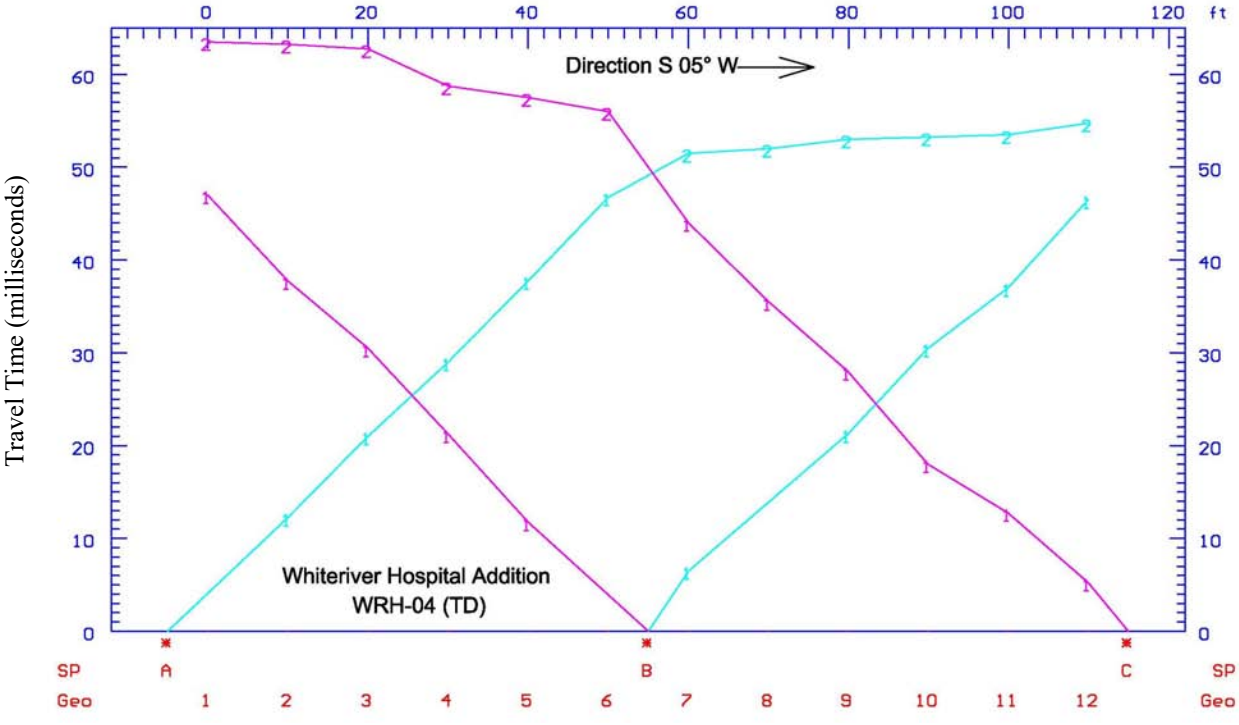
Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey
Seismic Line Photographs—WRH-03
Figure 8

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899



Interpreted Velocity Profile



Time/Distance Plot

Refer to Figure 2 for seismic survey line location and Figure 10 for photographs of the seismic survey line layout

Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey WRH-04
Velocity Profile & Time-Distance Plot
Figure 9

Geological Consultants Inc.

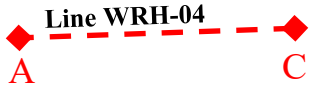
PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899

Figure 10; Photo 1: Seismic Survey Line WRH-04 view looking south from Shot Point A toward Shot Point C.

Figure 10; Photo 2: Seismic Survey Line WRH-04 view looking north from Shot Point C toward Shot Point A.

Photographs of seismic survey line WRH-04 taken July 26, 2024 by N. Marin, Geoscientist; Geological Consultants Inc. Project No. 2024-122.

Explanation:



Seismic survey line location: A-shot point start; C-shot point end. Refer to Figure 9 for interpreted seismic line velocity zone cross-section and travel time-distance plot.

Whiteriver Indian Hospital Addition
Whiteriver, AZ
Seismic Refraction Survey
Seismic Line Photographs—WRH-04
Figure 10

Geological Consultants Inc.

PO Box 39609
Phoenix, Arizona 85069-9609
Phone 602-864-1888
Fax 602-864-1899

APPENDIX A

SEISMIC REFRACTION SURVEY

APPENDIX A

SEISMIC REFRACTION SURVEY

A.1 GENERAL

In general, seismic wave velocities are related to the hardness, consolidation, and density of the materials through which seismic (shock) waves travel. Seismic velocities of subsurface soils and bedrock can be correlated to some of the physical properties of the material with reasonable levels of confidence. As with rock rippability (ease of excavation) for example, the Caterpillar tractor Company has correlated ranges of seismic velocities in different rock and soil materials to qualitative estimates of rippability for their D-9 tractor with a mounted hydraulic No.9 ripper.

The use of seismic velocities measured in various soils and rock types are considered reasonably conservative for evaluating soil and rock characteristics by "indirect" shallow geophysical seismic methods. Some general correlations are as follows:

- Soil, loose surface material, alluvium and strongly weathered and broken bedrock has velocities ranging from 500 feet per second (fps) to 1,200 fps;
- Moderately hard, slightly to moderately cemented, dense alluvial and colluvial sediments and moderately weathered and broken bedrock range from 1,200 fps to 3,000 fps;
- Very dense, hard, well-cemented soils and moderately competent bedrock range from 3,000 fps to 6,000 fps;
- Sound, relatively homogeneous or tightly jointed bedrock and uniformly, strongly cemented soils (silica hardpan, caliche, calcrete, etc.) have seismic velocities greater than 6,000 fps.

Soils and rock with velocities of less than 3,000 fps can usually be excavated with conventional earth moving equipment. Where materials with velocities in excess of 6,000 fps are found, blasting would normally be required for efficient fragmentation. However, if the rock is thinly bedded, jointed, or fractured, it may be possible to break the rock with heavy ripping using a single shank ripper or large ram-hoe. The resulting fragments will be of a size consistent with the fracture spacing and the progress of the excavation would be very slow. The intermediate material (velocities between 3,000 fps and 6,000 fps) would likely require heavy equipment and possibly the localized use of jack- hammers, ram-hoes, or selective blasting to provide cost-effective excavation.

A.2 DATA COLLECTION

Refraction data were collected along seismic survey lines consisting of 12 geophones spaced 10 feet apart. This geometry provided coverage of about 110 feet along each survey line. Refer to Figure 2 for the seismic survey line locations. Seismic waves were generated at shot points located at line ends and the center to measure shallow materials (near-surface) seismic velocities. Data were recorded from both line ends so the effect of layer inclination, or dip on velocity boundaries, could be calculated. This geometry provided at least 40 feet, or more, of penetration at most line locations.

A.3 REFRACTION SEISMIC SURVEY LIMITATIONS

The seismic survey data presented in this report are derived from and interpreted from an indirect geophysical investigative technique (seismic refraction surveys) employed at the specific locations indicated and from observations made of the surface geologic conditions exposed at the site. The interpretations made at the specific seismic survey sites are believed to be reasonable based on the information available at the time of this study. The interpretations may not represent, nor are they intended to represent, the subsurface condition at other locations.

Geologic contacts between rock and soil units are approximate, may be either gradual or abrupt, and the calculated depths could vary from 10 to 20 percent or more. Geological and geotechnical information provided others and our experience on similar projects in similar geological terrain were considered in the interpretations of subsurface conditions.

A.4 REFRACTION DATA PROCESSING

Seismic Refraction Interpretation Programs (SIP) computer programs by RIMROCK GEOPHYSICS, were used to analyze seismic data obtained in the field. The programs calculate average velocities of any number of layers assuming the multilayered intervals do not include velocity inversions or "hidden" zones (i.e., high velocity zone over a low velocity zone). Thicknesses of each layer, except for the lowermost layer, are calculated along with the dip (inclination) angle of the layer boundary. The depth below the ground surface to each layer boundary is also provided.

Input data, velocity of each layer and seismic wave arrival times, obtained during the field work are checked by the computer program to assure that they satisfy reciprocity at least within 20 percent. These data are used to develop a meaningful geological model used to interpret subsurface stratigraphic conditions.

APPENDIX B

ROCK HARDNESS & EXCAVATION CHARACTERISTICS

Tables B-1 and B-2

Table B-1
Rock Hardness & Excavation Characteristics[1]

Rock Hardness Description	Identification Criteria	Unconfined Compressive Strength		Seismic Compression (P-Wave) Velocity		Excavation Characteristics
		MPa	psi	m/s	f/s	
Very Soft Rock	Material crumbles under firm blows with the sharp end of geological pick; can be peeled with a knife; too hard to cut a triaxial sample by hand. SPT will refuse. Pieces up to 3-cm thick can be broken by finger pressure.	1.7 - 3.0	246 - 435	450 - 1,200	1,475 - 3,935	Easy Ripping
Soft Rock	Can just be scraped with a knife; indentations 1-mm to 3-mm show in specimen with firm blows of the pick point; has dull sound under hammer.	3.0 - 10.0	435 - 1,450	1,200 - 1,500	3,935 - 4,920	Hard Ripping
Hard Rock	Cannot be scraped with a knife; hand specimen can be broken with a pick with a single firm blow; rock rings under a hammer.	10.0 - 20.0	1,450 - 2,900	1,500 - 1,850	4,920 - 6,070	Very Hard Ripping
Very Hard Rock	Hand specimens break with a pick after more than one blow; rock rings under hammer	20.0 - 70.0	2,900 - 10,150	1,850 - 2,150	6,070 - 7,050	Extremely Hard Ripping or Blasting
Extremely Hard Rock	Specimen requires many blows with a geological pick to break through intact material; rock rings under a hammer.	> 70.0	> 10,150	> 2,150	> 7,080	Blasting

Note: (1) Table from Weaver, J.M.; 1975; Geological Factors Significant in the Assessment of Rippability; The Civil Engineer in South Africa (*Die siviele iIngenieur in Suid-Afrika*); Volume 17, Issue 12, December 1975; pp. 313-316.

Table B-2
Excavatability of Materials(2)

Material & Range of Marginal Rippability by Seismic Velocity (Cat, 1984; 1993)	Typical Bulldozer Used as Ripper (Cat, 1984; 1993)	Equivalent Backhoe (Kirsten, 1982; 1988)
"Caliche"		
4,000 – 6,000 fps	D7G, 200 HP	235
6,300 – 8,600 fps	D8L, 335 HP	245
6,300 – 8,700 fps	D9N, 370 HP	-
7,200 – 10,300 fps	D9L, 460 HP	RH 40
7,200 – 10,300 fps	D10N, 520 HP	-
7,400 – 10,600 fps	D10, 700 HP	-
7,600 – 11,000 fps	D11N, 770 HP	-
Conglomerate		
4,600 – 5,700 fps	D7G, 200 HP	235
7,600 – 9,300 fps	D8L, 335 HP	245
7,600 – 9,300 fps	D9N, 370 HP	-
8,400 – 10,600 fps	D9L, 460 HP	RH 40
8,400 – 10,600 fps	D10N, 520 HP	-
9,000 – 11,000 fps	D10, 700 HP	-
9,300 – 11,500 fps	D11N, 770 HP	-
Granite		
4,300 – 4,800 fps	D7G, 200 HP	235
6,800 – 8,000 fps	D8L, 335 HP	245
6,800 – 8,000 fps	D9N, 370 HP	-
7,300 – 8,400 fps	D9L, 460 HP	RH 40
7,300 – 8,400 fps	D10N, 520 HP	-
7,800 – 9,000 fps	D10, 700 HP	-
8,100 – 9,500 fps	D11N, 770 HP	-
Schist		
4,300 – 5,300 fps	D7G, 200 HP	235
7,200 – 9,000 fps	D8L, 335 HP	245
7,200 – 9,000 fps	D9N, 370 HP	-
7,700 – 9,500 fps	D9L, 460 HP	RH 40
7,700 – 9,500 fps	D10N, 520 HP	-
8,000 – 10,000 fps	D10, 700 HP	-
8,300 – 10,500 fps	D11N, 770 HP	-

Note: Bulldozer and backhoe power are presented by Kirsten (1982, 1988) as a measure of equivalent performance for excavation. The Caterpillar D6D bulldozer and 225 backhoe and D4E/D5B bulldozer and 215 backhoe are considered equivalent. Seismic velocities below marginal indicate that the material is rippable. Seismic velocities above marginal indicate that the material is non-rippable. All velocities are approximate and represent a typical range. See the Caterpillar Performance Handbook (Caterpillar, 1984, 1993 or current edition) for details on use of this information. Different model configurations include variations in weight and horsepower.

From AMEC, 2005

Note: (2) From AMEC; 2005; consultants report prepared for City of Phoenix entitled "Refraction Seismic Evaluation, Deer Valley Road-7th Street to Cave Creek Road"; COP Project No. ST85100044, AMEC Job No. 5-119-000199, Report No. 2; 2 September 2005.

APPENDIX F
Refraction Microtremor

SUPPLEMENTAL SUBSURFACE SITE CHARACTERIZATION

Whiteriver Indian Hospital
Whiteriver, Arizona
Geolines Project No. NM-240013

Prepared for:

Atek Engineering Consultants
111 S Weber Drive, Suite 1
Chandler, AZ 85226

Prepared by:

Geolines LLC
PO Box 52065
Albuquerque, NM 87181

Tel: (505) 250-0058
Email: zachary.rockhold@geolinesllc.com

SUPPLEMENTAL SUBSURFACE SITE CHARACTERIZATION

Whiteriver Indian Hospital
Whiteriver, Arizona
Geolines Project No. NM-240013

INTRODUCTION

Background

This Subsurface Site Characterization is intended to provide supplemental engineering properties of subsurface materials to Atek Engineering Consultants (Atek) from Geolines LLC (Geolines). This exploration was requested by Antonio Lopez, PE at one (1) array locations, and is intended to supplement a geotechnical evaluation of the Whiteriver Indian Hospital project by Atek.

SURFACE SESMIC EXPLORATION

Refraction Microtremor (ReMi) methods were used to calculate the average velocity of shear waves in materials underlying the geophone array location. Calculated average shear wave velocities over segments of the arrays were used to develop cross sections showing shear wave velocities v. depth. Additionally Geolines was asked to provide a calculated average shear wave velocity of subsurface materials at the Whiteriver Indian Hospital site to a depth of 30 meters (100 feet) for an IBC Site Class.

Shear Wave Velocity Profiles

Refraction Microtremor (ReMi) techniques are routinely used to establish calculated average shear wave velocity of subsurface profiles to 100 feet depth for seismic design. ReMi is used to explore subsurface conditions to more than 1000 feet in oil and mineral exploration (Faster Better Shear Wave Velocity to 100 Meters Depth from Refraction Microtremor Arrays: John N. Louie, Seismological Laboratory and Department of Geological Sciences, Mackay School of Mines, University of Nevada, Reno, Feb 27, 2001). The method can generally estimate shear wave velocities to within 20 percent of measurements by direct methods such as down-hole surveys. The total depth of investigation varies with material type and seismic velocities. Two-dimensional cross sections are presented to 50 feet below existing grades. For most site conditions, resolution for bed thickness is usually 0.3 to 1 times the geophone spacing. In this exploration the geophone spacing, or distance between geophones, was seven feet for all arrays.

Fieldwork

Surface wave measurements for ReMi analysis were obtained at four geophone array locations using a Seismic Source DAQ III Data Acquisition Link seismograph. Each geophone array consisted of 24, 10-Hz (nominal) Geospace Technologies p-wave geophones. Digital samples of surface waves under passive and active conditions were recorded at two millisecond intervals for events of 30 seconds in duration, respectively, for ReMi analysis. After setting up each geophone array, about seven, 30 second events were recorded to obtain surface wave measurements under ambient conditions. After ambient conditions were recorded, about seven, 30 second active source recordings were obtained while striking the ground with a 12-pound sledgehammer about twice per second for about three seconds. The data collected from each array was reduced, processed and stacked. Useable data collected under active and passive conditions at each geophone array location are stacked, as some readings emphasize different portions of the total frequency spectrum available for analysis.

Approximate array locations are shown with array beginnings and endings (Geophone 1 and 24) on Plates 1, *Site Map, Overall* in Attachment 1. Approximate staked boring locations are shown on Plate 1, *Site Map, Overall* in Attachment 1. GPS coordinates for the arrays at geophone locations 01, 12, and 24 for each array, were obtained by a sub meter GPS receiver (GEODE). Latitude/longitude pairs based on WGS84 are provided in the attached Plate 2, *GPS Data, Array 1*. GPS coordinates for the staked boring locations were obtained by a sub meter GPS receiver (GEODE). Latitude/longitude pairs based on WGS84 are provided in the attached Plate 2a, *GPS Data, Staked Boring Locations*.

Data Reduction and Results

Data collected from five overlapping segments of each array were analyzed to provide one-dimensional profiles of calculated shear wave velocities for materials underlying the geophone locations. The analytical segments included nine geophone spacings for all arrays. The analytical segments overlapped adjacent segments. In this investigation the overall geophone arrays consisted of 24 geophones. The analytical segments given as included geophone ranges are as follows: Segment 01 Geophones 01-09, Segment 02 Geophones 05-13, Segment 03 Geophones 09-17, Segment 04 Geophones 13-21, Segment 05 Geophones 16-24. The one-dimensional profile developed for each array segment averages the calculated shear wave velocity of underlying materials over the length and depth of each segment.

The one-dimensional shear wave velocity profile and average shear wave velocities were modeled for each array data set using Optim Software's SeisOpt® ReMi™v4.0 software. The field data were reduced and processed by the software to produce a velocity spectrum by slowness-frequency (p-f) transformation of the records. Using the processed data, the software produces a p-f image and the normal-mode dispersion trend is identified. Frequency-velocity pairs

comprising the dispersion curve are picked at the lower bounds of the trend of the high spectral ratio band identified in the p-f image.

To draw two-dimensional cross sections of shear wave velocities in materials underlying a geophone array, the one-dimensional profile from each segment is applied to the overall array length at the center of the analyzed segment. Two-dimensional cross sections showing the averaged results of shear wave velocity profiles developed as described are presented on Plate 4. One-dimensional profiles of shear wave velocities for analytical segments used to construct the cross sections are presented below the images shown on the plates. The p-f image and dispersion modeling picks for the array measurements are shown on Plate 4, *Dispersion Curve and p-f Image*. The dispersion curve modeling picks obtained from the p-f image were then used to develop a calculated dispersion curve and a one-dimensional shear wave velocity model for the site. Frequency-velocity picks and calculated dispersion curve fits are shown on Plate 4, *Dispersion Curve and p-f Image*.

The shear wave velocity profile for the array is presented in Plate 5, *Shear Wave Velocity Model*. The chart from ASCE 7-16 Chapter 20 Table 20.3-1 detailing seismic site classifications is presented on Plate 4, *ASCE 7-16 Site Classification*.

The calculated average shear wave velocities shown on the plates presented on Plate 7, *Velocity Table Array 01* in Attachment 1, can be used to estimate rippability of subsurface materials. The values shown in the tables for p-wave velocities are estimated by multiplying shear wave velocities by 1.75. When using charts developed by heavy equipment manufacturers to determine the applicability of a particular piece of equipment for excavation, the suggested practice is to multiply by 1.5 to 2 times the shear wave velocity shown on the profiles or cross sections in this report to enter the “seismic wave velocity” axis on the manufacturer’s charts. The term “seismic wave velocity” used in most rippability charts provided by equipment manufacturers are compression or p-wave velocities.

The calculated average shear wave velocity for 100 feet depth at the geophone array is 1640 feet per second (f/s). Based on this finding, a Site Class C as presented in the 2018/2021 IBC is appropriate.

Based on the 2D profile, Bedrock or shear wave velocities over 2,500 ft/s are seen approximately 6 feet to 42 feet below ground surface. velocities greater than 2,500 ft/s may exhibit difficulty when using standard drilling methods. The average velocities then drop into what appears to be a native material with velocities ranging from 900 to 1900 ft/s.

Limitations of Refraction Microtremor Techniques and Assumptions

The ReMi analytical method presents solutions that are not necessarily unique. Application of averages over overlapping segments and inherent uncertainties from non-unique solutions suggest that indicated depths where velocity changes occur, and the calculated velocities shown should be considered approximate. The software used to evaluate surface wave measurements as presented in this report used some assumptions to facilitate the analysis. The bulk density of soils was assumed at 2 g/cc and a Poisson's Ratio of 0.3 is inherent in the calculations.

Closure

The information provided in this report is the result of remote sensing instruments and techniques. Data provided are approximate and should be considered supplemental to the overall characterization efforts performed by others.

Professional services for this project were performed using that degree of care and skill ordinarily exercised under similar circumstances by specialists practicing in this or similar localities. No warranties, express or implied, are intended or made.

Respectfully Submitted:

08-13-2024

Zachary J. Rockhold
Owner

Attachment 1:
Plates

SUPPLEMENTAL SUBSURFACE SITE CHARACTERIZATION

Whiteriver Indian Hospital
Whiteriver, Arizona
Geolines Project No. NM-240013

Prepared for:

Atek Engineering Consultants
111 S Weber Drive, Suite 1
Chandler, AZ 85226

Prepared by:

Geolines LLC
PO Box 52065
Albuquerque, NM 87181

Tel: (505) 250-0058
Email: zachary.rockhold@geolinesllc.com

MAP LEGEND		Whiteriver Indian Hospital Whiteriver, Arizona	SITE MAP Overall	
Approximate Array Location Approximate Location Staked Boring # Approximate Location Reference Point	GEOLINES	Atek Engineering Consultants 111 S Weber Drive, Suite 1 Chandler, AZ 85226	PROJECT NO.:	PLATE NO.
			NM-240013	1

Global Positioning System Coordinates for Seismic Arrays

Project No.:	NM-240013
Project:	Atek Engineering Consultants 111 S Weber Drive, Suite 1 Chandler, AZ 85226
Date:	Wednesday, July 24, 2024
Comments:	General investigation area location provided by Atek. Acutal loactions of seismic lines adjusted based on field conditions. Endpoint coordinates provided by Geode Sub-Meter GPS manufractured from Juniper Systems, and map datum WGS84 was used.

Array Name	Array Orentation Geophone 1-24	Geophone Spacing (f)	Number of Geophones	Array Length (m)	Location Latitude/Longitude Latitude (Degrees)	Location Latitude/Longitude Longitude (Degrees)	Comments
Array 01	W to E	15.00	24	345.00	33.875445°	-109.960844°	Geophone 01
					33.875559°	-109.960318°	Geophone 12
					33.875670°	-109.959750°	Geophone 24

GEOLINES

Whiteriver Indian Hospital
Whiteriver, Arizona

GPS Data
Array 01

Atek Engineering Consultants
111 S Weber Drive, Suite 1
Chandler, AZ 85226

PROJECT NO.:	PLATE NO.
NM-240013	2

Global Positioning System Coordinates for Staked Boring Locations

Project No.:	NM-240013
Project:	Atek Engineering Consultants 111 S Weber Drive, Suite 1 Chandler, AZ 85226
Date:	Wednesday, July 24, 2024
Comments:	General investigation area location provided by Atek. Endpoint coordinates provided by Geode Sub-Meter GPS manufractured from Juniper Systems, and map datum WGS84 was used.

Proposed Boring Number	Location Latitude/Longitude Latitude (Degrees)	Location Latitude/Longitude Longitude (Degrees)	Comments
B1	33.875707°	-109.959564°	Staked Boring Location labeled "B1"
B3	33.875518°	-109.960268°	Staked Boring Location labeled "B3"
B7	33.875478°	-109.960836°	Staked Boring Location labeled "B7"
Reference Point	33.875501°	-109.959705°	"RP" on Site Map

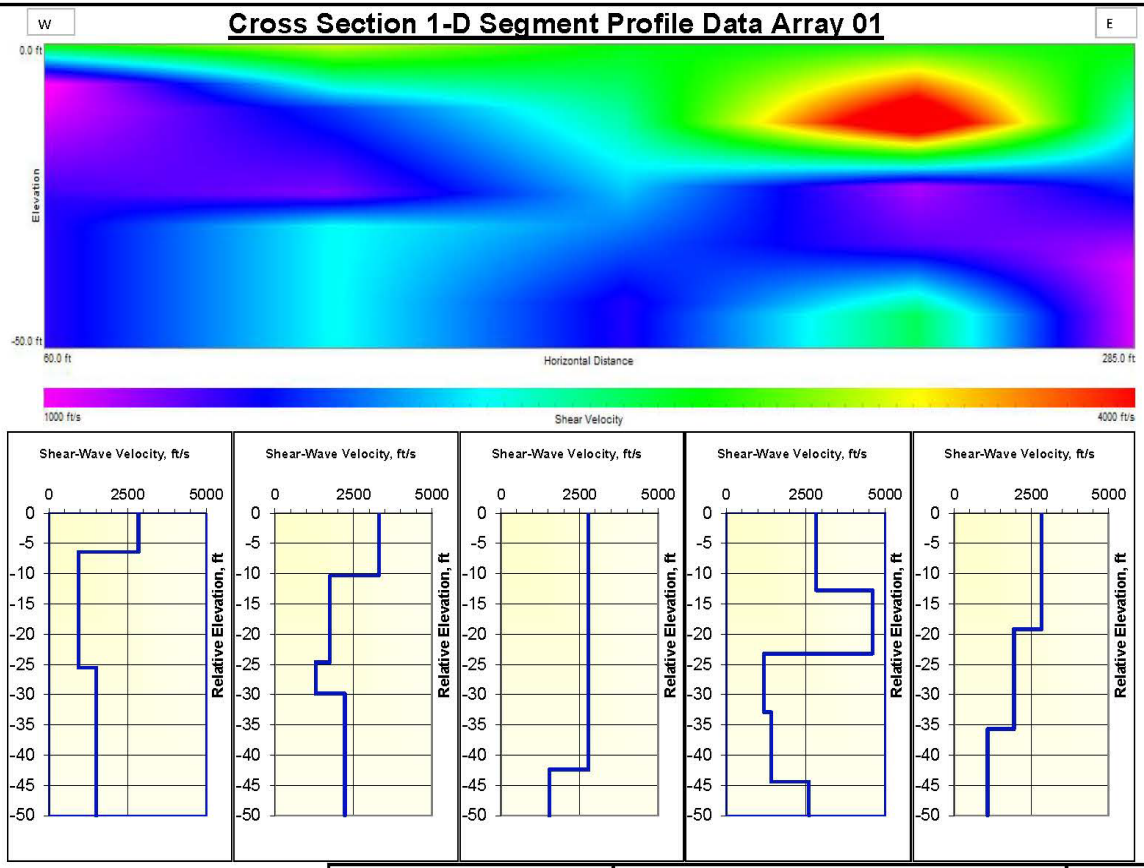
GEOLINES

Whiteriver Indian Hospital
Whiteriver, Arizona

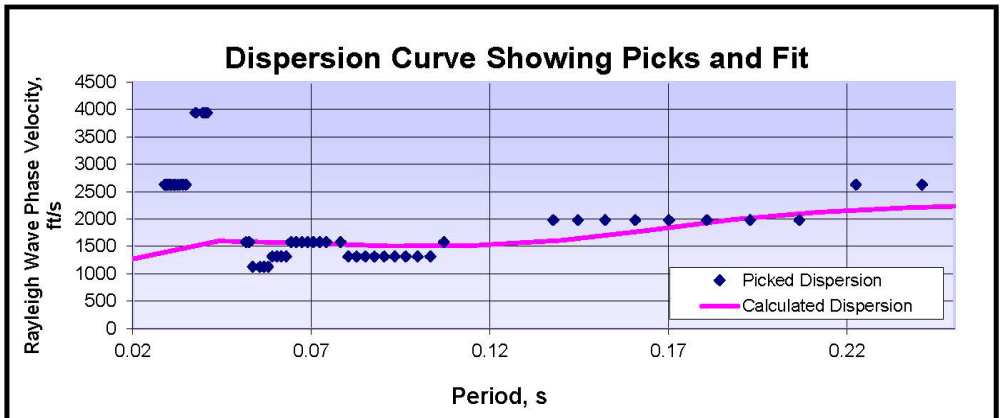
Atek Engineering Consultants
111 S Weber Drive, Suite 1
Chandler, AZ 85226

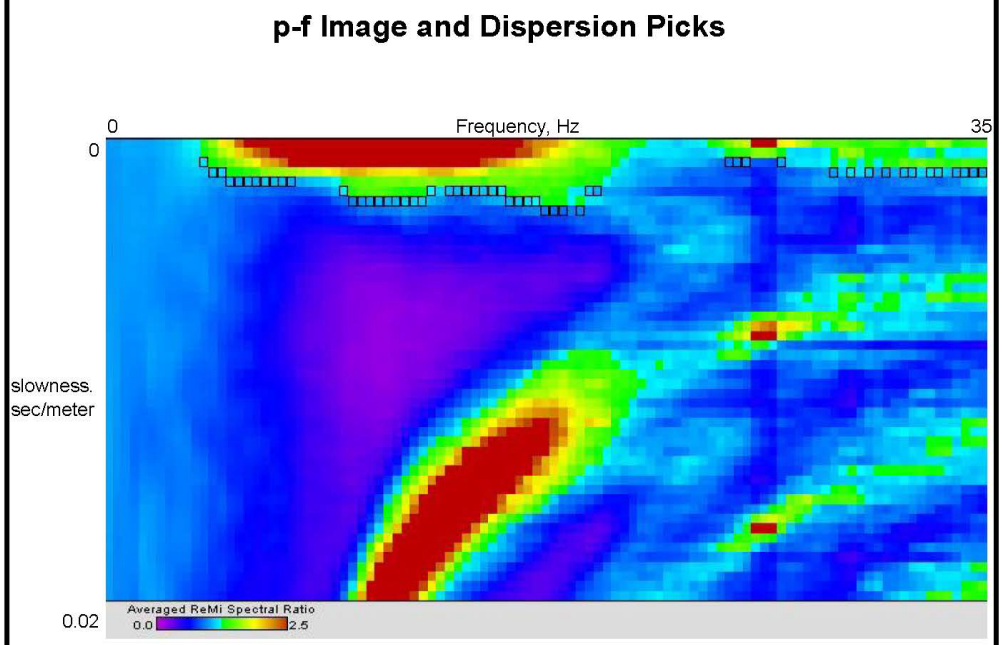
GPS Data
Staked Boring Locations

PROJECT NO.:	PLATE NO.
NM-240013	2a

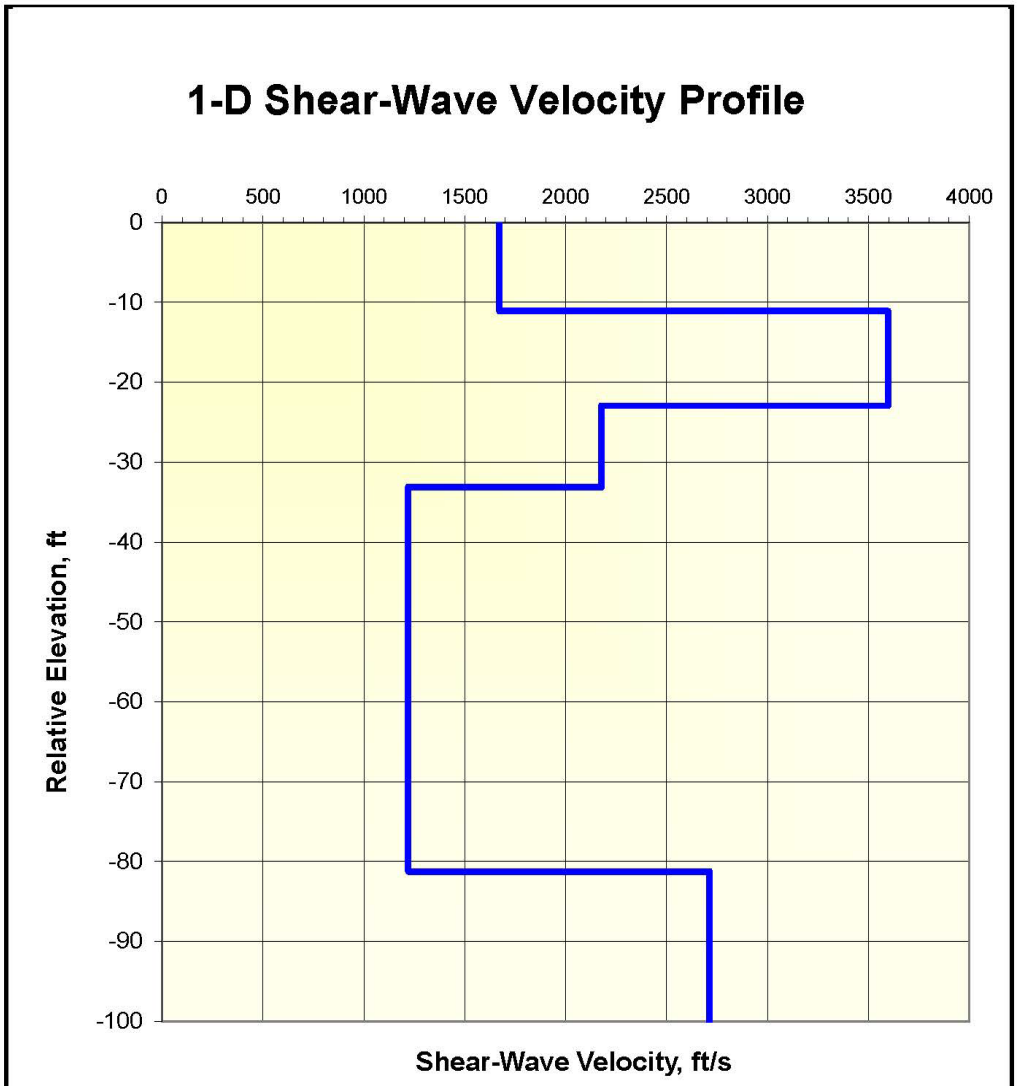


GEOLINES	Whiteriver Indian Hospital Whiteriver, Arizona	Cross Section 1-D Segment Profile Data Array 01
	Atek Engineering Consultants 111 S Weber Drive, Suite 1 Chandler, AZ 85226	PROJECT NO.: NM-240013 / PLATE NO.: 3





GEOLINES	Whiteriver Indian Hospital Whiteriver, Arizona	Dispersion Curve and p-f Image	
	Atek Engineering Consultants 111 S Weber Drive, Suite 1 Chandler, AZ 85226	PROJECT NO.:	PLATE NO.
		NM-240013	4



* The modeling methods used to calculate shear wave velocities do not necessarily have unique solutions, therefore velocities and depth to changes in velocities should be considered approximate.

GEOLINES	Whiteriver Indian Hospital Whiteriver, Arizona	SHEAR WAVE VELOCITY MODEL
	Whiteriver Indian Hospital Whiteriver, Arizona	PROJECT NO.: NM-240013 / PLATE NO.: 5

Table 20.3-1

Site Classification

Site Class	v_s	N or N_{ch}	$\bar{s}_u$
A. Hard rock	$> 5{,}000$ ft / s	NA	NA
B. Rock	2,500 to 5,000 ft / s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft / s	> 50 blows / ft	$> 2{,}000$ lb / ft^2
D. Stiff soil	600 to 1,200 ft / s	15 to 50 blows / ft	1,000 to 2,000 lb / ft^2
E. Soft clay soil	< 600 ft / s	< 15 blows / ft	$< 1{,}000$ lb / ft^2
	Any profile with more than 10 ft of soil that has the following characteristics: — Plasticity index $PI > 20$, — Moisture content $w \geq 40\%$, — Undrained shear strength $\bar{s}_u < 500$ lb / ft^2		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

Note: For SI: 1 ft = 0.3048 m; 1 ft / s = 0.3048 m / s; 1 lb / ft^2 = 0.0479 kN / m^2.

Print

GEOLINES	Whiteriver Indian Hospital Whiteriver, Arizona	**ASCE 7-16** **Site Classification**
	Atek Engineering Consultants 111 S Weber Drive, Suite 1 Chandler, AZ 85226	PROJECT NO.: NM-240013 / PLATE NO.: 6

Array 01

Array 1D Segment	Geophone Segment	Horizontal Array Segment (feet)	Placement on array (feet from 0)	Depth Below Surface (feet) From	To	Calculated Shear Wave Velocity (Feet/second)	Estimated p-Wave Velocity (Feet/second)
Seg 01	1 to 9	0 to 120	60	0	6	2847	4982
				6	26	943	1650
				26	50	1509	2641
Seg 02	5 to 13	60 to 180	120	0	10	3302	5779
				10	25	1750	3063
				25	30	1297	2270
				30	50	2222	3889
Seg 03	9 to 17	120 to 240	180	0	42	2778	4862
				42	50	1535	2686
Seg 04	13 to 21	180 to 300	240	0	13	2830	4953
				13	23	4596	8043
				23	33	1191	2084
				33	44	1411	2469
				44	50	2599	4548
Seg 05	16 to 24	225 to 345	285	0	19	2824	4942
				19	36	1936	3388
				36	50	1082	1894

GEOLINES

Whiteriver Indian Hospital
Whiteriver, Arizona

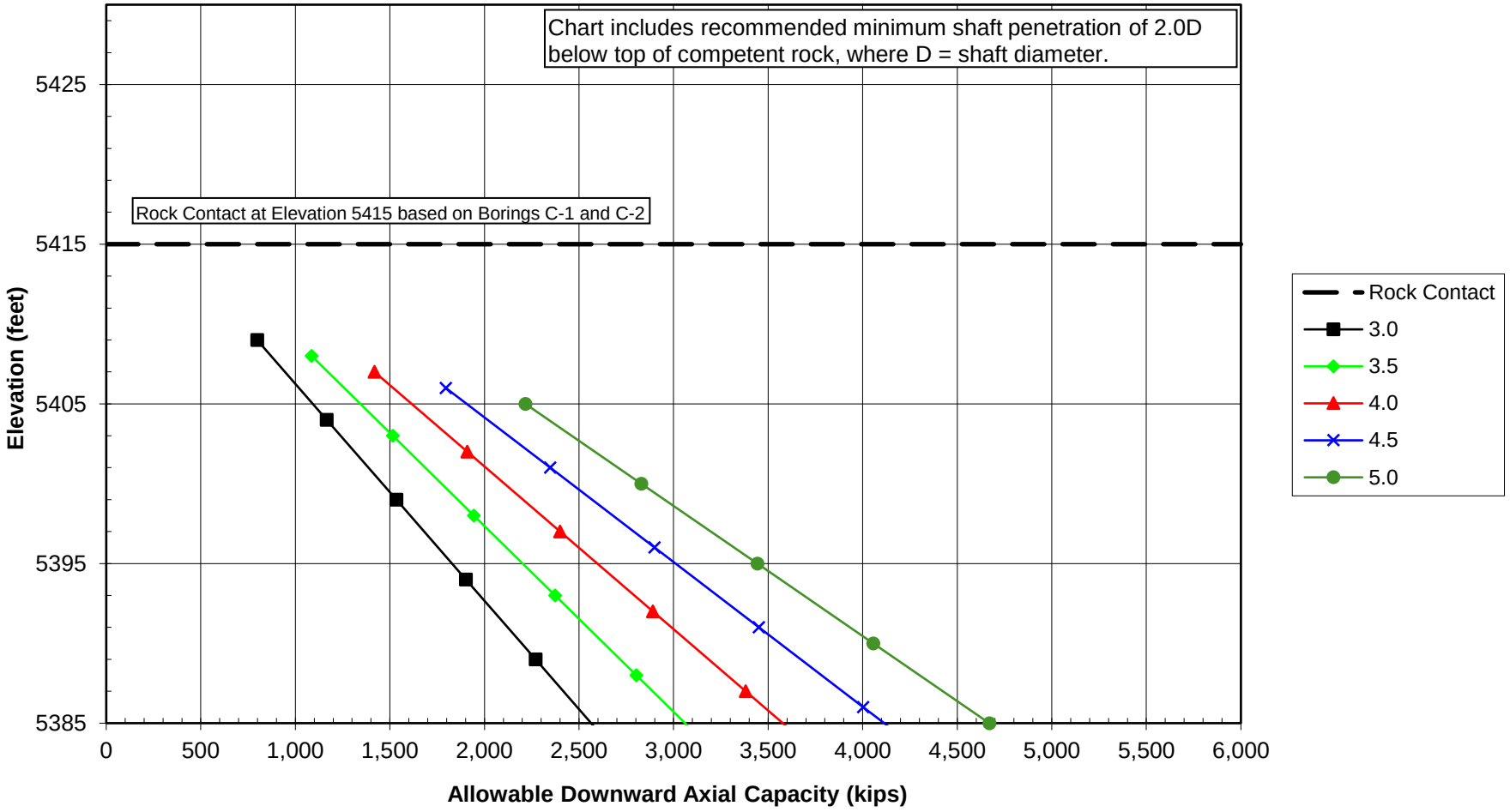
Velocity Tables
Array 01

Atek Engineering Consultants
111 S Weber Drive, Suite 1
Chandler, AZ 85226

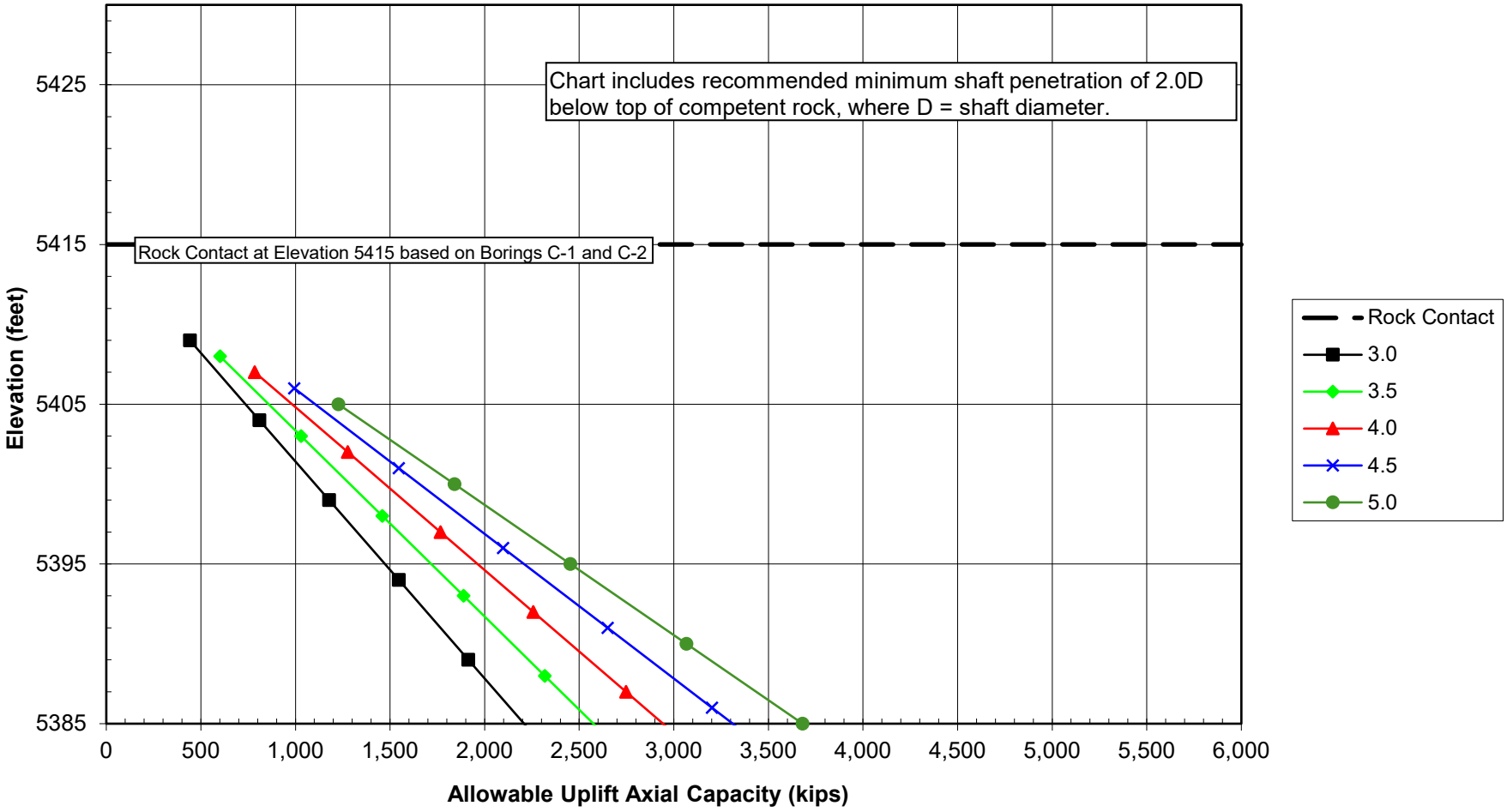
PROJECT NO.:	PLATE NO.
NM-240013	7

APPENDIX G
Allowable Downward Axial and Uplift Capacity

Design Chart 1
Whiteriver Indian Hospital
Allowable Axial Capacity of Drilled Shaft Rock Sockets
AASHTO Method (2002)



Design Chart 2
Whiteriver Indian Hospital
Allowable Uplift Capacity of Drilled Shaft Rock Sockets
AASHTO Method (2002)



APPENDIX H
Geology Cross Section Profile

GEOTECHNICAL EXPLORATION REPORT
IHS WHITERIVER WASTEWATER TREATMENT PLANT
200 WEST HOSPITAL DRIVE
WHITERIVER, ARIZONA

Prepared for:
Mabbet and Associates, Inc.
105 Central Street, Suite 4100
Stoneham, Massachusetts

ENGINEERING CONSULTANTS

Prepared by:
ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, Arizona 85226

ATEK Project # 250012

September 15, 2025

September 15, 2025
ATEK Project #250012

Stephen A. Vetere, PE, LSP, LEP, Vice President of Operations
Mabbet and Associates, Inc.
105 Central Street, Suite 4100
Stoneham, Massachusetts

Regarding: Geotechnical Exploration Report

Project: IHS Whiteriver Wastewater Treatment Plant
200 West Hospital Drive
Whiteriver, Arizona

Dear Mr. Vetere:

ATEK Engineering Consultants, LLC is pleased to present the attached Geotechnical Exploration Report for the IHS Whiteriver Wastewater Treatment Plant located in Whiteriver, Arizona within the Fort Apache Indian Reservation. The purpose of our study was to explore and evaluate the subsurface conditions at the proposed site to develop geotechnical engineering recommendations for project design and construction.

Based on our findings, the site is considered suitable for the proposed construction, provided geotechnical recommendations presented in the attached report are followed. Specific recommendations regarding the geotechnical aspects of the project design and construction are presented in the attached report. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,
ATEK Engineering Consultants, LLC

Registered Professional Engineer (Civil) CERTIFICATE NO. 71358 ANTONIO LOPEZ ESQUEDA DATE SIGNED 9/15/25 ARIZONA U.S.A.

Antonio Lopez, P.E.
Geotechnical Group Manager

Registered Professional Engineer (Civil) CERTIFICATE NO. 39511 ARMANDO ORTEGA Date Signed 9/15/2025 ARIZONA, U.S.A.

Armando Ortega, P.E.
Principal Geotechnical Engineer

Distribution: (1) Addresses (Electronic Copy)

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1. Project Description 1
1.2. Purpose 1
1.3. Scope of Services 2

2. FIELD EXPLORATION 2
2.1. General 2
2.2. Soil Test Borings 2

3. LABORATORY TESTING 4

4. GENERAL SITE CONDITIONS 4
4.1. Site Geology 4
4.2. Surface Conditions 5
4.3. Subsurface Conditions 5
4.4. Groundwater Conditions 6
4.5. Geologic Hazards 6
4.5.1. Liquefaction Potential 6
4.5.2. Collapsible Soils 6
4.5.3. Expansive Soils 7
4.6. Faulting 7
4.7. Seismic Considerations 7
4.8. Earth Fissures and Land Subsidence 8

5. ENGINEERING ANALYSES AND RECOMMENDATIONS 8
5.1. Earthwork 8
5.1.1. Frost Depth 9
5.1.2. Frost Consideration 9
5.1.3. Spread Footings - WWTP 10
5.1.4. Tank Foundation 10
5.1.4.1. Ring Foundation 10
5.1.4.2. Structural Slab with Thickened Edges 11
5.1.5. Mat Foundation 11
5.1.6. Retaining Wall Foundation 12
5.1.7. Sidewalks and Exterior Slabs 12
5.1.8. Onsite Pavement Site Preparation and Grading 13
5.1.9. Aggregate Base Course 13
5.1.10. Engineered Fill 14
5.2. Excavation 17
5.2.1. Trench Backfill 17
5.2.2. Temporary Excavations 19
5.2.1. Permanent Excavations and Slopes 20
5.3. Structures 20
5.3.1. Shallow Spread Footings 21
5.3.1.1. Structural Slab 22

atek
ENGINEERING CONSULTANTS

5.3.2. Mat Foundation 22
5.3.3. Resistance to Lateral Loads 23
5.3.3.1. Wall Drainage 24
5.3.3.2. Backfill Placement 24
5.4. Moisture Protection 25
5.5. Corrosion Potential 25
5.5.1. 10-point System 25
5.5.1.1. Electrical Resistivity 26
5.5.1.2. Oxidation-Reduction (Redox) Potential 27
5.5.1.3. Sulfides 27
5.5.1.4. Moisture 27
5.5.1.5. Concrete Corrosion 28
5.6. Onsite Pavement Areas 28

6. CLOSURE 29
6.1. Limitations 29
6.2. Recommended Additional Services 30

APPENDIX A – Site Location Map
APPENDIX B – Sample Location Plan
APPENDIX C – Field Study and Boring Logs
APPENDIX D – Laboratory Test

atek
ENGINEERING CONSULTANTS

1. INTRODUCTION

This report presents the results of our geotechnical exploration for the IHS Whiteriver Wastewater Treatment Plant located in Whiteriver, Arizona within the Fort Apache Indian Reservation. A Site Location Map is presented in **Appendix A** of this report. The following sections of this report describe our understanding of the project and our scope of services.

1.1. Project Description

The proposed project involves the construction of a new wastewater treatment facility in Whiteriver, Arizona within the White Mountain Apache Tribe. The planned construction will be constructed within Section 30 of Township 6 North, and Range 23 East of the Gila and Salt River Meridian. The construction involves three welded steel tanks, one reclaimed water tank and two domestic water tanks, a single facility building and a retaining wall with a maximum height of seven (7) feet. The reclaimed water tank will have a diameter of 32 feet, an approximate height of 26.5 feet, and a capacity of 150,000 gallons. The domestic water tanks will have a diameter of 42 feet, an approximate height of 33 feet, and a capacity of 325,000 gallons. The wastewater treatment facility building will have an approximate footprint of 16,100 square feet. The building will be divided into several areas such as solids handling, chemical storage, electrical room, blower room, aerobic digesters, equalization storage, headworks and process area. Additional enhancements will include on-site paved areas to accommodate deliveries and pickups, including garbage and biowaste handling, and drainage improvements.

1.2. Purpose

The purpose of this geotechnical study was to evaluate the general surface and subsurface conditions at the site, and to present recommendations related to geotechnical aspects of design and construction of the proposed project.

1.3. Scope of Services

Our study included a site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. This report presents geotechnical recommendations for design and construction of proposed structures. The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the "Limitations" section of this report.

2. FIELD EXPLORATION

2.1. General

Prior to the start of drilling, Arizona 811 and the Tribal Utility Authority were contacted to locate existing utilities at the boring locations. The field exploration was performed from August 7th to August 9th, 2025. Eight soil borings were drilled to depths ranging between three (3) and thirty (30) feet below existing grade. Two drilling methods were used during our exploration, Hollow Stem Auger (B-1, B-2, B-3, B-7, and B-8) and Tubex Down-The-Hole Hammer with casing advance (B-4, B-5 and B-6). Auger refusal was encountered at each boring location. The soil test borings were drilled using a CME-850 Track Drill rig equipped with 7 and ¼-inch outside diameter hollow stem augers and 5.5-inch casing with 3.5-inch down the hole hammer. The borings were located in the field at the approximate locations shown on the Sample Location Plan included in **Appendix B** of this report. Upon completion of the borings, the boreholes were backfilled with excavated materials.

2.2. Soil Test Borings

Disturbed and relatively undisturbed samples were taken at the direction of the field engineer during drilling operations. Relatively undisturbed samples of the subsurface materials were obtained using a California sampler with a 2.5-inch inside diameter and a 3.0-inch outside diameter. Disturbed samples were obtained using a Standard Penetration/Split Spoon Sampler (SPT) with a 1.5-inch inside diameter and 2.0-inch

outside diameter. The California and the SPT samplers were driven 12 and 18 inches, respectively, using a 140-pound hammer falling 30 inches, and blow counts for successive 6-inch penetration intervals were recorded. After the sampler was withdrawn from the borehole, the samples were removed, sealed to minimize moisture loss, and submitted to the laboratory.

Soil classifications made in the field from auger cuttings and samples were re-evaluated in the laboratory after further examination and testing. The soils were classified in accordance with the Unified Soil Classification System presented in **Appendix C**.

Sample classifications, blow counts recorded during sampling, and other related information, were recorded on the soil boring logs. The boring logs are presented in **Appendix C**. The information presented on the logs are a combination of factual and interpretive information. Lines delineating subsurface strata and group symbols are based on field observations made at the time of the field study. Actual subsurface lines delineating subsurface strata may be gradual and vary.

2.3. Earthwork shrinkage and ground compaction

The in-place density of the soils were obtained at the selected depths within the soil borings. These values were compared with the results of laboratory moisture-density relationship (Standard Proctor) tests to estimate earthwork shrink factor.

The following table presents estimated earthwork shrinkage of the site soils. These estimates are based on the relevant information gathered during the field study, laboratory testing and assumption that the site soils are being compacted to between 95 and 100 percent of maximum dry density as determined by American Society for Testing and Materials (ASTM) Test Method D 698.

Elevation (ft.)	Earthwork Shrinkage (%)	Ground Compaction (ft)
0-5	20	0.10

3. LABORATORY TESTING

Selected soil samples from the borings were tested in the laboratory for classification purposes and to evaluate their engineering properties. The laboratory tests included:

- Gradation;
- Hydrometer;
- Atterberg limits;
- Moisture content;
- One-dimensional consolidation;
- Undisturbed ring density;
- Standard Proctor;
- Swell potential of soil;
- pH tests;
- Resistivity tests;
- Sulfate content;
- Chloride content;
- Sulfide content;
- And redox potential.

A brief description of each test performed on the soil samples and the results are presented in **Appendix D** of this report.

4. GENERAL SITE CONDITIONS

4.1. Site Geology

The project is located on the Fort Apache Indian Reservation in Navajo County, within the White Mountains region of east-central Arizona. This zone is primarily influenced by Cenozoic volcanic activity and tectonic uplift associated with the Colorado Plateau and Basin and Range transition zone. The project site is located within the mapped

surficial Permian age Supai formation unit (PPs)[1]. The Supai formation is a sequence of sedimentary rocks which includes interbedded layers of sandstone, shale and limestone usually characterized by ledgy outcrops. The surficial soil consists of a mixture of gravelly sand, silt and clay.

4.2. Surface Conditions

The project is located on Lot 3, Section 30, Township 6 North, Range 23 East of the Gila-Salt River Principal Meridian in Whiteriver, Arizona, within the Fort Apache Indian Reservation. The site lies on a hillside west of Bourke Wash, running parallel to the existing overhead powerlines. The surface is characterized by angular, ledgy rock outcrops and subrounded cobbles ranging from approximately three (3) to twelve (12) inches in diameter. The area also supports dense vegetation, primarily tall Pinyon-Juniper trees. A gravelly earthen road runs parallel to the project site.

4.3. Subsurface Conditions

As indicated by the exploratory borings, in general the surface soils consist of fine-grained and coarse-grained soils, cobbles, potential boulders and potential bedrock. The fine-grained soils consist of Lean Clay with Sand (CL) and Sandy Lean Clay (CL) with a relative consistency of medium stiff to very stiff. The coarse-grained soils consist of Poorly Graded Gravel with Sand (GP), Silty Sand with Gravel (SM), Silty Gravel with Sand (GM), Silty Gravel (GM), Clayey Gravel with Sand (GC) with a relative density of medium dense to very dense. The plasticity index ranges from no to high plasticity. The underlying subsurface soils encountered during our field exploration consist of fine grained and coarse-grained soils. The fine-grained soils consist of Sandy Lean Clay (CL), Sandy Silt (ML), Sandy Lean Clay with Gravel (CL) with relative consistency of very stiff to hard. The coarse-grained soils consist of Silty Gravel with Sand (GM), Silty, Clayey Gravel with Sand (GC-GM), Poorly Graded Gravel with Sand (GP), Silty Sand with Gravel (SM), Clayey Gravel with Sand (GC) with a relative density of dense to very dense. The

[1] *Wilson, E.D., Moore, R.T., and O, Haire, R.T.; 1960; Geologic map of Navajo and Apache Counties, Arizona*

plasticity index ranges from no to medium plasticity. For additional information see Boring Logs presented in **Appendix C**.

4.4. Groundwater Conditions

Groundwater was not encountered within the soil test borings, and it is anticipated that groundwater will not be a factor in design or construction of the planned improvements. It should be noted that soil moisture conditions within the area may vary depending on rainfall and/or runoff conditions not apparent at the time of our field study.

4.5. Geologic Hazards

4.5.1. Liquefaction Potential

Based on the site soils and groundwater conditions encountered at the project site during this study, the preliminary potential for soil liquefaction is considered to be negligible.

4.5.2. Collapsible Soils

Collapsible soils are soils with the potential for a decrease in volume with an increase in external load or moisture content. These soils are typically found in areas of alluvial deposits with semi-arid to arid climates. Based on the information collected during our field study and subsequent laboratory testing, we anticipate collapse-susceptible soils will be encountered during construction. Based on ASTM Test Method D 5333, a calculated collapse potential, I_C, of the tested undisturbed ring samples collected during our field study resulted in 5.96 and 7.70 percent indicating a moderate to moderately severe collapse potential.

4.5.3. Expansive Soils

Expansive soils are soils with the potential for an increase in volume with an increase in moisture content. Based on the information collected during our field study and subsequent laboratory testing, we anticipate expansive-susceptible soils will be encountered during construction. Based on ASTM Test Method 4546, the expansive potential of the remolded sample collected during our field study, in the upper 5 feet, indicated an expansive potential.

4.6. Faulting

The project site is located approximately 29 miles southwest of the Concho Fault. The Concho Fault is northwest to southeast trending fault. The latest activity is estimated to be the Quaternary period. The slip rate is estimated at 0.2 mm per year[2].

4.7. Seismic Considerations

The project site is located in eastern Arizona which is an area of low seismic activity. The following values were developed using the Seismic Design Maps by Structural Engineers Association by Location, the ASCE 7-16 Reference and are based on knowledge of local geologic conditions, and subsurface soils encountered during our study. A 100-foot soil test boring was not advanced during our field study. The geographic coordinates listed below were used in developing the seismic design factors.

Central Latitude.....33.88362419˚
Central Longitude.....-109.96282253˚

[2] U.S. Geological Survey. (n.d.). *Concho fault* [PDF]. https://earthquake.usgs.gov/static/lfs/nshm/qfaults/Reports/1014.pdf

Seismic Design Factors	Value
Site Class	D
F_a, Site Coefficient	1.591
F_v, Site Coefficient	2.4
S_s, Mapped Spectral Acceleration at 0.2-second Period	0.261 g
S_1, Mapped Spectral Acceleration at 1.0-second Period	0.082 g
S_{MS}, Spectral Acceleration at 0.2-second Period Adjusted for Site Class	0.415 g
S_{M1}, Spectral Acceleration at 1.0-second Period Adjusted for Site Class	0.196 g
S_{DS}, Design Spectral Response Acceleration at 0.2-second Period	0.227 g
S_{D1}, Design Spectral Response Acceleration at 1.0-second Period	0.131 g

4.8. Earth Fissures and Land Subsidence

The project site is located in an area with no documented earth fissures (Natural Hazards in Arizona by Arizona Geological Survey) and in an area without a measured land subsidence (Arizona Land Subsidence Areas by Arizona Department of Water Resources).

5. ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1. Earthwork

All existing structural remnants, fill, topsoil, vegetation and organic soils should be removed from below structural areas. The following sections present earthwork recommendations based on our understanding of the project, the finding of our field exploration, results of the laboratory tests and engineering analysis. Based on the finding of our field exploration, laboratory test results and engineering analysis, it is our opinion that the proposed construction can be supported on a footing system as presented in the following sections. **The site contains oversized material greater than three inches. ATEK recommends this material to be screened and/or crushed if utilized in fill areas.**

5.1.1. Frost Depth

Based on review of the building codes and standards of the neighboring town of Pinetop-Lakeside the frost depth is 18-inches. To protect against frost heave, the use of fine-grained soils should be avoided in and around structural areas. The potential for snowpack adjacent to the structural areas may allow significant moisture to increase into fills around the outer edge of foundations therefore the exterior should be graded for positive drainage away from the structural areas.

5.1.2. Frost Consideration

The site soils are frost susceptible, and small amounts of water can affect the performance of the relatively lightly loaded slab-on-grade and concrete flatwork. Exterior slabs and flatwork should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible engineered fill per Section 5.1.10. Placement of non-frost susceptible material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from structures and flatwork and toward the site storm drainage system;
- Install drain tiles around the perimeter of the building, stoops, below exterior slabs and pavements, and connect them to the storm drainage system;
- Grade clayey subgrades such that groundwater, potentially perched, in overlying more permeable subgrades, such as sand or aggregate base, drain toward the site drainage system;
- Place non-frost susceptible fill as backfill beneath slabs and flatwork that are critical to the project;
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between non-frost susceptible soils and other soils.

5.1.3. Spread Footings - WWTP

The existing surface soils should be removed to a minimum depth of two (2) feet below bottom of proposed spread footing elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the structure and extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure. The exposed subsurface soils should be scarified to a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to within one (1) foot of finished pad elevation. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

Engineered Fill material meeting the recommendations for Low Expansive Imported Soils presented in Section 5.1.10 of this report should be placed within one (1) foot of the finished pad elevation. These soils should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.4. Tank Foundation

5.1.4.1. Ring Foundation

The existing surface soils should be removed to a minimum depth of three (3) feet below the bottom of proposed ring foundation elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the tank and extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure. The exposed subsurface soils should be scarified to

a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring the site to finished grade. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698. Material greater than three inches should be removed during earthwork operations.

5.1.4.2. Structural Slab with Thickened Edges

A structural slab with thickened edges may be used to support the welded steel tanks. The soil below the structural slab should be removed to a depth of two (2) feet below the bottom of the thickened edge. The over excavation of site soils should be extended laterally for a minimum distance of five (5) feet beyond the perimeter of structures. The exposed subsurface soils should be scarified to a minimum depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring site to grade. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698. Material greater than three inches should be removed during earthwork operations.

5.1.5. Mat Foundation

The soil below the mat foundation should be removed to a depth of two (2) feet below. The exposed subsurface soils should be scarified to a minimum depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum

moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring site to grade. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698. The over excavation of site soils should be extended laterally for a minimum distance of five (5) feet beyond the perimeter of the mat foundation.

5.1.6. Retaining Wall Foundation

The existing surface soils should be removed to a minimum depth of two (2) feet below bottom of proposed spread footing elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the retaining wall foundation and extend laterally for a minimum distance of two (2) feet on either side of the foundation. The exposed subsurface soils should be scarified to a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring the site to finished grade elevation. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.7. Sidewalks and Exterior Slabs

The site soil tested as part of this project exhibit swelling potential and should not be used within twelve (12) inches of finished subgrade. The existing surface soils should be removed to a minimum depth of twelve (12) inches below the bottom of proposed concrete flatwork. The exposed subsurface soils should be scarified to a depth of six (6) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Engineered Fill material meeting the recommendations for Low Expansive Imported Soils (non-frost susceptible) presented in Section 5.1.10 of this report should be placed within eight (8)

inches of the finished subgrade elevation. These soils should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.8. Onsite Pavement Site Preparation and Grading

The pavement section presented in this report is based on the site soils encountered during our field exploration. Any material with a diameter larger than three (3) inches within the pavement area should be removed during scarification. The native soils should be scarified to a depth of twelve (12) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.9. Aggregate Base Course

Aggregate base used in support of Portland cement concrete and asphaltic concrete pavements should conform to the local governing agency and/or Maricopa Association of Governments (MAG) Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40 when exposed to a maximum of 500 revolutions.

A minimum of four (4) inch layer of clean, granular material should be placed beneath concrete slabs to serve as a leveling base, and to aid in concrete curing. The material should conform to the gradation requirements set by the local governing agency and/or MAG section 702 specifications for Aggregate Base Course (ABC). The use of moisture barriers beneath the floor slabs may be helpful but is not a geotechnical requirement; however, the architect or the slab designer should evaluate their need.

All aggregate base material should be placed in lifts not greater than eight (8) inches and compacted to a minimum of 95 percent of maximum dry density below Portland cement concrete and one hundred percent of maximum dry density below asphaltic concrete pavements as determined by ASTM Test Method D 698 or as specified by local specification. The moisture content during compaction should be maintained within two percent of optimum moisture content.

5.1.10. Engineered Fill

Engineered fill may consist of native soils and/or imported soils. Pea gravel and poorly-graded materials should not be used as engineered fill unless approved by the geotechnical engineer. All engineered fills should be compacted as noted in Section 5.

1. Native soils can be used as fill material for the following:
   - general site grading
   - foundation areas
   - Unsuitable under slabs
   - foundation backfill
   - pavement areas

2. Imported soils with low expansive potentials could be used as fill material for the following:
   - general site grading
   - foundation areas
   - interior floor slab areas
   - foundation backfill
   - exterior slab areas
   - pavement areas

3. Imported soils (if required) should conform to the following:

Gradation	**Percent finer by weight (ASTM C136)**
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	50 (max)

Liquid Limit.....30 (max)

Plasticity Index.....15 (max)

Swell Test

Maximum Swell Potential .....1.5 %*

*Measured on a sample compacted to approximately 95 percent of the ASTM Test Method D 698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 144 psf surcharge and submerged.

Corrosion Potential	**(PPM)**
Sulfate Content (ARIZ 733)	1,000(max)
Chloride Content (ARIZ 736)	500(max)

4. In addition to the above, imported low-frost susceptible soils should conform to the following:

Gradation	**Percent finer by weight (ASTM C136)**
3"	100
No. 4 Sieve	25-60
No. 200 Sieve	15 (max)

Swell Test

Maximum Swell Potential 1.5*

*Measured on a sample compacted to approximately 95 percent of the ASTM Test Method D 698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 144 psf surcharge and submerged.

Corrosion Potential	**(PPM)**
Sulfate Content (ARIZ 733).....	1,000(max)
Chloride Content (ARIZ 736).....	500(max)

5. Aggregate base should conform to MAG and/or local governing specifications.

6. Frozen soils should not be used as fill or backfill.

7. The following are intended to guide in establishing adequate support for the conventional foundation elements:
    - Any natural washes, depressions or new excavations which are to be filled, should be widened as necessary to accommodate compaction equipment and provide a level base for placing fill.
    - Any engineered fill (backfill) materials placed beneath the foundations should meet the requirements for Engineered Fill Materials.
    - All footing excavations should be relatively level and free of loose or disturbed material and inspected by a qualified representative of the Geotechnical Engineer.

8. All fill soils to be used beneath the foundations; slabs and pavements should be approved by the Geotechnical Engineer. Fill should be placed in eight (8) inch loose lifts, moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Fill materials placed at depth greater than five (5) feet should be compacted to 100 percent of maximum dry density to finished grade elevation. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.2. Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 7 and ¼-inch outside diameter hollow stem augers and 5.5-inch casing with 3.5-inch down the hole hammer. We present the following general comments regarding ease of excavation with the understanding that they are opinions based on the test borings. The project consultant and contractor should become familiar with this report including boring logs to evaluate potential hard dig conditions. **Please note that excavation characteristics are best evaluated by performing test excavations with the size and type of equipment the contractor plans on using at the site, which was not conducted as part of this study.**

It is anticipated that shallow excavations of less than four (4) in the site soils can most likely be accomplished by conventional earth moving equipment in good operating condition. Auger refusal was encountered at depths ranging from four (4) feet and nine (9) feet on borings designated as B-1, B-2, B-3, and B-7 on a mixture of potential cobbles, gravel and sand. Due to the presence of potential boulders, cobbles and gravel, excavations deeper than four (4) feet deep may require specialized excavating equipment. Cohesionless soils were encountered at surface level and deeper. Cohesionless soils are prone to sloughing and caving and should be considered during grading operations. Please refer to Section 4 and the boring logs presented in **Appendix C** of this report for more information.

5.2.1. Trench Backfill

Materials

Pipe zone backfill (i.e., material beneath and in the immediate vicinity of the pipe) should consist of soil with a maximum particle size less than one inch. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of soil that meets the requirements for structural fill provided above.

If import material is used for pipe or trench zone backfill, we recommend it consist of fine-grained sand. In general, poorly graded coarse-grained sand and gravel should not be used for pipe or trench zone backfill due to the potential for site soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipes. We recommend the project Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Compaction Criteria

Backfill of trenches should utilize site soils with particle diameter less than 3-inches, in order to aid compaction and reduce potential differential settlement problems. Backfilling of utility trenches should be in 12-inch maximum loose lifts and compacted to a minimum of 90 percent and 95 percent of ASTM Test Method D 698 (standard Proctor), in non-structural areas and structural areas, respectively. Please note that the local governing agency specifications may surpass these trench backfill requirements. Jetting, flooding, or puddling of cohesive backfill soils should not be utilized under any circumstances.

Care must be used during compaction of backfill against stem walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated in close proximity to the below ground structures or earth retaining structures.

5.2.2. Temporary Excavations

General

All excavations must comply with applicable local, state, and federal safety regulations including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Generally, Construction site safety is solely the responsibility of the Contractor, who shall also be responsible for the means, methods, and sequencing of construction operations. We are providing the information below strictly as a service to our client. **Under no circumstances should the information be interpreted that ATEK is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.**

Excavations and Slopes

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced; and, if not followed, could result in substantial penalties to the Owner, Contractor, and/or earthwork subcontractor and/or utility subcontractors.

Near-surface soils encountered during our field study consisted predominantly of a mixture of Gravelly Silts, Clays and Sands. In our opinion, these soils would be considered a Type C soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1½(h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than five (5) feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within one-third the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Arizona.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water should be collected and disposed of outside the construction limits.

5.2.3. Permanent Excavations and Slopes

We recommend all permanent cut and fill slopes in soil be constructed at a gradient no steeper than 3(h):1(v). During wet weather, erosion could become a problem. Proper drainage and maintenance is recommended. To reduce the potential for surface erosion, a berm or "V" ditch may be located at the top of slopes subject to significant overland water flows in order to intercept and redirect surface runoff.

Fill placed on slopes steeper than 5(h):1(v) should be benched into the existing slope. It is recommended that the slope face be compacted as presented in the earthwork section of this report.

5.3. Structures

The anticipated frost depth for the project area is 18-inches below existing site grade. Therefore, concrete slabs and post-tensioned slab-on-ground foundations should have turn downs which extend below the anticipated frost depth.

5.3.1. Shallow Spread Footings

Shallow spread footings bearing on engineered fill can be used to support the structures as recommended (See section 5.1). Recommended footing depths and allowable bearing pressures are presented below.

Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.0	2,000
2.5	2,500
3.0	3,000
4.0+	4,000

***Note**: Footing depth is defined as the depth below the lowest adjacent finished grade elevation within 5-feet of the edge of the footing.

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

Continuous footings and isolated column footings should have a minimum width of 16-inches and 24 inches respectively. The minimum widths are recommended for ease of construction, and to provide a margin of safety against a local or punching shear failure of the foundation soils. All footings should be reinforced to reduce potential distress caused by differential foundation movement.

All the footing excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. If subsurface conditions are

encountered that are different than indicated by the borings, revised recommendations may be required.

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements over, a horizontal distance of 50 feet between similarly loaded footings, are expected to be less than ½-inch and ¾-inch for wall and column footings, respectively. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.3.1.1. Structural Slab

For design of structural slabs on grade, a modulus of subgrade reaction, ks, of 200 pci is recommended for slabs bearing on competent soils prepared as recommended above. This modulus of subgrade reaction is based on soils encountered during our field exploration, recommendations for subgrade soils preparation stated within the above referenced report, our experience with similar subgrade conditions and estimates obtained from ACI design charts.

Additionally, it is recommended that a thickened edge be constructed on the slab to minimize the potential for edge damage.

5.3.2. Mat Foundation

Mat foundations bearing on engineered fill as presented in Section 5.1 of this report may be used to support the proposed structures. An allowable bearing pressure of 3,000 pounds per square foot may be used for mat foundations bearing at a depth of 30 inches below adjacent grade or greater. A one third increase may be applied to the

recommended bearing pressure when considering short duration loads, such as wind and seismic.

A modulus of subgrade reaction of 400 kips per cubic foot (kcf) should be used for the design of the mat foundation. This value is based on a 1-foot square bearing area and needs to be scaled to account for mat foundation size effects. To obtain the modulus of subgrade reaction for a given mat foundation, the value of 400 kcf should be divided by the width of the effective loaded area, in feet. We estimate that the long-term total and differential settlement of new mat foundations constructed as recommended in this report should be on the order of 1-inch. In order to account for size effects a reduction is recommended for larger areas. The following approximation of ks (based on Terzaghi's equation) can be used for mats of various dimensions.

ks (in pci) = $150[(B+1)/(2B)]^2$ where B is the width of the mat (in feet)

5.3.3. Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 37 Pounds per Cubic Foot (PCF). Restrained walls should be designed to withstand a residual or long-term at-rest (Ko) earth pressure condition of 56 PCF.

A passive EFP of 300 PCF may be used for shallow spread footings. A coefficient of friction of 0.39 is recommended for computing lateral resistance between the base of footing and soil in analyzing lateral loads. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

Only cohesionless, free-draining granular materials should be used as backfill, adjacent to earth-retaining structures. We recommend that backfill directly behind the walls be compacted with light, hand-held compactors. Heavy compactors and grading

equipment should not be allowed to operate within three (3) feet of the walls during backfilling, to avoid developing excessive temporary or long-term lateral soil pressures. Positive gravity drainage of the backfill should be provided.

5.3.3.1. Wall Drainage

The above-recommended values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose of excess water that may accumulate behind earth retaining structures. In cases where site soils become saturated an equivalent fluid pressure of 90 PCF should be used.

Wall drainage should be collected by continuous perforated drainpipes, filter fabric, and gravel connected to weep holes. The drainpipe must run parallel to the wall. We recommend drain rock consist of durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should have an equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a permeability of at least 0.02 centimeters per second and minimum puncture strength of 50 pounds.

5.3.3.2. Backfill Placement

All backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Care must be used during compaction of backfill against the underground/retaining walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated next to the walls.

5.4. Moisture Protection

Soil support values reduce with an increase of moisture content. Therefore, positive drainage is essential to the successful performance of any structure. Good surface and subsurface drainage should be established during and after construction to prevent the soils below or adjacent to the structural areas and utility trenches from becoming wet.

Infiltration of water into utility or foundation excavations must be prevented during construction. The drainage design must route all storm and sprinkler water away from the structural areas in a positive manner. All water should be diverted away from areas where it could penetrate the ground surface near the structural areas. Watering of plants should be avoided adjacent to the buildings. Desert-type landscaping is advisable near the structural areas. Plants, which require more water, should be located and drained away from the structural areas.

5.5. Corrosion Potential

5.5.1. 10-point System

The 10-point soil evaluation includes the following soil tests: resistivity, pH, oxidation-reduction (redox) potential, sulfides, and moisture. For each of these tests, results are categorized according to their contribution to corrosivity. The test results are assigned point values based on Table A.1 found in Appendix A of the American National Standard for Polyethylene Encasement For Ductile-Iron Pipes Systems (ANSI/AWWA C105/A21.5-99), dated 1999. The above referenced corrosion testing is applicable to carbon steel pipe. A sum of points greater than or equal to 10, is considered corrosive to ductile iron pipes and carbon steel pipe and protection against exterior corrosion should be provided. The sum of points of the site soils sampled is 11 (greater than 10), hence, the site soils be considered corrosive to high carbon steel and protection against exterior corrosion should be provided.

5.5.1.1. Electrical Resistivity

Electrical Resistivity of a soil is a measure of resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. As a soil's resistivity decreases, its corrosivity increases.

A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is shown in the following table.

Resistivity (ohm-cm)	Corrosivity Classification
0 to 1,000	Severely corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately corrosive
Over 10,000	Mildly corrosive

Sample Location	Depth (ft)	pH	Resistivity (Ohm-cm)
Bulk Sample B-2	0.0' - 5.0'	7.3	1,250
Bulk Sample B-7	0.0' – 4.0'	7.3	1,410

Resistivity test results indicate ten (10) points and the pH test results indicates zero (0) points in the 10-point soil evaluation for the reservoir location.

Based on the laboratory tests as shown above, this soil would be considered "corrosive". It should be noted that these corrosion conditions are for the soils at submerged moisture conditions. Resistivity at drier moisture contents would be less corrosive than the results of the test.

The pH values of the samples tested were neutral. In most cases, pH is not a significant factor in corrosion in the near-neutral pH range (5<pH<9).

Estimated life for various gage galvanized CMP, based on Figure 6.7 of the Handbook of Steel Drainage & Highway Construction Products published by American Iron and Steel

Institute Fourth Edition, 1993, is tabulated below. Details of the laboratory test results are presented in the **Appendix C** of this report.

Sample Location	Depth (ft)	Design Life (yrs)		
		16 Gage	14 Gage	12 Gage
Bulk Sample B-2	0.0' - 5.0'	75	97	134
Bulk Sample B-7	0.0' – 4.0'	59	77	106

5.5.1.2. Oxidation-Reduction (Redox) Potential

The redox potential of a soil is significant in assessing corrosion potential because the most common sulfate-reducing bacteria can live only in anaerobic conditions. A negative redox potential indicates that anaerobic conditions are present in which sulfate reducers can live. The redox potential of site soils are 293mV and 273mV and results in zero (0) points in the 10-point soil evaluation.

5.5.1.3. Sulfides

A positive sulfides reaction reveals a potential problem caused by sulfate reducing bacteria. A negative sulfides reaction was observed from the soil sample analyzed and results in zero (0) points in the 10-point soil evaluation.

5.5.1.4. Moisture

The prevailing moisture condition of the soil is important to all soil corrosion. The specific moisture content of the soil is not necessary but rather the drainage characteristics and moisture condition. A conservative classification of the site soils is fair drainage and generally moist which results in one (1) point in the 10-point soil evaluation.

5.5.1.5. Concrete Corrosion

Selected samples of the near-surface soils encountered at the site were subjected to chemical analysis for the purpose of corrosion assessment. The samples were tested for soluble sulfates, and soluble chlorides. The samples were tested in general accordance with Arizona Test Methods 733, and 736 for soluble sulfates, and soluble chlorides, respectively. The test results are provided in **Appendix C**.

Based on provisions of American Concrete Institute (ACI) 318 Section 4.3, Table 4.3.1, Requirements for Concrete Exposed to Sulfate-Containing Solutions a sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible. Based on the laboratory results, sulfate contents of the site soils tested indicate a negligible corrosion potential to concrete.

Based on the laboratory result of the sample collected for this project, chloride contents of the site soils tested indicate negligible corrosion potential.

5.6. Onsite Pavement Areas

The on-site soils should be suitable as pavement subgrade soils provided all unsuitable debris, rubble, oversized cobbles, etc. are removed. A flexible and/or rigid pavement is recommended for the pavement areas. The recommended pavement sections are based on the assumption that the subgrade soils are prepared in accordance with Section 5.1 of this report.

The flexible pavement section should consist of Central Plant Mix Asphaltic Concrete Pavement (AC) on compacted Aggregate Base Course (ABC) as recommended in the table below. Flexible pavement should be placed in accordance with MAG Section 321 and local municipality standards.

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)
Light Duty Pavement	3.0	8.0
Heavy Duty Pavement	4.0	8.0

Our calculations for design of the pavements section is based upon our classification of the subsurface soils, the calculated traffic in 18 kips equivalent single axle loads, the site preparation and grading recommendations provided above. A design life of 20 years was used in design.

Areas subject to sustained, heavy concentrated loads, such as dumpster areas should be paved with Portland Cement Concrete (PCC). A pavement section of 6 inches of PCC on 4 inches of aggregate base course is recommended in these areas. We should be contacted for additional recommendations if there will be any areas subjected to volumes of traffic heavier than those assumed for this report.

6. CLOSURE

6.1. Limitations

Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar localities. No warranty is expressed or implied.

The recommendations contained in this report are based on our field exploration, laboratory test results, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the test borings excavated during the field subsurface exploration. It is anticipated that some variations in the soil conditions will exist on-site. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to the recommendations

contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractor, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on 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 ATEK of such intended use. Based on the intended use of this report, ATEK may require that additional work be performed and that an updated report be issued.

6.2. Recommended Additional Services

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction. These tests and observations should be performed by the Geotechnical Engineer's representative and should include, but not limited to the following:

- Observe and document that any existing surficial vegetation and other

deleterious materials have been removed from the site as required in site preparation section.

- Approve any material used as import to document that it meets the requirements outlined above before placement.

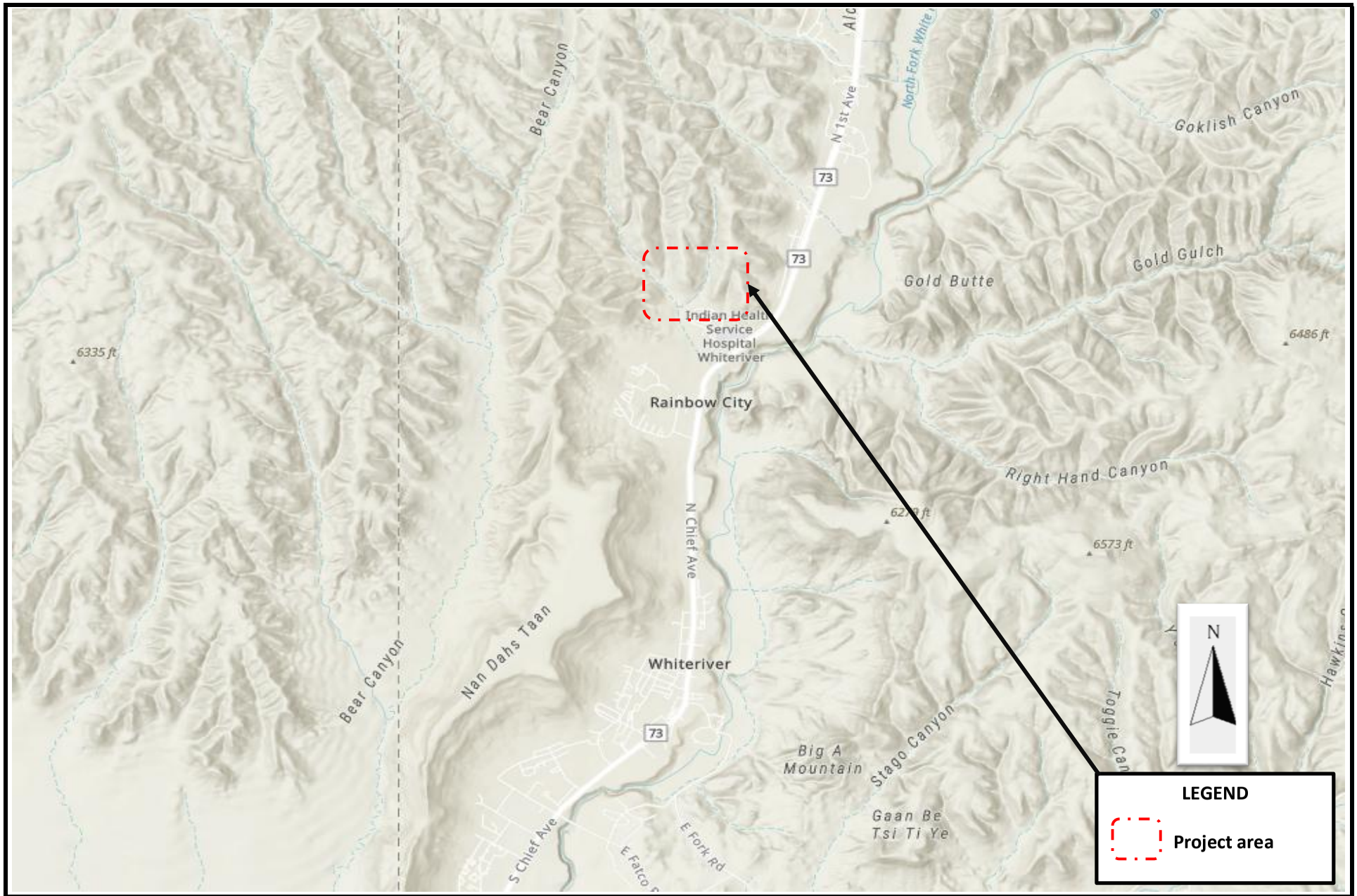
- Monitor the backfill procedures.

- Perform field density tests, as needed, to verify compaction compliance. The representative should monitor the progress of compaction and filling operations.

- Keep records of on-site activities and progress.

Observation of footing excavations should be performed prior to placement of reinforcing and concrete to confirm that satisfactory bearing materials are present. Construction testing, including field and laboratory evaluation of fill and backfill materials, concrete and steel should be performed to determine whether applicable project requirements have been met.

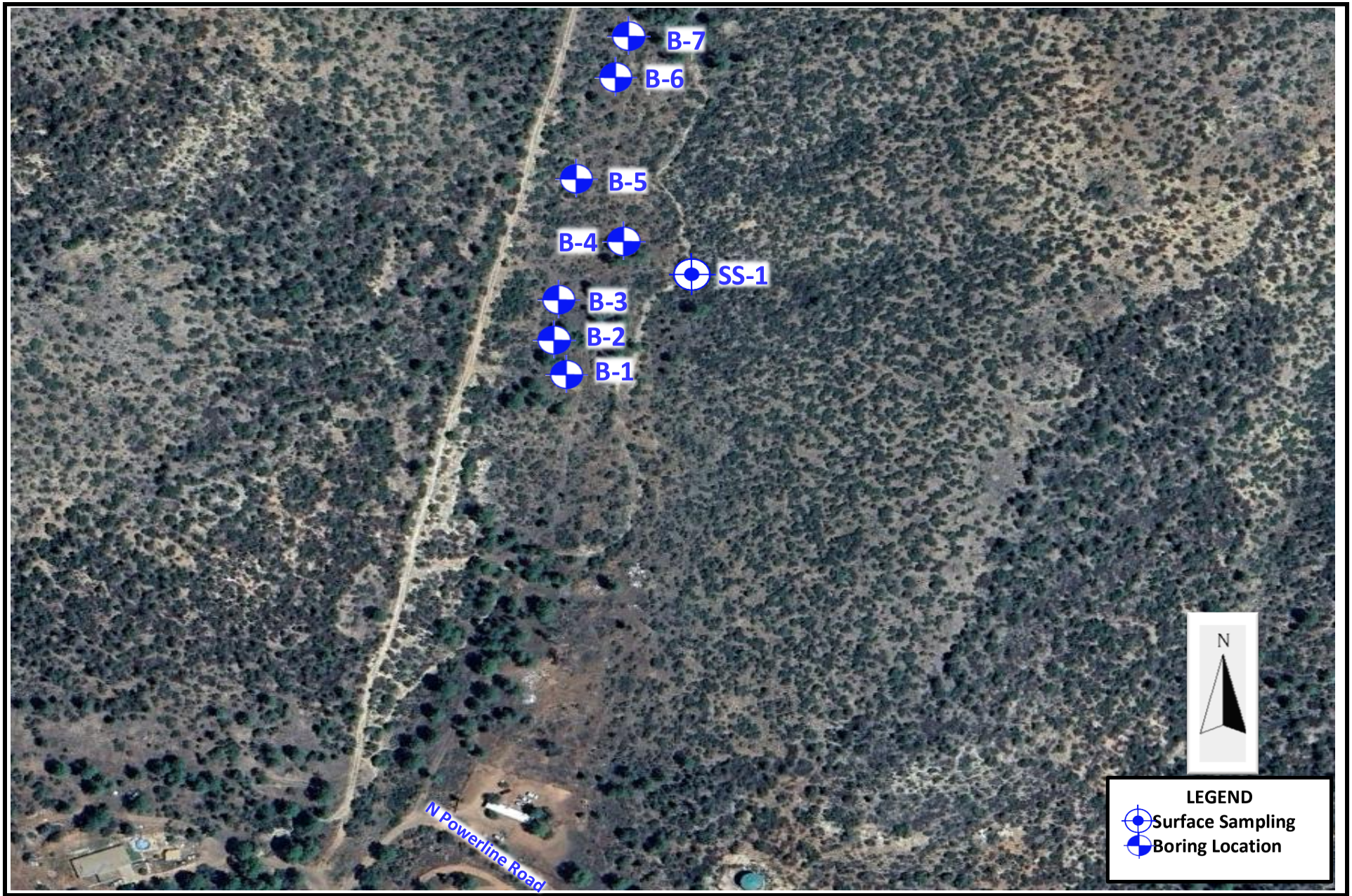
APPENDIX A
Site Location Map



Basemap provided by ArcGIS	Project #: 250012 Date: 9/15/2025 Drawn by: AM	**Site Location Map - Sheet 1 of 1** IHS Whiteriver Wastewater Treatment Plant Whiteriver, Arizona	atek ENGINEERING CONSULTANTS 111 South Weber Drive, Suite 1 Chandler, AZ 85226

APPENDIX B
Sample Location Plan

atek
ENGINEERING CONSULTANTS



Basemap provided by Google Earth	Project #: 250012	**Boring Location Plan - Sheet 1 of 2**	atek ENGINEERING CONSULTANTS
	Date: 9/15/2025	IHS Whiteriver Wastewater Treatment Plant	111 South Weber Drive, Suite 1
	Drawn by: AM	Whiteriver, Arizona	Chandler, AZ 85226

Project #:	250012	**Boring Location Plan - Sheet 2 of 2**
Date:	9/15/2025	IHS Whiteriver Wastewater Treatment Plant
Drawn by:	AM	Whiteriver, Arizona

Basemap provided by Google Earth

atek ENGINEERING CONSULTANTS
111 South Weber Drive, Suite 1
Chandler, AZ 85226

APPENDIX C
FIELD STUDY AND BORING LOGS

atek
ENGINEERING CONSULTANTS

APPENDIX C
FIELD STUDY

BORINGS

The subsurface conditions at the site were explored on August 7 to August 9, 2025, by drilling soil borings using a truck mounted CME drill rig with 7 and a ¼-inch outside diameter hollow stem auger. The locations of soil test borings performed for this study are shown in **Appendix B** of this report.

The locations of borings were located by visual sighting and pacing from existing site features and, therefore, should be considered approximate. Actual boring locations may vary from those indicated in **Appendix B**.

Our field engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table); and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System – C1
Log Key – C2
Charts and Definitions – C3
Terminology Used to Describe Soils – C4
Logs of Soil Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LESS THAN 5% PASSING NO. 200 SIEVE	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% PASSING NO. 200 SIEVE	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LESS THAN 5% PASSING NO. 200 SIEVE	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% PASSING NO. 200 SIEVE	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

Note: Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing No. 200 sieve require dual USCS symbols. (See KEY A-3 if provided)

atek ENGINEERING CONSULTANTS

Drafted By: ALE

Date: September, 2025

Project Number: 250012

UNIFIED SOIL CLASSIFICATION SYSTEM

IHS Whiteriver Wastewater Treatment Plant
Mabbet and Associates, Inc.
Whiteriver, Arizona

KEY

C-1

LOG SYMBOLS

BULK / GRAB SAMPLE

MODIFIED CALIFORNIA SAMPLER
(2.5 inch inside diameter)

GRAB SAMPLE

STANDARD PENETRATION
SPLIT SPOON SAMPLER
(2.0-inch O.D. X 1.5-inch I.D.)

SHELBY TUBE
(3 inch outside diameter)

NON-STANDARD PENETRATION
SPLIT SPOON SAMPLER
(1.5-inch O.D. X 0.9-inch I.D.)

BDBGM SIZE CORE BARREL
(1.65-inch I.D.)

BW44 SIZE CORE BARREL
(1.75-inch I.D.)

HQ-3 SIZE CORE BARREL
(2.4-inch I.D.)

WATER LEVEL
(level after completion)

WATER LEVEL
(level where first encountered)

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.

2. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

3. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.

4. In general, the Unified Soil Classification designations presented on the logs were based on visual classification in the field, modified where appropriate by visual classifications in the office, and/or laboratory gradation and index testing.

5. NA = Not Analyzed

atek ENGINEERING CONSULTANTS

Drafted By: ALE
Date: September, 2025

Project Number: 250012

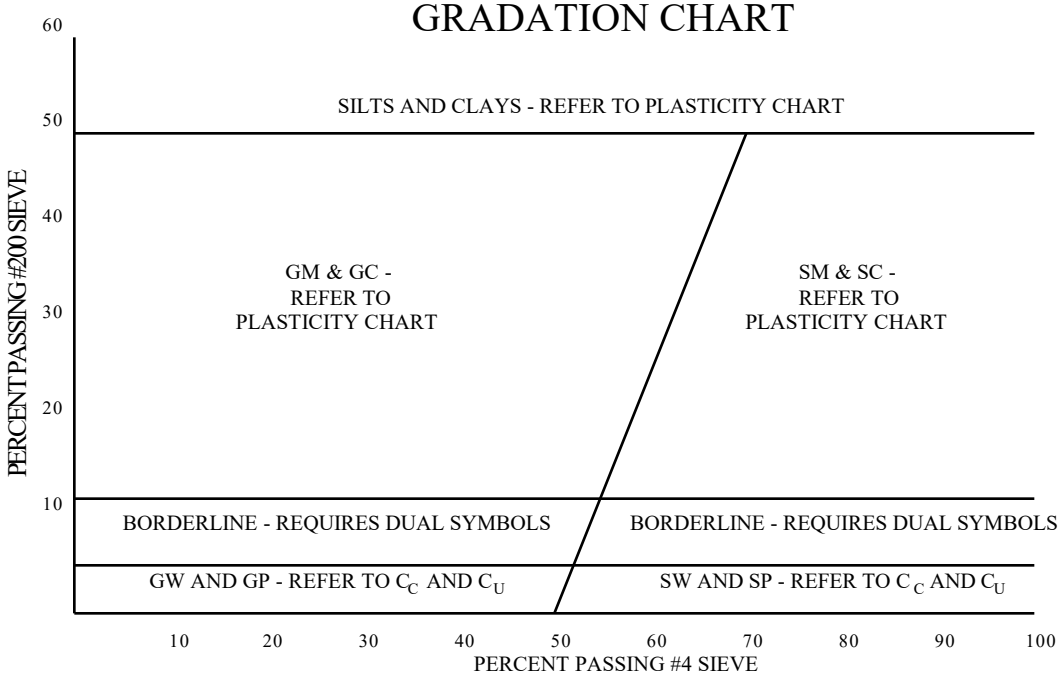
LOG KEY

IHS Whiteriver Wastewater Treatment Plant
Mabbet and Associates, Inc.
Whiteriver, Arizona

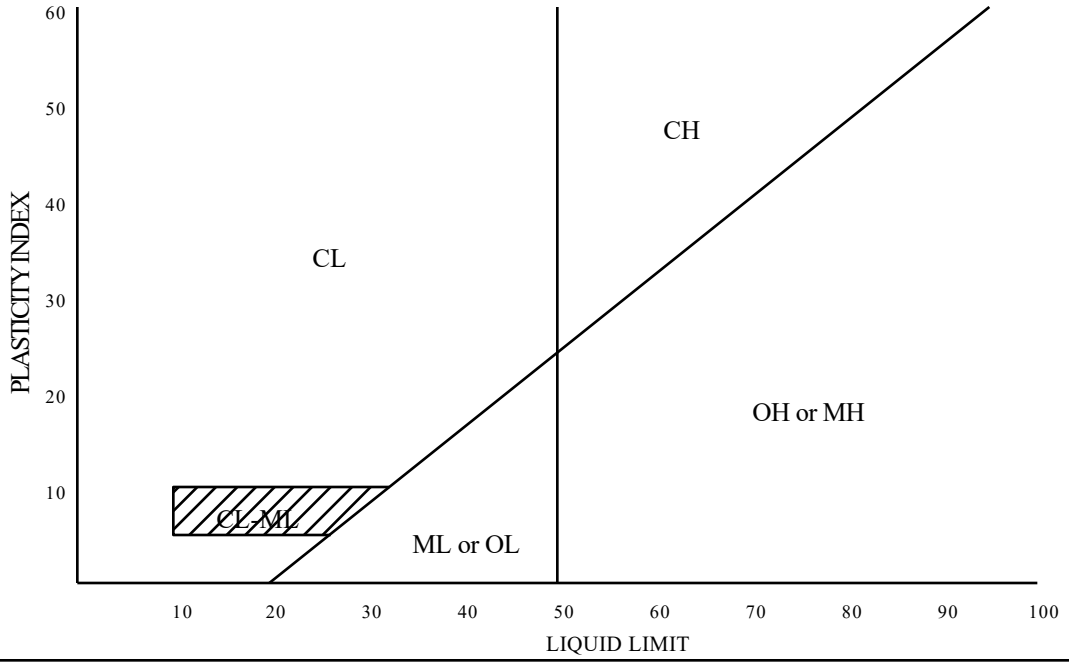
KEY

C-2

GRADATION CHART



PLASTICITY CHART



Plasticity of Fines (FHWA NHI-06-088)	
Plasticity Index	Plasticity Adjective
0	Nonplastic
1-10	Low plasticity
>10-20	Medium Plasticity
>20-40	High Plasticity
>40	Very plastic

Definitions of Soil Particles	
Soil Fraction	Particle Size Range
Boulders	Greater than 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Coarse Gravel	75mm to 19mm (3in. to 3/4in.)
Fine Gravel	19mm (3/4in.) to No. 4 Sieve
Coarse Sand	No. 4 sieve to No. 10 sieve
Medium Sand	No. 10 sieve to No. 40 sieve
Fine Sand	No. 40 sieve to No. 200 sieve
Fines	Less than No. 200 sieve

atek ENGINEERING CONSULTANTS

Drafted By: ALE

Date: September, 2025

Project Number: 250012

CHARTS & DEFINITIONS

IHS Whiteriver Wastewater Treatment Plant
Mabbet and Associates, Inc.
Whiteriver, Arizona

KEY

C-3

TERMINOLOGY USED ON THE BORING LOGS TO DESCRIBE
THE FIRMNESS, DENSITY, OR CONSISTENCY OF SOILS

The standard penetration resistance (N) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1.5" I.D. samplers.

1. Terms for description of partially saturated and/or cemented soils including clays, cemented granular materials, silts and silty and clayey granular soils.

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

2. Terms for description of coarse grain soils. (FHWA NHI-06-088)

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
51+	Very dense

3. Terms for description of fine grain soils. (FHWA NHI-06-088)

N	Relative Consistency
0-2	Very soft
3-4	Soft
5-8	Medium stiff
9-15	Stiff
16-30	Very stiff
31+	Hard

atek ENGINEERING CONSULTANTS

Drafted By: ALE
Date: September, 2025

Project Number: 250012

TERMINOLOGY USED TO DESCRIBE SOILS

IHS Whiteriver Wastewater Treatment Plant
Mabbet and Associates, Inc.
Whiteriver, Arizona

KEY

C-4

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-1		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/8/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			3-5	5.6 5.7	72	34	14	77	CL		LEAN CLAY WITH SAND (CL), 7% fine to coarse graded gravel, 16% fine to coarse grained sand, 77% fines, medium stiff, medium plasticity, reddish brown, slightly moist, no cementation, strong reaction to HCl		
			2-8-31								Hard		
											Heavy auger grinding @ 3.5 feet on cobbles and gravel Auger refusal @ 4.0 feet on very dense cobbles, gravel and sand	4	

Auger refusal @ 4.0 feet bgs.
Bottom of sampler @ 4.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-1

Fig. 1

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-2		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/8/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			5-5	5.5	79.3				CL		SANDY LEAN CLAY (CL), stiff, low plasticity, reddish brown, slightly moist, no cementation, strong reaction to HCl		
			16-18-17						SM		SILTY SAND WITH GRAVEL (SM), dense, no plasticity, tan, slightly moist, no cementation, moderate reaction to HCl Auger grinding @ 3.0 feet on cobbles and gravel	2.5	
5			23-21	5.5	96.7				CL		SANDY LEAN CLAY (CL), hard, low plasticity, reddish brown, slightly moist, no cementation, weak reaction to HCl Heavy auger grinding @ 5.0 feet on cobbles and gravel	5	
			50/5"								Auger refusal @ 9.0 feet on very dense sand, gravel and cobbles	9.4	

Auger refusal @ 9.0 feet bgs.
Bottom of sampler @ 9.4 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-2

Fig. 2

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-3		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/9/2025	Date Finished: 8/9/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			5-6	6.8 6.9	71.7	43	23	75	CL		LEAN CLAY WITH SAND (CL), 8% fine to coarse graded gravel, 17% fine to coarse grained sand, 75% fines, stiff, high plasticity, reddish brown, slightly moist, no cementation, weak reaction to HCl		
			4-6-12								Very stiff, medium plasticity, strong reaction to HCl		Swell Potential of Soil = 1.8%
			10-17-24								Encountered gravel layer @ 3.5 feet	4.3	
5									SM		SILTY SAND WITH GRAVEL (SM), dense, no plasticity, tan, slightly moist, no cementation, strong reaction to HCl Auger refusal @ 4.0 feet on cobbles, gravel, and sand	5.5	

Auger refusal @ 4.0 feet bgs.
Bottom of sampler @ 5.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-3

Fig. 3

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-4		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/9/2025	Date Finished: 8/9/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			11-15			35	10	41	GM		SILTY GRAVEL WITH SAND (GM), 43% fine to coarse graded gravel, 16% fine to coarse grained sand, 41% fines, medium dense, low plasticity, brown, slightly moist, no cementation, strong reaction to HCl		
5			11-50/5"	1.1		27	6	14	GP-GM		SILTY, CLAYEY GRAVEL WITH SAND (GP-GM), 50% fine to coarse graded gravel, 36% fine to coarse grained sand, 14% fines, very dense, low plasticity, tan, slightly moist, no cementation, strong reaction to HCl	5	
10			10-23-16								Dense, tan and gray		
15			50/2"									15.2	

Bottom of Casing @ 15.0 feet bgs.
Bottom of sampler @ 15.2 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-4

Fig. 4

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-5		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/8/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									GM		SILTY GRAVEL WITH SAND (GM), no plasticity, brown and gray, slightly moist, no cementation, weak reaction to HCl		
5			8-13	5.6	81.2				ML		SANDY SILT (ML), very stiff, low plasticity, reddish brown, slightly moist, no cementation, strong reaction to HCl	5	
10			10-18-15						GM		SILTY GRAVEL WITH SAND (GM), dense, no plasticity, tan, slightly moist, no cementation, strong reaction to HCl	10	
15			18-50/2"								Very dense, tan and gray		
20			50/0"										

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-5

Fig. 5

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-5		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/8/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
25			50/4"								Tan		
30			10-26-50/3"									31.3	

Bottom of Casing @ 30.0 feet bgs.
Bottom of sampler @ 31.3 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-5

Fig. 5

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 2
Borehole Number: B-6		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/7/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
									GC		CLAYEY GRAVEL WITH SAND (GC), low plasticity, brown, slightly moist, no cementation, weak reaction to HCl		
											Heavy hammer grinding @ 2.5 feet on gravel		
5			24-50/3"	6.0		35	15	40			40% fine to coarse graded gravel, 20% fine to coarse grained sand, 40% fines, very dense, medium plasticity, moderately cemented, strong reaction to HCl		
10			17-16-16								Dense, light brown, no cementation, strong reaction to HCl	12	
									ML		SANDY SILT (ML), no plasticity, reddish brown, slightly moist, no cementation, strong reaction to HCl	13	
									GP		POORLY GRADED GRAVEL WITH SAND (GP), no plasticity, gray, slightly moist, no cementation, no reaction to HCl		
15			50/1"								Very dense		
20			50/4"						SM		SILTY SAND WITH GRAVEL (SM), very dense, no plasticity, light brown and gray, slightly moist, no cementation, weak reaction to HCl	20	
									CL		SANDY LEAN CLAY (CL), low plasticity, reddish brown, slightly moist, no cementation, strong reaction to HCl	21.5	

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-6

Fig. 6

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 2 of 2
Borehole Number: B-6		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/7/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
25			6-7-10								Very stiff, medium plasticity		
30			10-15-50/3"						CL		SANDY LEAN CLAY WITH GRAVEL (CL), hard, medium plasticity, reddish brown, slightly moist, no cementation, strong reaction to HCl	30 31.3	

Bottom of Casing @ 30.0 feet bgs.
Bottom of sampler @ 31.3 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-6

Fig. 6

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-7		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/9/2025	Date Finished: 8/9/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			SPT			LL	PI						
			19-18-16	6.9		41	21	40	GC		CLAYEY GRAVEL WITH SAND (GC), 43% fine to coarse graded gravel, 17% fine to coarse grained sand, 40% fine, high plasticity, dense to very dense, reddish brown, slightly moist, no cementation, strong reaction to HCl Heavy auger grinding @ 2.0 - 4.0 feet on cobbles, gravel, and sand Tan		
			50/3"								Auger refusal on very dense sand gravel and cobbles.	4.3	

Auger refusal @ 4.0 feet bgs.
Bottom of sampler @ 4.3 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Shelby, Bulk Sample, Grab Sample, Penetrometer, Vane Shear, California

Operation Types: Hand Auger, ODEX, Auger Hollow Stem, Bullnose, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-7

Fig. 7

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-8		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/9/2025	Date Finished: 8/9/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT	PLASTICITY INDEX	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			SPT			LL	PI						
						54	16	30	GM		SILTY GRAVEL WITH SAND (GM), 45% fine to coarse graded gravel, 25% fine to coarse grained sand, 30% fines, medium plasticity, light brown, slightly moist, no cementation, strong reaction to HCl	3	

Bottom of hand auger @ 3.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-8

Fig. 8

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: IHS Whiteriver Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: SS-1		Driller: Southlands	Logger: German Lopez Romo
Drilling Equipment: CME-850	Borehole Diameter (in.): 7.25 HSA	Date Started: 8/8/2025	Date Finished: 8/8/2025

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
						NV	NP	13	GM		SILTY GRAVEL WITH SAND (GM), 61% fine to coarse graded gravel, 26% fine to coarse grained sand, 13% fines, no plasticity, brown and gray, slightly moist, no cementation, strong reaction to HCl	2.5	
5						NV	NP	14	GM		SILTY GRAVEL (GM), 75% fine to coarse graded gravel, 11% fine to coarse grained sand, 14% fines, no plasticity, brown and gray, slighlty moist, no cementation, strong reaction to HCl	5	

Bottom of auger @ 5.0 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A

Remarks: Not Encountered

ATEK Project Number: 250012

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING SS-1

Fig. 9

250012 FINAL LOGS.GPJ ` 9-16-25 ` M Mendoza ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

APPENDIX D
Laboratory Test

APPENDIX D
LABORATORY TESTING

LABORATORY TESTS
Laboratory tests were performed on selected samples to aid in soil classification and to evaluate physical properties of the soils, which may affect the Geotechnical aspects of project design and construction. A description of the laboratory testing program is presented below.

Sieve Analysis
Sieve analyses were performed to evaluate the gradation characteristics of the material and to aid in soil classification. Tests were performed in general accordance with ASTM Test Method C 136 and D 2487.

Atterberg Limits
Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Tests were performed in general accordance with ASTM Test Method D 4318.

Moisture Content
Moisture content tests were performed to evaluate moisture-conditioning requirements during site preparation and earthwork grading. Moisture content was evaluated in general accordance with ASTM Test Method D 2216.

One-Dimensional Consolidation
A one-dimensional consolidation test was performed on a ring sample to evaluate consolidation potential of the site soil. Test procedure was in general accordance with ASTM Test Method D 2435.

Undisturbed Ring Density
Undisturbed ring density tests were performed on ring samples to evaluate the in-situ density and moisture content of the site soils. Test procedures were in general accordance with ASTM Test Method D 2937.

Standard Proctor
Standard Proctor tests were performed on bulk soil samples to evaluate the maximum dry density and optimum moisture of the site soils. Test procedures were in general accordance with ASTM Test Method D 698A.

Swell Test
Swell test was performed on bulk soil samples to evaluate the expansion potential of the site soils. Test procedures were in general accordance with ASTM Test Method D 4829.

pH and Resistivity
pH and resistivity tests were performed on the bulk soil sample to evaluate the site soil corrosion potential. Test procedure was in general accordance with Arizona Test Method 236.

Sulfate Content
Sulfate content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 733.

Chloride Content
Chloride content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 736.

Free Sulfide
Free Sulfide test was performed to identify the presence of reactive sulfide minerals that can oxidize pipes, tanks, and concrete structures.

Redox Potential
Redox Potential test was performed to identify the oxidation-reduction potential of soil. The method provides a standardized way to evaluate soil redox status, which is important for understanding corrosion potential.

atek
ENGINEERING CONSULTANTS

PROJECT: IHS Whiteriver Wastewater Treatment Plant
LOCATION: Whiteriver, Arizona
SAMPLE DATE: 8/7/2025

PROJECT: 250012
WORK ORDER: 2500258
REVIEWED BY: M Mendoza

MOISTURE CONTENT OF SOIL -- ASTM D 2216

LAB #	SAMPLE SOURCE	MOISTURE		
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT
1	Bulk, B-1 @ 0.0'-4.0'	506.0	479.1	5.6%
9	Bulk, B-3 @ 0.0'-4.0'	505.3	473.1	6.8%
14	SPT, B-4 @ 5.0'-5.9'	363.5	359.4	1.1%
23	Ring, B-6 @ 5.0'-5.8'	1,151.6	1,086.3	6.0%
29	Bulk, B-7 @ 0.0'-4.0'	506.1	473.4	6.9%

111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT: IHS Whiteriver Wastewater Treatment Plant
LOCATION: Whiteriver, Arizona
SAMPLE DATE: 8/7/2025

PROJECT: 250012
WORK ORDER: 2500258
REVIEWED BY: M Mendoza

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD -- ASTM D 2937

LAB #	SAMPLE SOURCE	MOISTURE			# OF RINGS	WET WEIGHT + RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT				
2	Ring, B-1 @ 0.0'-1.0'	551.0	521.4	5.7%	6	801.9	250.9	72.0
5	Ring, B-2 @ 0.0'-1.0'	505.1	478.9	5.5%	5	729.7	224.6	79.3
10	Ring, B-3 @ 0.0'-1.0'	555.2	519.4	6.9%	6	823.0	267.8	71.7

111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT:	IHS Whiteriver Wastewater Treatment Plant	**PROJECT NO:**	250012
LOCATION:	Whiteriver, Arizona	**WORK ORDER NO:**	2500258
DATE SAMPLED:	8/7/2025	**REVIEWED BY:**	A Lopez, PE

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

					COBBLES		GRAVEL									SAND								Silt or Clay	
							Coarse					Fine				Coarse		Medium			Fine				
Location & Depth	**USCS**	**LL**	**PL**	**PI**	**6"**	**4"**	**3"**	**2"**	**1 1/2"**	**1 1/4"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**1/4"**	**#4**	**#8**	**#10**	**#16**	**#30**	**#40**	**#50**	**#100**	**#200**	**Lab #**

PERCENT PASSING BY WEIGHT

Bulk, B-1 @ 0.0'-4.0'	CL	34	20	14	100	100	100	100	100	100	99	99	98	96	95	93	91	91	89	87	85	84	80	77	1
SPT, B-4 @ 0.0'-1.0'	GM	35	25	10	100	100	100	66	66	66	66	66	63	61	58	57	55	54	53	51	50	48	46	41	13
SPT, B-4 @ 5.0'-5.9'	GC-GM	27	21	6	100	100	100	100	100	100	92	92	78	69	57	50	42	35	30	24	21	19	19	14	14
Ring, B-6 @ 5.0'-5.8'	GC	35	20	15	100	100	100	100	90	90	84	75	73	69	64	60	56	56	53	50	48	47	44	40	23
Bulk, B-8 @ 0.0'-3.0'	GM	54	38	16	100	100	100	100	90	87	82	74	67	63	58	55	50	49	47	44	43	42	38	30	32
Bulk, SS-1 @ 0.0'-2.5'	NT	NT	NT	NT	100	100	100	100	93	88	80	73	59	51	43	39	34	30	26	22	20	19	19	13	33
Bulk, SS-1 @ 2.5'-5.0'	NT	NT	NT	NT	100	100	100	83	70	62	51	45	36	32	27	25	24	23	21	19	19	18	18	14	34

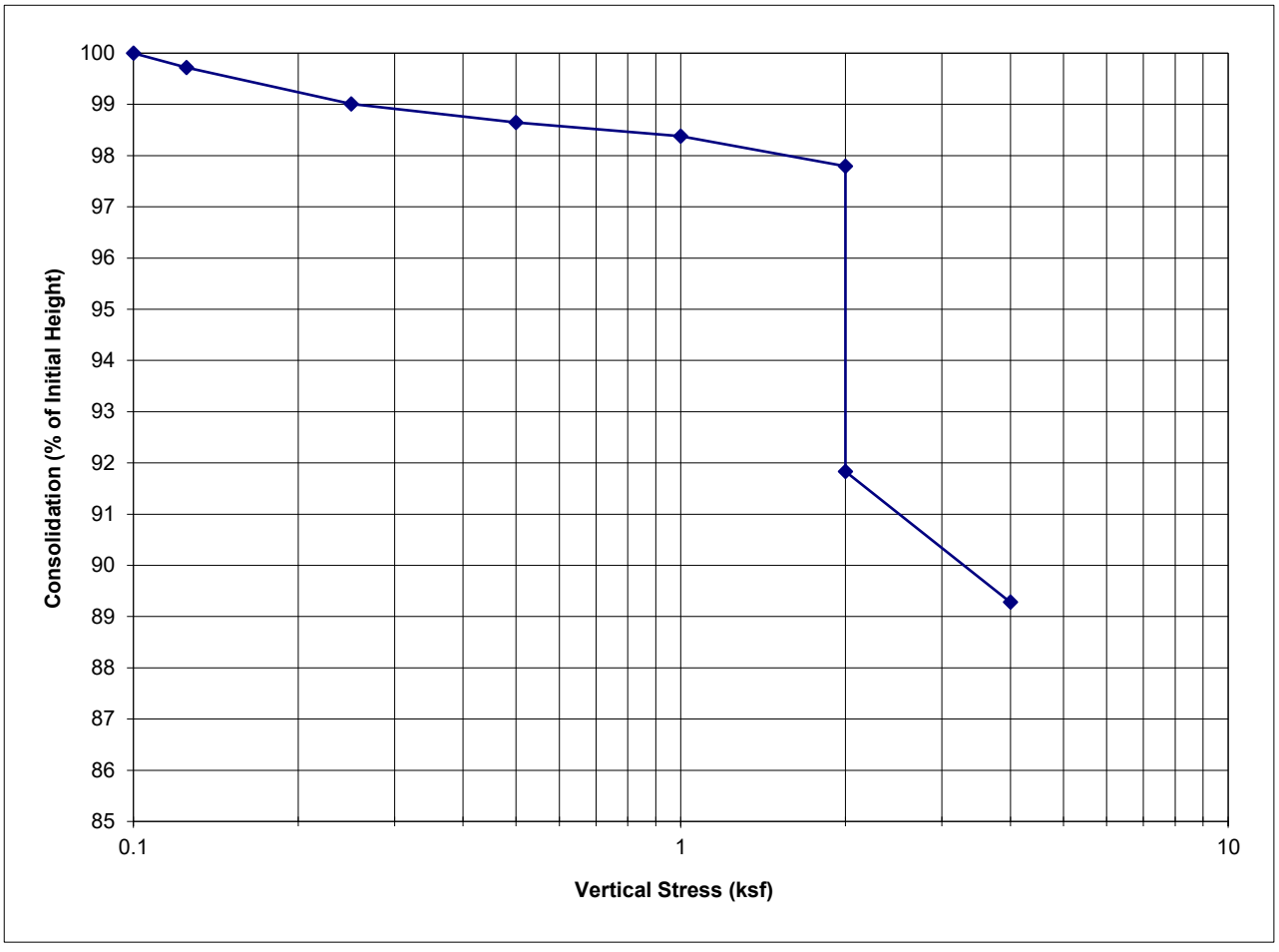
This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

atek
ENGINEERING CONSULTANTS

Project:	IHS Whiteriver Wastewater Treatment Plant	**Project Number:**	250012
Project Location:	Whiteriver, Arizona	**Work Order Number:**	2500258
Client:	Mabbet and Associates, Inc.	**Lab Number:**	7
Material:	Native	**Date Sampled:**	08/07/25
Sample Source:	Ring Sample B-2 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.11
Initial Moisture Content	5.5%	Final Moisture Content	19.9%
Initial Dry Density(pcf)	96.7	Final Dry Density(pcf)	108.3
Initial Degree of Saturation	20%	Final Degree of Saturation	100%
Initial Void Ratio	0.7	Final Void Ratio	0.5
Estimated Specific Gravity	2.65	Saturated at	2 ksf
		Hydro Collapse Potential	5.96%



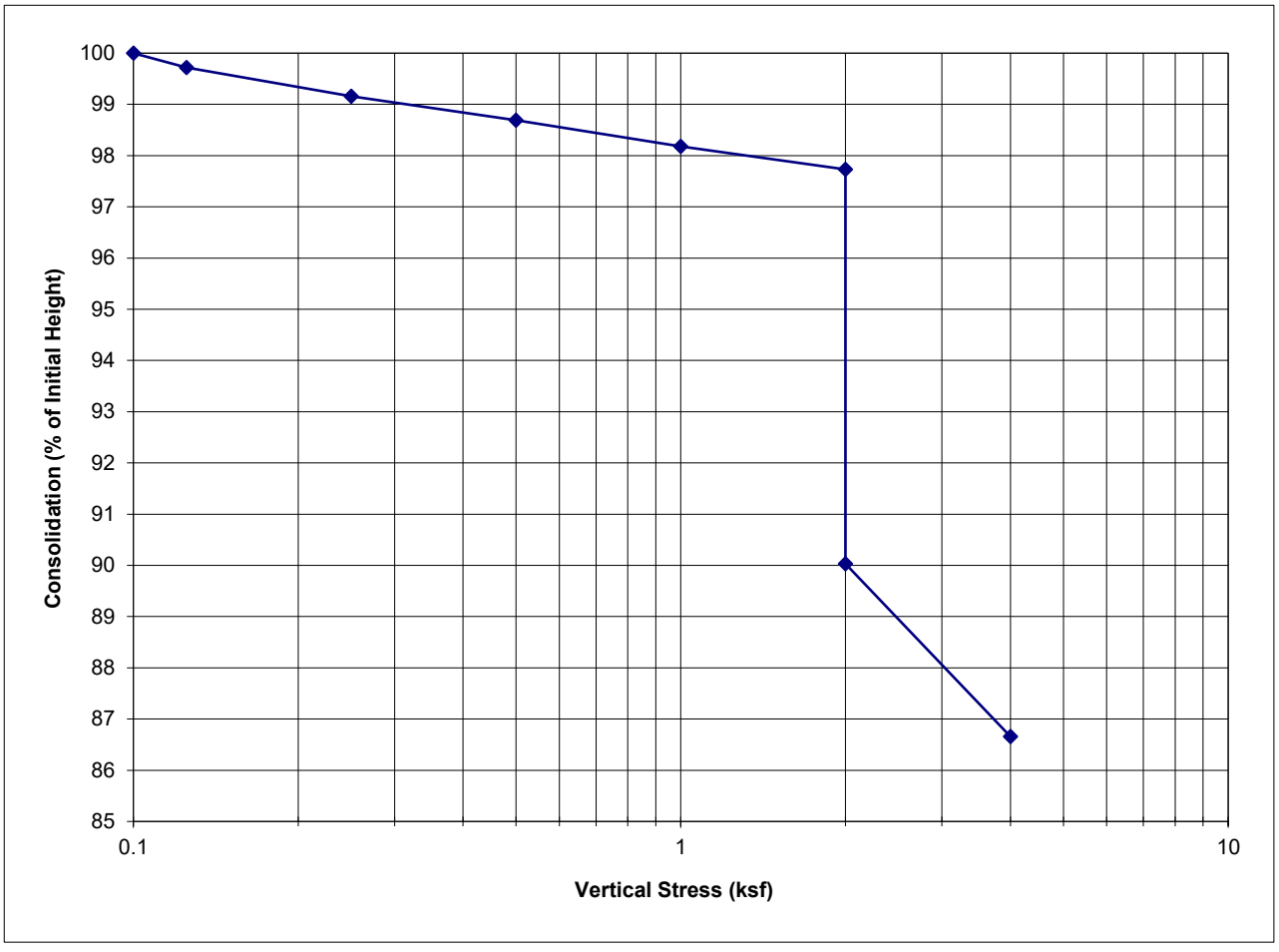
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	IHS Whiteriver Wastewater Treatment Plant	**Project Number:**	250012
Project Location:	Whiteriver, Arizona	**Work Order Number:**	2500258
Client:	Mabbet and Associates, Inc.	**Lab Number:**	17
Material:	Native	**Date Sampled:**	08/07/25
Sample Source:	Ring Sample B-5 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	3.99
Initial Moisture Content	5.6%	Final Moisture Content	28.8%
Initial Dry Density(pcf)	81.2	Final Dry Density(pcf)	93.7
Initial Degree of Saturation	14%	Final Degree of Saturation	100%
Initial Void Ratio	1.0	Final Void Ratio	0.8
Estimated Specific Gravity	2.65	Saturated at	2 ksf
		Hydro Collapse Potential	7.70%



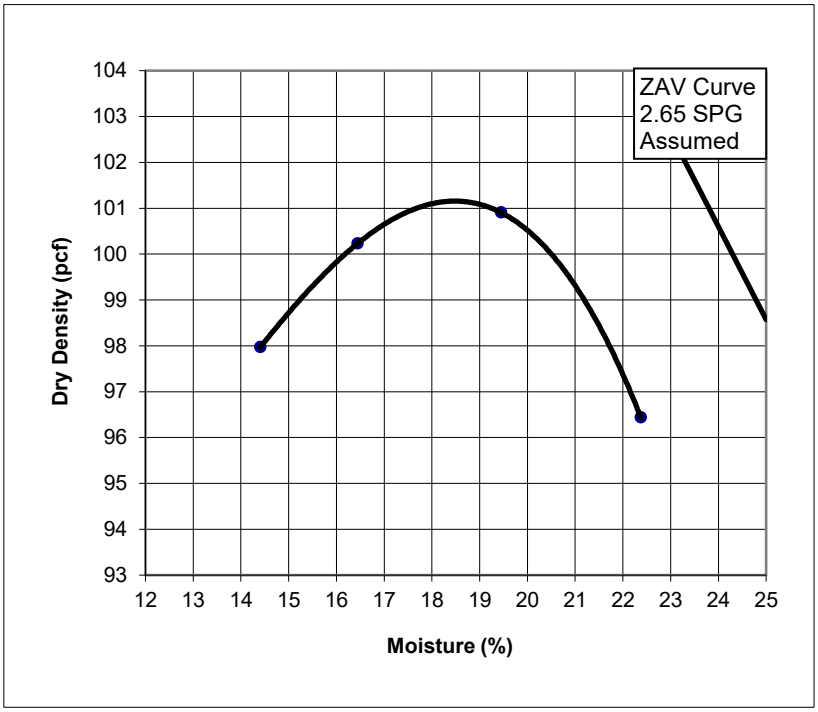
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT:	IHS Whiteriver Wastewater Treatment Plant	**PROJECT NO:**	250012
LOCATION:	Whiteriver, Arizona	**WORK ORDER NO:**	2500258
MATERIAL:	Native	**LAB NO:**	9
SAMPLE SOURCE:	Bulk, B-3 @ 0.0'-4.0'	**SAMPLE DATE:**	8/7/2025

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)
Maximum dry density:	101.2	1620
Optimum moisture (%):	18.5	18.5



SIEVE SIZE	PERCENT PASSING
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	99
3/4 in / 19 mm	99
1/2 in / 12.5 mm	97
3/8 in / 9.5 mm	95
1/4 in / 6.4 mm	93
#4, 4.75mm	92
#8, 2.36mm	90
#10, 2.00mm	90
#16, 1.18mm	89
#30, 0.60mm	88
#40, .425mm	88
#50, .300mm	87
#100, .150mm	84
#200, .075mm	75

LL:	43
PL:	20
PI:	23
USCS:	CL
AASHTO:	A-7-6(16)

NOTES:

AASHTO Description: Clayey Soils

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.

Reviewed by: Antonio Lopez, PE

111 S. Weber Dr., Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	IHS Whitewater Wastewater Treatment Plant	**Project Number:**	250012
Location:	Whitewater, Arizona	**Work Order Number:**	2500258
Client:	Magget and Associates, Inc.	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	08/07/25
Sample Source:	See Below		

Swell Potential of Soil ASTM D4546

Sample Number	Sample Source	Swell (%)	Target Compaction (%)	Actual Compaction (%)	Target Moisture (%)	Actual Moisture (%)
9	Bulk, B-3 @ 0.0'-4.0'	1.8	95.0	94.9	15.5	16.8

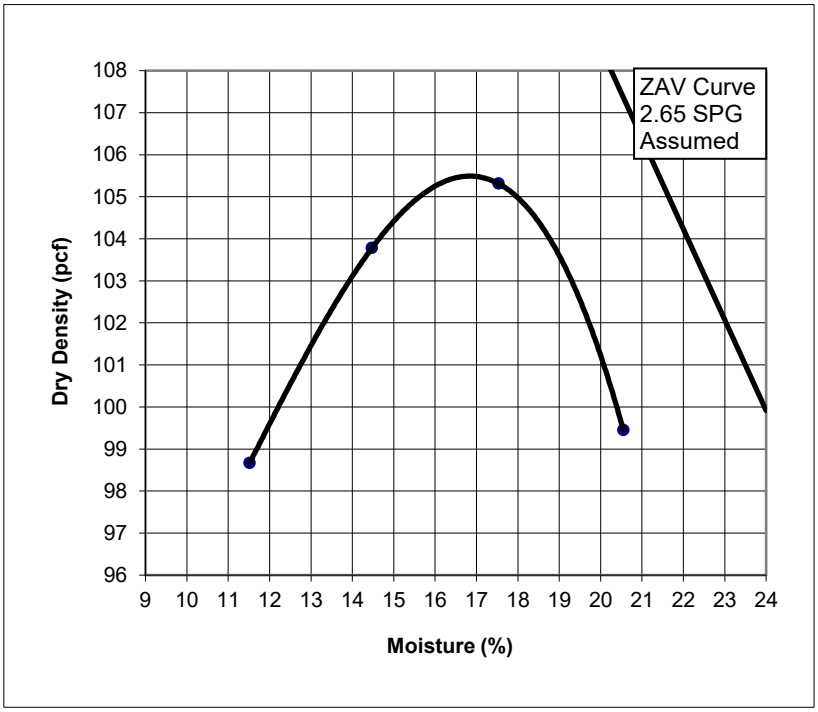
Note: Ring Samples were subjected to a 144 psf surcharge.

atek
ENGINEERING CONSULTANTS

PROJECT:	IHS Whiteriver Wastewater Treatment Plant	**PROJECT NO:**	250012
LOCATION:	Whiteriver, Arizona	**WORK ORDER NO:**	2500258
MATERIAL:	Native	**LAB NO:**	29
SAMPLE SOURCE:	Bulk, B-7 @ 0.0'-4.0'	**SAMPLE DATE:**	8/7/2025

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)
Maximum dry density:	105.5	1690
Optimum moisture (%):	16.8	16.8



SIEVE SIZE	PERCENT PASSING
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	97
1 1/4 in / 32 mm	90
1 in / 25 mm	82
3/4 in / 19 mm	77
1/2 in / 12.5 mm	69
3/8 in / 9.5 mm	65
1/4 in / 6.4 mm	60
#4, 4.75mm	57
#8, 2.36mm	54
#10, 2.00mm	52
#16, 1.18mm	50
#30, 0.60mm	48
#40, .425mm	47
#50, .300mm	46
#100, .150mm	46
#200, .075mm	40

LL:	41
PL:	20
PI:	21
USCS:	GC
AASHTO:	A-7-6(4)

NOTES:

AASHTO Description: Clayey Soils

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.

Reviewed by: A Lopez, PE

111 S. Weber Dr., Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT NAME:	IHS Whiteriver Wastewater Treatment Plant	**PROJECT:**	250012
LOCATION:	Whiteriver, Arizona	**WORK ORDER:**	2500258
SAMPLE DATE:	8/7/2025	**REVIEWED BY:**	A Lopez, PE
SAMPLE SOURCE:	Bulk, SS-1 @ 0.0'-2.5'		

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D422)

WEIGHT OF SAMPLE DISPERSED	85.55
PERCENT PASSING #10 SIEVE	30.13
SPECIFIC GRAVITY OF SOLIDS	2.64

HYDROMETER RESULTS (% PASSING)

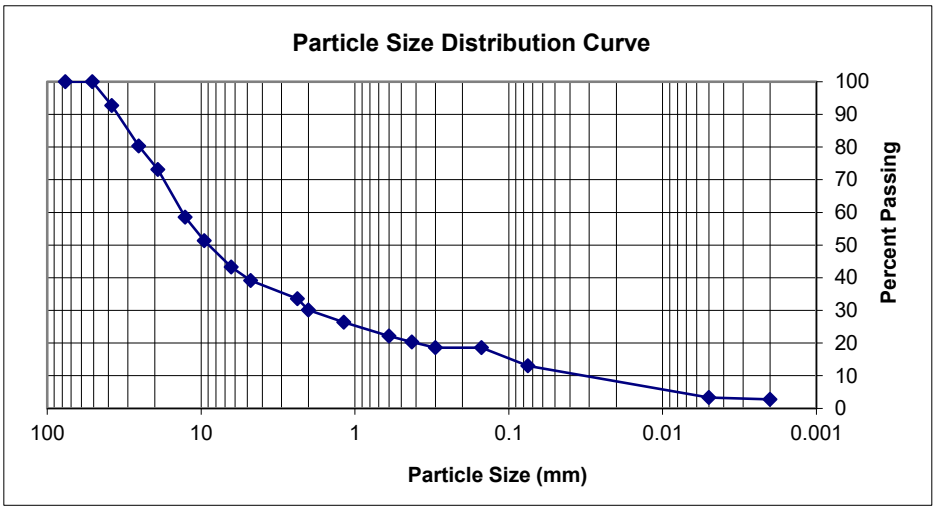
PARTICLE SIZE (DIA. mm)	0.0702	0.0518	0.0334	0.0198	0.0141	0.0101	0.0021	0.0015
PERCENT SAMPLE TESTED	32.8	25.7	22.2	17.6	16.4	14.1	9.4	8.3
PERCENT TOTAL SAMPLE	9.9	7.8	6.7	5.3	4.9	4.2	2.8	2.5

FULL SIEVE ANALYSIS
MECHANICAL SIEVE & HYDROMETER
(% PASSING)

3 IN	100
2 IN	100
1 1/2 IN	93
1 IN	80
3/4 IN	73
1/2 IN	59
3/8 IN	51
1/4 IN	43
# 4	39
# 8	34
# 10	30
# 16	26
# 30	22
# 40	20
# 50	19
# 100	19
# 200	13
0.005 mm	3
0.002 mm	3

MECHANICAL SIEVE ANALYSIS AFTER HYDROMETER (% PASSING)

#200	#100	#50	#40	#30	#16	#10
16	18	20	21	23	27	30



111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT NAME:	IHS Whiteriver Wastewater Treatment Plant	**PROJECT:**	250012
LOCATION:	Whiteriver, Arizona	**WORK ORDER:**	2500258
SAMPLE DATE:	8/7/2025	**REVIEWED BY:**	A Lopez, PE
SAMPLE SOURCE:	Bulk, SS-1 @ 2.5'-5.0'		

PARTICLE-SIZE ANALYSIS OF SOILS (ASTM D422)

WEIGHT OF SAMPLE DISPERSED	72.34
PERCENT PASSING #10 SIEVE	22.81
SPECIFIC GRAVITY OF SOLIDS	2.64

HYDROMETER RESULTS (% PASSING)

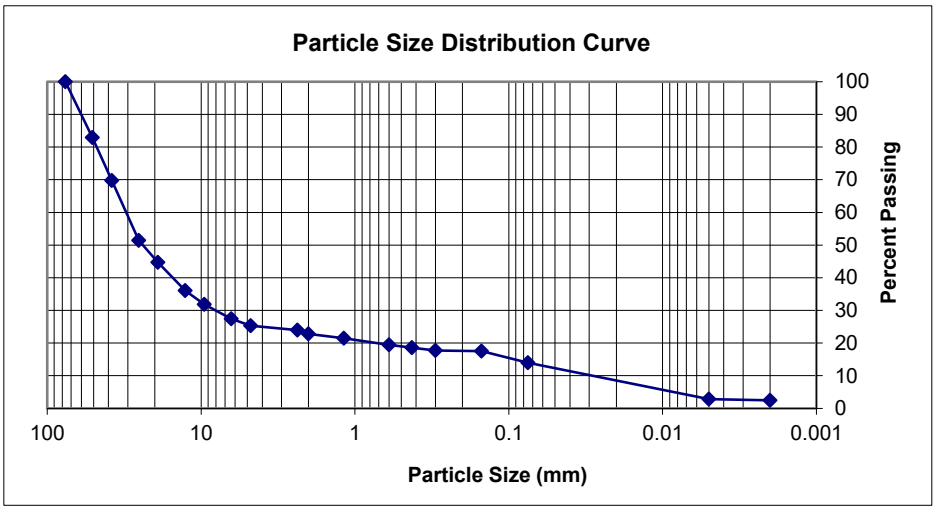
PARTICLE SIZE (DIA. mm)	0.0702	0.0522	0.0336	0.0199	0.0142	0.0101	0.0021	0.0015
PERCENT SAMPLE TESTED	38.7	29.0	24.9	19.4	18.0	15.2	11.1	9.8
PERCENT TOTAL SAMPLE	8.8	6.6	5.7	4.4	4.1	3.5	2.5	2.2

FULL SIEVE ANALYSIS
MECHANICAL SIEVE & HYDROMETER
(% PASSING)

3 IN	100
2 IN	83
1 1/2 IN	70
1 IN	51
3/4 IN	45
1/2 IN	36
3/8 IN	32
1/4 IN	27
# 4	25
# 8	24
# 10	23
# 16	21
# 30	19
# 40	19
# 50	18
# 100	18
# 200	14
0.005 mm	3
0.002 mm	2

MECHANICAL SIEVE ANALYSIS AFTER HYDROMETER (% PASSING)

#200	#100	#50	#40	#30	#16	#10
14	14	17	18	19	21	23



111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	IHS Whiteriver Wastewater Treatment Plant	**Project Number:**	250012
Location:	Whiteriver, Arizona	**Work Order Number:**	2500258
Client:	Mabbet and Associates, Inc.	**Lab Number:**	See Below
Material:	See Below	**Date Sampled:**	08/07/25
Sample Source:	See Below		

pH & Resistivity (AZ 236)

Sample Number	Sample Source	Resistivity (Ohm-cm)	pH
4	Bulk, B-2 @ 0.0'-5.0'	1,250	7.3
29	Bulk, B-7 @ 0.0'-4.0'	1,410	7.3

111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

MOTZZ LABORATORY, INC.

Report: 957287
Reported: 8/26/2025
Received: 8/22/2025
PO: 2500258

Laboratory Analysis Report

Atek Engineering Consultants
Antonio Lopez
111 South Weber Dr Suite 1
Chandler, AZ 85226

Project: 250012

Lab Number	Sample ID	
957287-1	4) Bulk, B-2	(0.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Chloride	ARIZ 736b	31	ppm
Free Sulfide	Sodium Azide	Negative	
Redox Potential	ASTM G200-09	293	(Eo) mV
Sulfate	ARIZ 733b	60	ppm

Lab Number	Sample ID	
957287-2	29) Bulk, B-7	(0.0-4.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Chloride	ARIZ 736b	12	ppm
Free Sulfide	Sodium Azide	Negative	
Redox Potential	ASTM G200-09	273	(Eo) mV
Sulfate	ARIZ 733b	58	ppm

GEOTECHNICAL EXPLORATION REPORT
HON DAH WASTEWATER TREATMENT PLANT
WHITE MOUNTAIN APACHE TRIBE
PINETOP, ARIZONA

Prepared for:
Mabbet and Associates, Inc.
105 Central Street, Suite 4100
Stoneham, MA 02180

ENGINEERING CONSULTANTS

Prepared by:
ATEK Engineering Consultants, LLC
111 South Weber Drive, Suite 1
Chandler, Arizona 85226

ATEK Project # 250013

July 31, 2025

July 31, 2025
ATEK Project #250013

Stephen A. Vetere, PE, LSP, LEP, Vice President of Operations
Mabbet and Associates, Inc.
105 Central Street, Suite 4100
Stoneham, MA

Regarding: Geotechnical Exploration Report

Project: Hon Dah Wastewater Treatment Plant
White Mountain Apache Tribe
Pinetop, Arizona

Dear Mr. Vetere:

ATEK Engineering Consultants, LLC is pleased to present the attached Geotechnical Exploration Report for the Hon Dah Wastewater Treatment Plant located in Pinetop, Arizona within the White Mountain Apache Tribe. The purpose of our study was to explore and evaluate the subsurface conditions at the proposed site to develop geotechnical engineering recommendations for project design and construction.

Based on our findings, the site is considered suitable for the proposed construction, provided geotechnical recommendations presented in the attached report are followed. Specific recommendations regarding the geotechnical aspects of the project design and construction are presented in the attached report. The recommendations contained within this report are dependent on the provisions provided in the Limitations and Recommended Additional Services sections of this report.

We appreciate the opportunity of providing our services for this project. If you have questions regarding this report or if we may be of further assistance, please contact the undersigned.

Sincerely,
ATEK Engineering Consultants, LLC

Registered Professional Engineer (Civil) CERTIFICATE NO. 71358 ANTONIO LOPEZ ESQUEDA DATE SIGNED 07-30-25 ARIZONA U.S.A.

Antonio Lopez, P.E.
Geotechnical Group Manager

Registered Professional Engineer (Civil) CERTIFICATE NO. 39511 ARMANDO ORTEGA Date Signed 07/30/25 ARIZONA, U.S.A.

Armando Ortega, P.E.
Principal Geotechnical Engineer

Distribution: (1) Addresses (Electronic Copy)

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1. Project Description 1
1.2. Purpose 1
1.3. Scope of Services 1

2. FIELD EXPLORATION 2
2.1. General 2
2.2. Soil Test Borings 2
2.3. Earthwork shrinkage and ground compaction 3

3. LABORATORY TESTING 3

4. GENERAL SITE CONDITIONS 4
4.1. Site Geology 4
4.2. Surface Conditions 5
4.3. Subsurface Conditions 5
4.4. Groundwater Conditions 6
4.5. Geologic Hazards 6
4.5.1. Liquefaction Potential 6
4.5.2. Collapsible Soils 6
4.5.3. Expansive Soils 6
4.6. Faulting 7
4.7. Seismic Considerations 7
4.8. Earth Fissures and Land Subsidence 8

5. ENGINEERING ANALYSES AND RECOMMENDATIONS 8
5.1. Earthwork 8
5.1.1. Frost Depth 8
5.1.2. Spread Footings - WWTP 9
5.1.3. Tank Foundation 10
5.1.3.1. Ring Foundation 10
5.1.3.2. Structural Slab with Thickened Edges 10
5.1.4. Mat Foundation 11
5.1.5. Sidewalks and Exterior Slabs 11
5.1.6. Onsite Pavement Site Preparation and Grading 12
5.1.7. Aggregate Base Course 12
5.1.8. Engineered Fill 13
5.2. Excavation 15
5.2.1. Trench Backfill 16
5.2.2. Temporary Excavations 17
5.3. Structures 18
5.3.1. Shallow Spread Footings 19
5.3.2. Structural Slab 20
5.3.3. Mat Foundation 20
5.3.4. Resistance to Lateral Loads 21

atek
ENGINEERING CONSULTANTS

5.3.4.1. Wall Drainage 22
5.3.4.2. Backfill Placement 22
5.4. Moisture Protection 22
5.5. Corrosion Potential 23
5.5.1. 10-point System 23
5.5.1.1. Electrical Resistivity 23
5.5.1.2. Oxidation-Reduction (Redox) Potential 25
5.5.1.3. Sulfides 25
5.5.1.4. Moisture 25
5.5.1.5. Corrosion (Concrete) 25
5.6. Onsite Pavement Areas 26

6. CLOSURE 27
6.1. Limitations 27
6.2. Recommended Additional Services 28

APPENDIX A – Site Location Map
APPENDIX B – Sample Location Plan
APPENDIX C – Field Study and Boring Logs
APPENDIX D – Laboratory Test

1. INTRODUCTION

This report presents the results of our geotechnical exploration for the Hon Dah Wastewater Treatment Plant located in Pinetop, Arizona, within the White Mountain Apache Tribe. A Site Location Map is presented in **Appendix A** of this report. The following sections of this report describe our understanding of the project and our scope of services.

1.1. Project Description

The proposed project involves the construction of a new wastewater treatment facility near Pinetop, Arizona within the White Mountain Apache Tribe. The planned construction will be constructed at the center of Sections 22, 23, 26 and 27 of Township 8 North, and Range 23 East of the Gila and Salt River Meridian. The construction involves a welded steel tank and a single building. The welded steel tank will have a diameter of 33 feet and 25 feet tall with a capacity of 20,100 cubic feet of water. The water treatment facility building will have an approximate footprint of 13,312 square feet. The building will be divided into several areas such as solid handing, chemical storage, electrical room, blower room, aerobic digestors, equalization storage, headworks and process area. Additional enhancements will include on-site paved areas to accommodate deliveries and pickups, including garbage and bio-waste handling.

1.2. Purpose

The purpose of this geotechnical study was to evaluate the general surface and subsurface conditions at the site, and to present recommendations related to geotechnical aspects of design and construction of the proposed project.

1.3. Scope of Services

Our study included a site reconnaissance, subsurface exploration, soil sampling, field and laboratory testing, engineering analyses, and preparation of this report. This report presents geotechnical recommendations for design and construction of proposed structures. The recommendations contained in this report are subject to the limitations presented herein. Attention is directed to the "Limitations" section of this report.

2. FIELD EXPLORATION

2.1. General

Prior to the start of drilling, Arizona 811 was contacted to locate existing utilities at the boring locations. The field exploration was performed on June 4, 2025. Five soil borings were drilled to depths ranging between fifteen (15) and twenty (20) feet below existing grade. The soil test borings were drilled using a truck mounted CME-75 power drill rig equipped with 7 and ¼-inch outside diameter hollow stem augers. The borings were located in the field at the approximate locations shown on the Sample Location Plan included in **Appendix B** of this report. Upon completion, the boreholes were backfilled with excavated materials.

2.2. Soil Test Borings

Disturbed and relatively undisturbed samples were taken in the direction of the field engineer during drilling operations. Relatively undisturbed samples of the subsurface materials were obtained using a California sampler with a 2.5-inch inside diameter and a 3.0-inch outside diameter. Disturbed samples were obtained using a Standard Penetration/Split Spoon Sampler (SPT) with a 1.5-inch inside diameter and 2.0-inch outside diameter. The California and the SPT samplers were driven 12 and 18 inches, respectively, using a 140-pound hammer falling 30 inches, and blow counts for successive 6-inch penetration intervals were recorded. After the sampler was withdrawn from the borehole, the samples were removed, sealed to minimize moisture loss, and submitted to the laboratory.

Soil classifications made in the field from auger cuttings and samples were re-evaluated in the laboratory after further examination and testing. The soils were classified in accordance with the Unified Soil Classification System presented in **Appendix C**.

Sample classifications, blow counts recorded during sampling, and other related information, were recorded on the soil boring logs. The boring logs are presented in **Appendix C**. The information presented on the logs is a combination of factual and interpretive information. Lines delineating subsurface strata and group symbols are based on field observations made at the time of the field study. Actual subsurface lines delineating subsurface strata may be gradual and vary.

2.3. Earthwork shrinkage and ground compaction

The in-place density of the soils were obtained at the selected depths within the soil borings. These values were compared with the results of laboratory moisture-density relationship (Standard Proctor) tests to estimate earthwork shrink factor.

The following table presents estimated earthwork shrinkage of the site soils. These estimates are based on the relevant information gathered during the field study, laboratory testing and assumption that the site soils are being compacted to between 95 and 100 percent of maximum dry density as determined by ASTM Test Method D698.

Elevation (ft.)	Earthwork Shrinkage (%)	Ground Compaction (ft)
0-5	15-20	0.10

3. LABORATORY TESTING

Selected soil samples from the borings were tested in the laboratory for classification purposes and to evaluate their engineering properties. The laboratory tests included:

- Gradation;
- Atterberg limits;
- Moisture content;
- One-dimensional consolidation;
- Undisturbed ring density;
- Standard Proctor;
- Swell potential of soil;
- pH tests;
- Resistivity tests;
- Organic content;
- Sulfide content;
- Redox potential;
- Sulfate content;
- And chloride content.

A brief description of each test performed on the soil samples and the results are presented in **Appendix D** of this report.

The table below represents the organic content evaluated within borings designated B-1 and B-3. The organic content is the ratio as a percentage of the weight of the organic material in a given mass of soil to the weight of the solid particles. The organic content was completed in general accordance with American Society for Testing and Materials (ASTM) Test Method D 2974.

Sample Location	Organic Content (%)
Hand Sample B-1 @ 0.0'-1.0'	8.74
Hand Sample B-3 @ 0.0'-1.0'	8.94

4. GENERAL SITE CONDITIONS

4.1. Site Geology

The project is located on the Fort Apache Indian Reservation in Navajo County, within the White Mountains region of east-central Arizona. This zone is primarily influenced by Cenozoic volcanic activity and tectonic uplift associated with the Colorado Plateau

and Basin and Range transition zone. The project site is located within the mapped surficial contact Quaternary basalt unit (Qb)[1]. The basalt is related to the Springville volcanic field which encompasses over 400 volcanic vents, located approximately 38 miles east of the site.

4.2. Surface Conditions

The project is located within Section 22, 23, 26 and 27, Township 8 North, Range 23 East Gila-Salt River Principal Meridian in Pinetop, Arizona within the White Mountain Apache Tribe. At the time of our field study the site was vacant with moderately dense surface covering of native pine trees consisting of new growth and mature trees. A rough graded earthen road was observed on the western boundary of the site. Topography gently slopes down towards the west to east, and relatively flat from north to south.

4.3. Subsurface Conditions

As indicated by the exploratory borings, in general the surface consists of residual soils. The residual soil consists of coarse-grained soils and fine-grained soils. The coarse-grained soils consist of medium dense to dense Silty Sand with Gravel (SM) with medium plasticity. The fine-grained soils consist of very stiff Sandy Lean Clay with and without Gravel (CL) with low to medium plasticity. The underlying subsurface soils encountered during our field exploration consisted of coarse-grained soils and fine-grained soils. The coarse-grained soils consist of loose to medium dense, Clayey Gravel with Sand (GC), Poorly Graded Gravel with Clay and Sand (GP-GC), Poorly Graded Gravel with Sand (GP) and Clayey Gravel with and without Sand (GC) with no to medium plasticity. The fine-grained soils consist of very stiff Sandy Lean Clay (CL) with low plasticity. For additional information see Boring Logs Presented in **Appendix C**.

[1] *Wilson, E.D., Moore, R.T., and O, Haire, R.T.; 1960; Geologic map of Navajo and Apache Counties, Arizona*

4.4. Groundwater Conditions

Perched groundwater was encountered at a depth of 20 feet within soil boring designated B-4. It is anticipated that groundwater will not be a factor in design or construction of the planned improvements unless utilities go beyond the depth of perched groundwater level. It should be noted that soil moisture conditions within the area may vary depending on rainfall and/or runoff conditions not apparent at the time of our field study.

4.5. Geologic Hazards

4.5.1. Liquefaction Potential

Based on the site soils and groundwater conditions encountered at the project site during this study, the preliminary potential for soil liquefaction is considered to be negligible.

4.5.2. Collapsible Soils

Collapsible soils are soils with the potential for a decrease in volume with an increase in external load or moisture content. These soils are typically found in areas of alluvial deposits with semi-arid to arid climates. Based on the information collected during our field study and subsequent laboratory testing, we anticipate collapse-susceptible soils will be encountered during construction. Based on American Society for Testing and Materials (ASTM) D 5333, a calculated collapse potential, I_C, of the tested undisturbed ring samples collected during our field study resulted in a range between 0.37 and 5.0 percent indicating a slight to moderate collapse potential.

4.5.3. Expansive Soils

Expansive soils are soils with the potential for an increase in volume with an increase in moisture content. Based on the information collected during our field study and

subsequent laboratory testing, we anticipate expansive-susceptible soils will be encountered during construction. Based on ASTM 4546, the expansive potential of the remolded sample collected during our field study, in the upper 5 feet, indicated an expansive potential.

4.6. Faulting

The project site is located approximately 25 miles southwest of the Concho Fault. The Concho Fault is northwest to southeast trending fault. The latest activity is estimated to be the Quaternary period. The slip rate is estimated at 0.2 mm per year[2].

4.7. Seismic Considerations

The project site is located in east central Arizona which is an area of low seismic activity. The following values were developed using the Seismic Design Maps by Structural Engineers Association by Location, the ASCE 7-16 Reference and are based on knowledge of local geologic conditions, and subsurface soils encountered during our study. A 100-foot soil test boring was not advanced during our field study. The geographic coordinates listed below were used in developing the seismic design factors.

Central Latitude.....34.067963˚
Central Longitude.....-109.894224˚

Seismic Design Factors	Value
Site Class	D
F_a, Site Coefficient	1.595

[2] U.S. Geological Survey. (n.d.). *Concho fault* [PDF]. https://earthquake.usgs.gov/static/lfs/nshm/qfaults/Reports/1014.pdf

F_v, Site Coefficient	2.4
S_s, Mapped Spectral Acceleration at 0.2-second Period	0.256 g
S_1, Mapped Spectral Acceleration at 1.0-second Period	0.080 g
S_{MS}, Spectral Acceleration at 0.2-second Period Adjusted for Site Class	0.409 g
S_{M1}, Spectral Acceleration at 1.0-second Period Adjusted for Site Class	0.193 g
S_{DS}, Design Spectral Response Acceleration at 0.2-second Period	0.272 g
S_{D1}, Design Spectral Response Acceleration at 1.0-second Period	0.128 g

4.8. Earth Fissures and Land Subsidence

The project site is located in an area with no documented earth fissures (Natural Hazard in Arizona-by-Arizona Geological Survey) and in an area without measured land subsidence (Land Subsidence in Arizona-by-Arizona Department of Water Resources).

5. ENGINEERING ANALYSES AND RECOMMENDATIONS

5.1. Earthwork

All existing fill, topsoil, vegetation and organic soils should be removed from below structural areas. The following sections present earthwork recommendations based on our understanding of the project, the finding of our field exploration, results of the laboratory tests and engineering analysis. Based on the finding of our field exploration, laboratory test results and engineering analysis, it is our opinion that the proposed construction can be supported on a footing system as presented in the following sections.

5.1.1. Frost Depth

Based on review of Table R301.2(1) of the Climate and Geographic Design for Apache County, Arizona, the frost depth is 18-inches for McNary, Arizona. A city approximately two (2) miles east of the project site. To protect against frost heave, the use of fine-grained soils should be avoided in and around structural areas. The potential for

snowpack adjacent to the structural areas may allow significant moisture to increase into fills around the outer edge of foundations therefore the exterior should be graded for positive drainage away from the structural areas. Also, to reduce the potential for moisture migration through earthwork operations, refer to section 5.4 of this report.

5.1.2. Spread Footings - WWTP

The existing surface soils should be removed to a minimum depth of three (3) feet below the bottom of proposed spread footing elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the structure and extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure. The exposed subsurface soils should be scarified to a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to within one (1) foot of finished pad elevation. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

Engineered Fill material meeting the recommendations presented in section 5.1.8 of this report should be placed within one (1) foot of the finished pad elevation. These soils should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

5.1.3. Tank Foundation

5.1.3.1. Ring Foundation

The existing surface soils should be removed to a minimum depth of four (4) feet below the bottom of proposed spread footing elevation or below the existing surface elevation, whichever is deeper. The excavation of the site soils should be within the entire footprint of the tank and extend laterally for a minimum distance of five (5) feet beyond the perimeter of structure. The exposed subsurface soils should be scarified to a depth of eight (8) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring the site to finished grade. Optimum moisture content and maximum dry density should be determined by ASTM D 698. Material greater than three inches should be removed during earthwork operations.

5.1.3.2. Structural Slab with Thickened Edges

A structural slab with thickened edges may be used to support the welded steel tank. The soil below the structural slab should be removed to a depth of three (3) feet below the bottom of the thickened edge. The over excavation of site soils should be extended laterally for a minimum distance of 5-feet beyond the perimeter of structures. The exposed subsurface soils should be scarified to a minimum depth of 8-inches, moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring site to grade. Optimum moisture content and maximum dry density should be determined by American Society for Testing and Materials (ASTM) D 698. Material greater than three inches should be removed during earthwork operations.

5.1.4. Mat Foundation

The soil below the mat foundation should be removed to a depth of two (2) feet below. The exposed subsurface soils should be scarified to a minimum depth of 8-inches, moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. The excavated material should then be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density and used as engineered fill to bring site to grade. Optimum moisture content and maximum dry density should be determined by ASTM D 698. The over excavation of site soils should be extended laterally for a minimum distance of 5-feet beyond the perimeter of the mat foundation.

5.1.5. Sidewalks and Exterior Slabs

The site soil tested as part of this project exhibit swelling potential and should not be used within twelve (12) inches of finished subgrade. The existing surface soils should be removed to a minimum depth of twelve (12) inches below the bottom of proposed concrete flatwork. The exposed subsurface soils should be scarified to a depth of six (6) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Engineered Fill material meeting the recommendations for Low Expansive Imported Soils (non-frost susceptible) presented in section 5.1.8 of this report should be placed within eight (8) inches of the finished subgrade elevation. These soils should be moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM D 698.

5.1.6. Onsite Pavement Site Preparation and Grading

The pavement section presented in this report is based on the site soils encountered during our field exploration. Any material with a diameter larger than three (3) inches within the pavement area should be removed during scarification. The native soils should be scarified to a depth of twelve (12) inches: moisture conditioned to within two (2) percent of optimum moisture content and compacted to a minimum of ninety-five (95) percent of maximum dry density. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.1.7. Aggregate Base Course

Aggregate base used in support of Portland cement concrete and asphaltic concrete pavements should conform to the local governing agency and/or Maricopa Association of Governments (MAG) Section 702 Specifications. The plasticity index of the fraction of material passing the No. 40 sieve should not exceed five when tested in accordance with ASTM Test Method D 4318. Coarse aggregate should have a percent of wear, when subjected to the Los Angeles abrasion test (ASTM Test Method C 131), of no greater than 40 when exposed to a maximum of 500 revolutions.

A minimum of four (4) inch layer of clean, granular material should be placed beneath concrete slabs to serve as a leveling base, and to aid in concrete curing. The material should conform to the gradation requirements set by the local governing agency and/or MAG section 702 specifications for Aggregate Base Course (ABC). The use of moisture barriers beneath the floor slabs may be helpful, but is not a geotechnical requirement; however, the architect or the slab designer should evaluate their need.

All aggregate base material should be placed in lifts not greater than eight (8) inches and compacted to a minimum of 95 percent of maximum dry density below Portland cement concrete and one hundred percent of maximum dry density below asphaltic concrete pavements as determined by ASTM Test Method D 698 or as specified by local

specification. The moisture content during compaction should be maintained within two percent of optimum moisture content.

5.1.8. Engineered Fill

Engineered fill may consist of native soils and/or imported soils. Pea gravel and poorly-graded materials should not be used as engineered fill unless approved by the geotechnical engineer. All engineered fills should be compacted as noted in section 5.

1. Native soils can be used as fill material for the following:
    - general site grading
    - foundation areas
    - foundation backfill
    - pavement areas

2. Imported soils with low expansive potentials could be used as fill material for the following:
    - general site grading
    - foundation areas
    - interior floor slab areas
    - foundation backfill
    - exterior slab areas
    - pavement areas

3. Imported soils (if required) should conform to the following:

Gradation	**Percent finer by weight (ASTM C136)**
3"	100
No. 4 Sieve	50-100
No. 200 Sieve	50 (max)
Liquid Limit	30 (max)
Plasticity Index	15 (max)

Swell Test

Maximum Swell Potential .....1.5 %*

*Measured on a sample compacted to approximately 95 percent of the ASTM D 698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

Corrosion Potential	**(PPM)**
Sulfate Content (ARIZ 733)	1,000(max)
Chloride Content (ARIZ 736)	500(max)

4. Imported soils (low-frost susceptible) should conform to the following:

Gradation	**Percent finer by weight (ASTM C136)**
3"	100
No. 4 Sieve	25-60
No. 200 Sieve	15 (max)

Swell Test

Maximum Swell Potential 1.5*

*Measured on a sample compacted to approximately 95 percent of the ASTM D 698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

Corrosion Potential	**(PPM)**
Sulfate Content (ARIZ 733)	1,000(max)
Chloride Content (ARIZ 736)	500(max)

5. Aggregate base should conform to MAG and/or local governing specifications.
6. Frozen soils should not be used as fill or backfill.

7. The following are intended to guide in establishing adequate support for the conventional foundation elements:

- Any natural washes, depressions or new excavations which are to be filled, should be widened as necessary to accommodate compaction equipment and provide a level base for placing fill.
- Any engineered fill (backfill) materials placed beneath the foundations should meet the requirements for Engineered Fill Materials.
- All footing excavations should be relatively level and free of loose or disturbed material and inspected by a qualified representative of the Geotechnical Engineer.

8. All fill soils to be used beneath the foundations; slabs and pavements should be approved by the Geotechnical Engineer. Fill should be placed in eight (8) inch loose lifts, moisture conditioned to within 2 percent of optimum moisture content and compacted to a minimum of 95 percent of maximum dry density. Fill materials placed at depth greater than five (5) feet should be compacted to 100 percent of maximum dry density to finished grade elevation. Optimum moisture content and maximum dry density should be determined by ASTM Test Method D 698.

5.2. Excavation

The field sampling and exploration was performed using a truck-mounted drill rig with 7 and ¼-inch outside diameter hollow stem augers. We present the following general comments regarding ease of excavation with the understanding that they are opinions based on the test borings. The project consultant and contractor should become familiar with this report including boring logs to evaluate potential hard dig conditions. **Please note that excavation characteristics are best evaluated by performing test excavations with the size and type of equipment the contractor plans on using at the site, which was not conducted as part of this study.**

It is anticipated that shallow excavations in the site soils can most likely be accomplished by conventional earth moving equipment in good operating condition. Cohesionless soils were encountered within the boring depths. Cohesionless soils are

prone to sloughing and caving and should be considered during grading operations. Please refer to Section 4 and the boring logs presented in **Appendix** C of this report for more information.

5.2.1. Trench Backfill

Materials

Pipe zone backfill (i.e., material beneath and in the immediate vicinity of the pipe) should consist of soil with a maximum particle size less than one inch. Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of soil that meets the requirements for structural fill provided above.

If import material is used for pipe or trench zone backfill, we recommend it consist of fine-grained sand. In general, poorly graded coarse-grained sand and gravel should not be used for pipe or trench zone backfill due to the potential for site soil migration into the relatively large void spaces present in this type of material and water seepage along trenches backfilled with coarse-grained sand and/or gravel.

Recommendations provided above for pipe zone backfill are minimum requirements only. More stringent material specifications may be required to fulfill local codes and/or bedding requirements for specific types of pipes. We recommend the project Civil Engineer develop these material specifications based on planned pipe types, bedding conditions, and other factors beyond the scope of this study.

Compaction Criteria

Backfill of trenches should utilize site soils with particle diameter less than 3-inches, in order to aid compaction and reduce potential differential settlement problems. Backfilling of utility trenches should be in 12-inch maximum loose lifts, and compacted to a minimum of 90 percent and 95 percent of ASTM D-698 (standard Proctor), in non-structural areas and structural areas, respectively. Please note that the local governing

agency specifications may surpass these trench backfill requirements. Jetting, flooding, or puddling of cohesive backfill soils should not be utilized under any circumstances.

Care must be used during compaction of backfill against stem walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated in close proximity to the below ground structures or earth retaining structures.

5.2.2. Temporary Excavations

General

All excavations must comply with applicable local, state, and federal safety regulations including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Generally, Construction site safety is solely the responsibility of the Contractor, who shall also be responsible for the means, methods, and sequencing of construction operations. We are providing the information below strictly as a service to our client. **Under no circumstances should the information be interpreted that ATEK is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.**

Excavations and Slopes

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, and/or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced; and, if not followed, could result in substantial penalties to the Owner, Contractor, and/or earthwork subcontractor and/or utility subcontractors.

Near-surface soils encountered during our field study consisted predominantly of Silty Sands with Gravel (SM). In our opinion, these soils would be considered a Type C soil when applying OSHA regulations. For this soils type OSHA recommends a maximum slope inclination of 1½(h):1(v) or flatter for excavations 20 feet or less in depth. Steeper cut slopes may be utilized for excavations less than five (5) feet deep depending on the strength, moisture content, and homogeneity of the soils as observed in the field. Flatter slopes and/or trench shields may be required if loose, cohesionless soils and/or water are encountered along the slope face.

Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within one-third the slope height from the top of any excavation. Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning may be required to provide structural stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any) should be designed by a professional engineer registered in the State of Arizona.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff water should be collected and disposed of outside the construction limits.

5.3. Structures

The anticipated frost depth for the project area is 18-inches below existing site grade. Therefore, concrete footings and concrete slabs should have turn downs which extend below the anticipated frost depth.

5.3.1. Shallow Spread Footings

Shallow spread footings bearing on engineered fill can be used to support the structures as recommended (See section 5.1). Recommended footing depths and allowable bearing pressures are presented below.

Allowable Bearing Pressure for Shallow Foundations

Footing Depth Below Finished Grade (ft.)*	Allowable Bearing Pressure (psf)
2.0	2,000
2.5	2,500
3.0	3,000
4.0+	4,000

***Note**: Footing depth is defined as the depth below the lowest adjacent finished grade elevation within 5-feet of the edge of the footing.

A one-third increase may be applied to the design bearing pressures when considering short duration loads, such as wind and seismic.

Continuous footings and isolated column footings should have a minimum width of 16-inches and 24 inches respectively. The minimum widths are recommended for ease of construction, and to provide a margin of safety against a local or punching shear failure of the foundation soils. All footings should be reinforced to reduce potential distress caused by differential foundation movement.

All the footing excavations should be observed by the Geotechnical Engineer prior to placement of reinforcing steel and/or concrete. If subsurface conditions are encountered that are different than indicated by the borings, revised recommendations may be required.

Settlement of footings designed as recommended above are estimated not to exceed 1-inch. Differential settlements over, a horizontal distance of 50 feet between similarly loaded footings, are expected to be less than ½-inch and ¾-inch for wall and column footings, respectively. Significant moisture increases above those recommended for compaction could result in additional movements. In order to minimize the sensitivity of the structure to differential settlements, footings should be reinforced to allow for a degree of load redistribution should a localized zone of supporting soils become saturated.

5.3.2. Structural Slab

For design of structural slabs on grade, a modulus of subgrade reaction, ks, of 150 pci is recommended for slabs bearing on competent soils prepared as recommended above. This modulus of subgrade reaction is based on soils encountered during our field exploration, recommendations for subgrade soils preparation stated within the above referenced report, our experience with similar subgrade conditions and estimates obtained from ACI design charts.

Additionally, it is recommended that a thicken edge be constructed on the slab to minimize the potential for edge damage.

5.3.3. Mat Foundation

Mat foundations bearing on engineered fill as presented in section 5.1 of this report may be used to support the proposed structures. An allowable bearing pressure of 3,000 pounds per square foot may be used for mat foundations bearing at a depth of 30 inches below adjacent grade or greater. A one third increase may be applied to the recommended bearing pressure when considering short duration loads, such as wind and seismic.

A modulus of subgrade reaction of 400 kips per cubic foot (kcf) should be used for the design of the mat foundation. This value is based on a 1-foot square bearing area and needs to be scaled to account for mat foundation size effects. To obtain the modulus of subgrade reaction for a given mat foundation, the value of 400 kcf should be divided by the width of the effective loaded area, in feet. We estimate that the long-term total and differential settlement of new mat foundations constructed as recommended in this report should be on the order of 1-inch. In order to account for size effects a reduction is recommended for larger areas. The following approximation of ks (based on Terzaghi's equation) can be used for mats of various dimensions.

ks (in pci) = $150[(B+1)/(2B)]^2$ where B is the width of the mat (in feet)

5.3.4. Resistance to Lateral Loads

Proposed walls/structures that will retain soil must be designed to withstand lateral soil pressures. Cantilevered retaining walls, or unrestrained walls subject to lateral earth pressures, should be designed for an equivalent fluid pressure (EFP) of 37 Pounds per Cubic Foot (PCF). Restrained walls should be designed to withstand a residual or long-term at-rest (Ko) earth pressure condition of 55 PCF.

A passive EFP of 300 PCF may be used for shallow spread footings. A coefficient of friction of 0.36 is recommended for computing lateral resistance between the base of footing and soil in analyzing lateral loads. Vehicular surcharge loads and/or hydrostatic pressure will increase the recommended EFP.

Only cohesionless, free-draining granular materials should be used as backfill, adjacent to earth-retaining structures. We recommend that backfill directly behind the walls be compacted with light, hand-held compactors. Heavy compactors and grading equipment should not be allowed to operate within 3 feet of the walls during backfilling, to avoid developing excessive temporary or long-term lateral soil pressures. Positive gravity drainage of the backfill should be provided.

5.3.4.1. Wall Drainage

The above-recommended values do not include lateral pressures due to hydrostatic forces. Therefore, wall backfill should be free draining and provisions should be made to collect and dispose of excess water that may accumulate behind earth retaining structures. In cases where site soils become saturated an equivalent fluid pressure of 90 PCF should be used.

Wall drainage should be collected by continuous perforated drainpipes, filter fabric, and gravel connected to weep holes. The drainpipe must run parallel to the wall. We recommend drain rock consist of durable stone having 100 percent passing the 1-inch sieve and zero percent passing the No. 4 sieve. Synthetic filter fabric should have an equivalent opening size (EOS), U.S. Standard Sieve, of between 40 and 70, a permeability of at least 0.02 centimeters per second and minimum puncture strength of 50 pounds.

5.3.4.2. Backfill Placement

All backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Care must be used during compaction of backfill against the below ground tanks walls. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional excessive wall pressure due to compaction method. To reduce the potential for a subsurface wall blowout, heavy construction equipment should not be operated next to the walls.

5.4. Moisture Protection

Soil support values reduce with an increase of moisture content. Therefore, positive drainage is essential to the successful performance of any structure. Good surface and

subsurface drainage should be established during and after construction to prevent the soils below or adjacent to the structural areas and utility trenches from becoming wet.

Infiltration of water into utility or foundation excavations must be prevented during construction. The drainage design must route all storm and sprinkler water away from the structural areas in a positive manner. All water should be diverted away from areas where it could penetrate the ground surface near the structural areas. Watering of plants should be avoided adjacent to the buildings. Desert-type landscaping is advisable near the structural areas. Plants, which require more water, should be located and drained away from the structural areas.

5.5. Corrosion Potential

5.5.1. 10-point System

The 10-point soil evaluation includes the following soil tests: resistivity, pH, oxidation-reduction (redox) potential, sulfides, and moisture. For each of these tests, results are categorized according to their contribution to corrosively. The test results are assigned point values based on Table A.1 found in Appendix A of the American National Standard for Polyethylene Encasement For Ductile-Iron Pipes Systems (ANSI/AWWA C105/A21.5-99), dated 1999. The above referenced corrosion testing is applicable to carbon steel pipe. A sum of points greater than or equal to 10, is considered corrosive to ductile iron pipes and carbon steel pipe and protection against exterior corrosion should be provided. The sum of points of the site soils sampled is 7 (less than 10), hence, the site soils be considered not corrosive to high carbon steel.

5.5.1.1. Electrical Resistivity

Electrical Resistivity of a soil is a measure of resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. As a soil's resistivity decreases, its corrosivity increases.

A commonly accepted correlation between soil resistivity and corrosivity towards ferrous metals is shown in the following table.

Resistivity (ohm-cm)	Corrosivity Classification
0 to 1,000	Severely corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately corrosive
Over 10,000	Mildly corrosive

Sample Location	pH	Resistivity (Ohm-cm)
Bulk Sample B-1 @ 0.0'-5.0'	5.6	1,180
Bulk Sample B-4 @ 0.0'-5.0'	5.7	2,380
Bulk Sample B-5 @ 0.0'-5.0'	5.9	2,130
Average	**5.7**	**1,897**

Resistivity test results indicate five (5) points, and the pH test results indicate zero (0) points in the 10-point soil evaluation for the reservoir location.

Based on the laboratory tests as shown above, this soil would be considered "corrosive". It should be noted that these corrosion conditions are for the soils at submerged moisture conditions. Resistivity at drier moisture contents would be less corrosive than the results of the test.

The pH values of the samples tested were neutral. In most cases, pH is not a significant factor in corrosion in the near-neutral pH range (5<pH<9).

Estimated life for various gage galvanized CMP, based on Figure 6.7 of the Handbook of Steel Drainage & Highway Construction Products published by American Iron and Steel Institute Fourth Edition, 1993, is tabulated below. Details of the laboratory test results are presented in the **Appendix C** of this report.

Sample Location	Design Life (yrs)		
	16 Gage	14 Gage	12 Gage
Bulk Sample B-1 @ 0.0'-5.0'	21	28	39
Bulk Sample B-4 @ 0.0'-5.0'	33	43	60

Bulk Sample B-5 @ 0.0'-5.0'	34	44	61

5.5.1.2. Oxidation-Reduction (Redox) Potential

The redox potential of a soil is significant in assessing corrosion potential because the most common sulfate-reducing bacteria can live only in anaerobic conditions. A negative redox potential indicates that anaerobic conditions are present in which sulfate reducers can live. The redox potential of site soils are 359 mV and 377 mV resulting in zero (0) points in the 10-point soil evaluation.

5.5.1.3. Sulfides

A positive sulfides reaction reveals a potential problem caused by sulfate reducing bacteria. A negative sulfides reaction was observed from the soil sample analyzed and results in zero (0) points in the 10-point soil evaluation.

5.5.1.4. Moisture

The prevailing moisture condition of the soil is important to all soil corrosion. The specific moisture content of the soil is not necessary but rather the drainage characteristics and moisture condition. A conservative classification of the site soils is fair drainage and generally moist which results in two (2) point in the 10-point soil evaluation.

5.5.1.5. Corrosion (Concrete)

Selected samples of the near-surface soils encountered at the site were subjected to chemical analysis for the purpose of corrosion assessment. The samples were tested for

soluble sulfates, and soluble chlorides. The samples were tested in general accordance with Arizona Test Methods 733, and 736 for soluble sulfates, and soluble chlorides, respectively. The test results are provided in **Appendix C**.

Based on provisions of American Concrete Institute (ACI) 318 Section 4.3, Table 4.3.1, Requirements for Concrete Exposed to Sulfate-Containing Solutions a sulfate concentration below 0.10 percent by weight (1,000 ppm) is negligible. Based on the laboratory results, sulfate contents of the site soils tested indicate a negligible corrosion potential to concrete.

Based on the laboratory result of the sample collected for this project, chloride contents of the site soils tested indicate negligible corrosion potential.

5.6. Onsite Pavement Areas

The on-site soils should be suitable as pavement subgrade soils provided all unsuitable debris, rubble, oversized cobbles, etc. are removed. A flexible and/or rigid pavement is recommended for the pavement areas. The recommended pavement sections are based on the assumption that the subgrade soils are prepared in accordance with section 5.1 of this report.

The flexible pavement section should consist of Central Plant Mix Asphaltic Concrete Pavement (AC) on compacted Aggregate Base Course (ABC) as recommended in the table below. Flexible pavement should be placed in accordance with MAG Section 321 and local municipality standards.

PAVEMENT AREA	ASPHALT SURFACE THICKNESS (IN)	AGGREGATE BASE COURSE THICKNESS (IN)

Light Duty Pavement	3.0	8.0
Heavy Duty Pavement	4.0	8.0

Our calculations for the design of the pavements section are based upon our classification of the subsurface soils, the calculated traffic in 18 kips equivalent single axle loads, the site preparation and grading recommendations provided above. A design life of 20 years was used in design.

Areas subject to sustained, heavy concentrated loads, such as dumpster areas should be paved with Portland Cement Concrete (PCC). A pavement section of 8 inches of PCC on 4 inches of aggregate base course is recommended in these areas. We should be contacted for additional recommendations if there will be any areas subjected to volumes of traffic heavier than those assumed for this report.

6. CLOSURE

6.1. Limitations

Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable Geotechnical Engineers practicing in this or similar localities. No warranty is expressed or implied.

The recommendations contained in this report are based on our field exploration, laboratory test results, and our understanding of the proposed construction. The subsurface data used in the preparation of this report was obtained from the test borings excavated during the field subsurface exploration. It is anticipated that some variations in the soil conditions will exist on-site. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to the recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

It is the Client's responsibility to see that all parties to the project including the designer, contractor, subcontractor, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

This report is for the exclusive purpose of providing Geotechnical Engineering and/or testing information and recommendations. The scope of services for this project does not include, either specifically or by implication, any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken. This report has also not addressed the site geology and the possible presence of geologic hazards.

This report may be used only by the Client and only for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both on 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 ATEK of such intended use. Based on the intended use of this report, ATEK may require that additional work be performed and that an updated report be issued.

6.2. Recommended Additional Services

The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be performed during the construction. These tests and observations should be performed by the Geotechnical Engineer's representative and should include, but not limited to the following:

- Observe and document that any existing surficial vegetation and other deleterious materials have been removed from the site as required in site

preparation section.

- Approve any material used as import to document that it meets the requirements outlined above before placement.

- Monitor the backfill procedures.

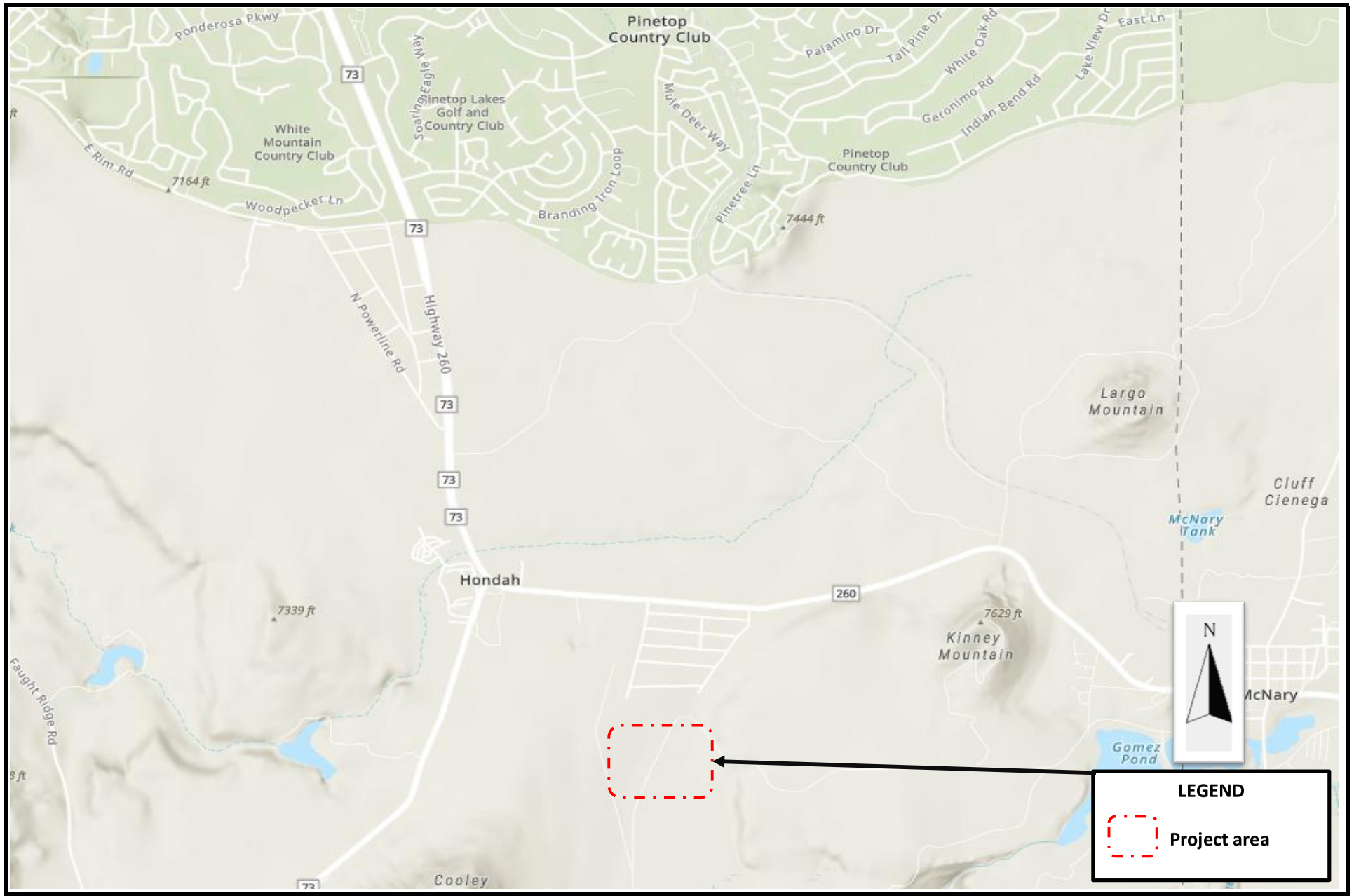
- Perform field density tests, as needed, to verify compaction compliance. The representative should monitor the progress of compaction and filling operations.

- Keep records of on-site activities and progress.

Observation of footing excavations should be performed prior to placement of reinforcing and concrete to confirm that satisfactory bearing materials are present. Construction testing, including field and laboratory evaluation of fill and backfill materials, concrete and steel should be performed to determine whether applicable project requirements have been met.

APPENDIX A
Site Location Map

atek
ENGINEERING CONSULTANTS



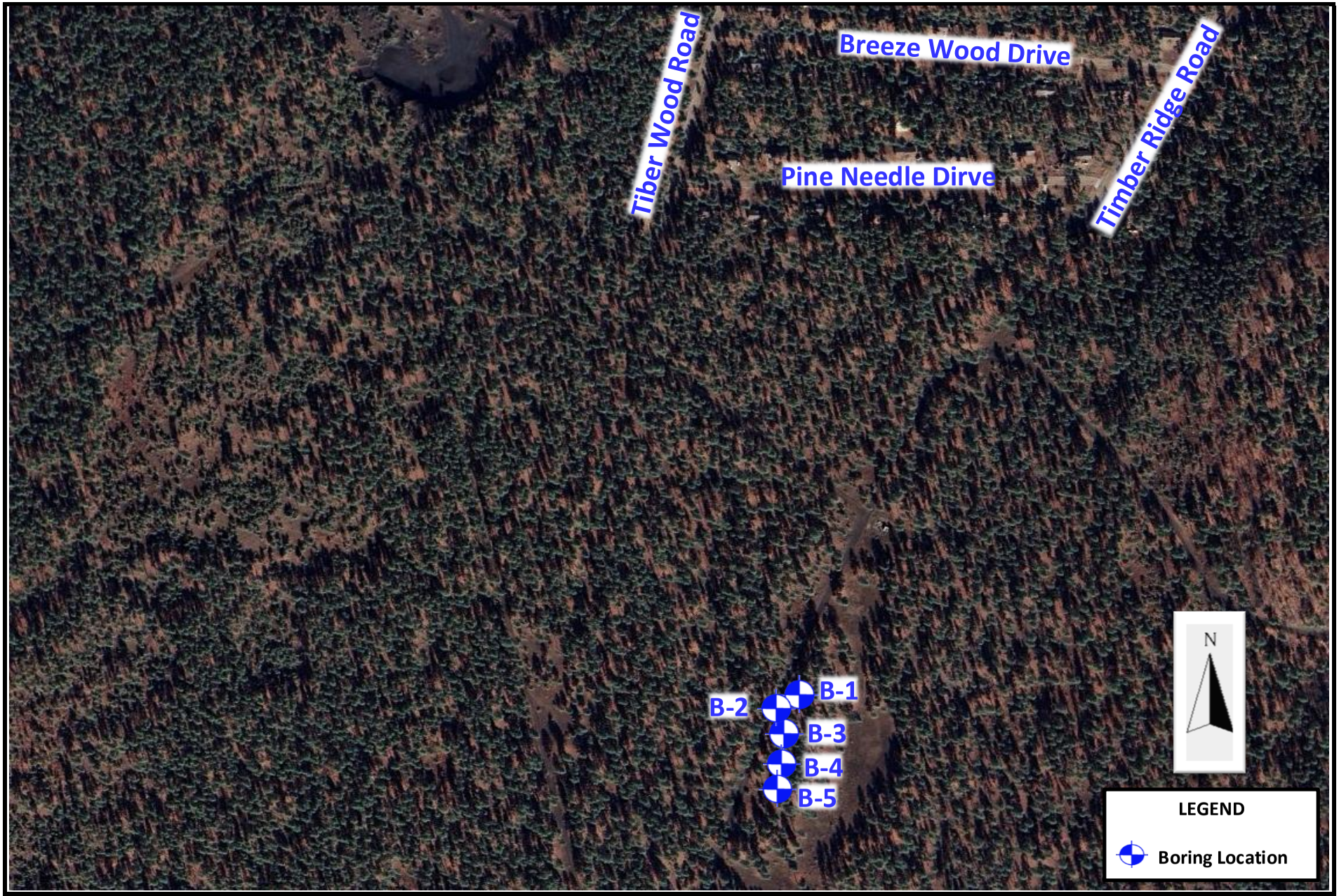
Project #:	250013	**Site Location Map - Sheet 1 of 1**
Date:	6/17/2025	Hon Dah Wastewater Treatment Plant Pinetop, Arizona
Drawn by:	GLR	

Basemap provided by ArcGIS

atek ENGINEERING CONSULTANTS
111 South Weber Drive, Suite 1
Chandler, AZ 85226

APPENDIX B
Sample Location Plan

atek
ENGINEERING CONSULTANTS



Basemap provided by Google Earth	Project #: 250013 Date: 6/17/2025 Drawn by: GLR	**Boring Location Plan - Sheet 1 of 1** Hon Dah Wastewater Treatment Plant Pinetop, Arizona	atek ENGINEERING CONSULTANTS 111 South Weber Drive, Suite 1 Chandler, AZ 85226

Project #: 250013	**Boring Location Plan - Sheet 1 of 1**	atek ENGINEERING CONSULTANTS
Date: 6/17/2025	Hon Dah Wastewater Treatment Plant	111 South Weber Drive, Suite 1
Drawn by: GLR	Pinetop, Arizona	Chandler, AZ 85226

Basemap provided by Google Earth

APPENDIX C
FIELD STUDY AND BORING LOGS

APPENDIX C
FIELD STUDY

BORINGS

The subsurface conditions at the site were explored on June 4, 2025, by drilling soil borings using a truck mounted CME drill rig with 7 and a ¼-inch outside diameter hollow stem auger. The locations of soil test borings performed for this study are shown in **Appendix B** of this report.

The locations of borings were located by visual sighting and pacing from existing site features and, therefore, should be considered approximate. Actual boring locations may vary from those indicated in **Appendix B**.

Our field engineer maintained a log of the excavations; visually classified soils encountered according to the Unified Soil Classification System (USCS) (see USCS Table); and obtained samples of the subsurface materials.

SAMPLING PROCEDURES

Soil samples obtained from the borings were packaged and sealed in the field to reduce moisture loss and disturbance, and returned to our laboratory for further testing. After borings were completed, they were backfilled with the excavated soils.

LIST OF ATTACHMENTS

The following plates are attached and complete this appendix.

Unified Soil Classification System – C1
Log Key – C2
Charts and Definitions – C3
Terminology Used to Describe Soils – C4
Logs of Soil Borings

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LESS THAN 5% PASSING NO. 200 SIEVE	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% PASSING NO. 200 SIEVE	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LESS THAN 5% PASSING NO. 200 SIEVE	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% PASSING NO. 200 SIEVE	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

Note: Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing No. 200 sieve require dual USCS symbols. (See KEY A-3 if provided)

atek ENGINEERING CONSULTANTS

Drafted By: ALE
Date: July, 2025

Project Number: 250013

UNIFIED SOIL CLASSIFICATION SYSTEM

Hon Dah Wastewater Treatment Plant
Mabbet and Associates, Inc.
Pinetop, Arizona

KEY

C-1

LOG SYMBOLS

BULK / GRAB SAMPLE

MODIFIED CALIFORNIA SAMPLER
(2.5 inch inside diameter)

GRAB SAMPLE

STANDARD PENETRATION
SPLIT SPOON SAMPLER
(2.0-inch O.D. X 1.5-inch I.D.)

SHELBY TUBE
(3 inch outside diameter)

NON-STANDARD PENETRATION
SPLIT SPOON SAMPLER
(1.5-inch O.D. X 0.9-inch I.D.)

BDBGM SIZE CORE BARREL
(1.65-inch I.D.)

BW44 SIZE CORE BARREL
(1.75-inch I.D.)

HQ-3 SIZE CORE BARREL
(2.4-inch I.D.)

WATER LEVEL
(level after completion)

WATER LEVEL
(level where first encountered)

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.

2. No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.

3. Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.

4. In general, the Unified Soil Classification designations presented on the logs were based on visual classification in the field, modified where appropriate by visual classifications in the office, and/or laboratory gradation and index testing.

5. NA = Not Analyzed

atek ENGINEERING CONSULTANTS

Drafted By: ALE	Project Number:
Date: July, 2025	250013

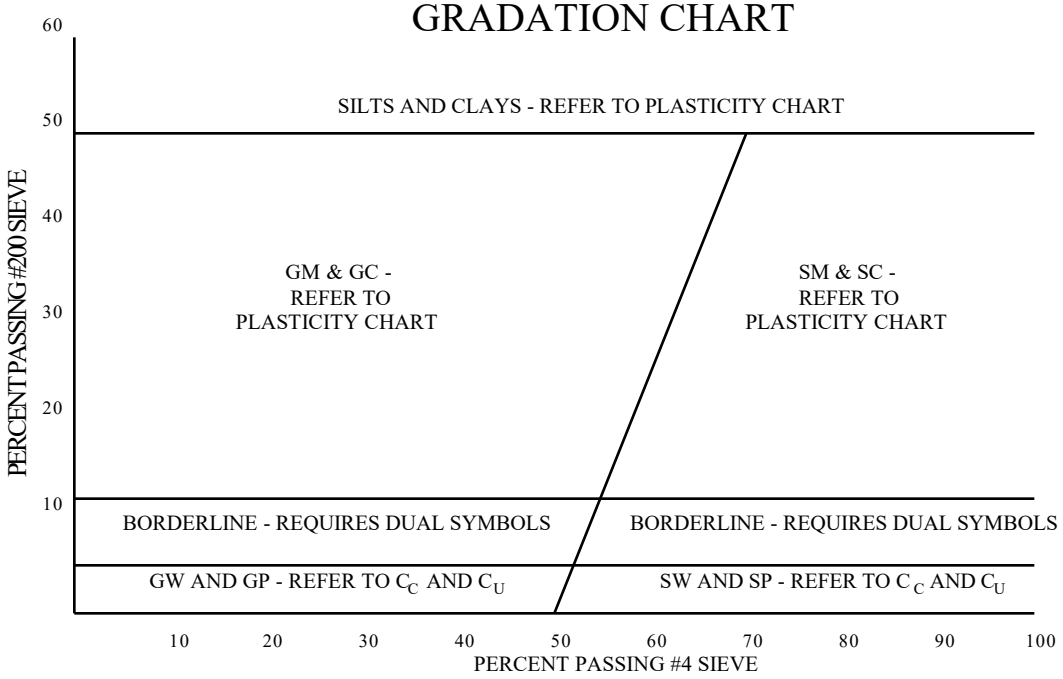
LOG KEY

Hon Dah Wastewater Treatment Plant
Mabbet and Associates, Inc.
Pinetop, Arizona

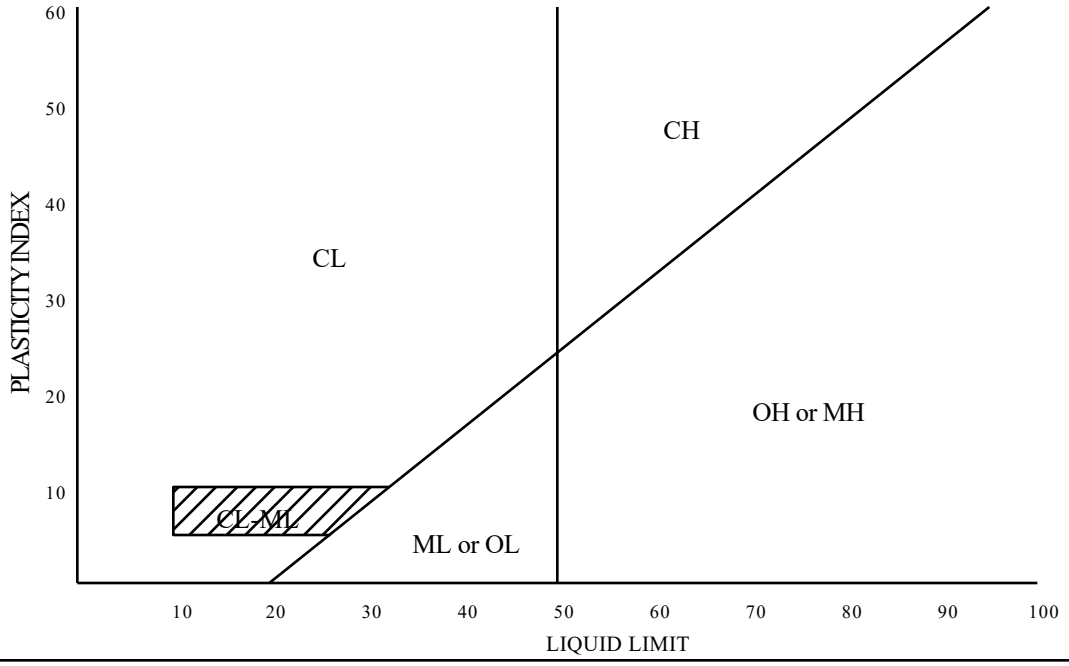
KEY

C-2

GRADATION CHART



PLASTICITY CHART



Plasticity of Fines (FHWA NHI-06-088)	
Plasticity Index	Plasticity Adjective
0	Nonplastic
1-10	Low plasticity
>10-20	Medium Plasticity
>20-40	High Plasticity
>40	Very plastic

Definitions of Soil Particles	
Soil Fraction	Particle Size Range
Boulders	Greater than 300mm (12in.)
Cobbles	300mm to 75mm (12in. to 3in.)
Coarse Gravel	75mm to 19mm (3in. to 3/4in.)
Fine Gravel	19mm (3/4in.) to No. 4 Sieve
Coarse Sand	No. 4 sieve to No. 10 sieve
Medium Sand	No. 10 sieve to No. 40 sieve
Fine Sand	No. 40 sieve to No. 200 sieve
Fines	Less than No. 200 sieve

atek ENGINEERING CONSULTANTS

Drafted By: ALE
Date: July, 2025

Project Number: 250013

CHARTS & DEFINITIONS

Hon Dah Wastewater Treatment Plant
Mabbet and Associates, Inc.
Pinetop, Arizona

KEY

C-3

TERMINOLOGY USED ON THE BORING LOGS TO DESCRIBE
THE FIRMNESS, DENSITY, OR CONSISTENCY OF SOILS

The standard penetration resistance (^{N}) in blows per foot is obtained by the ASTM D1586 procedure using 2" O.D., 1.5" I.D. samplers.

1. Terms for description of partially saturated and/or cemented soils including clays, cemented granular materials, silts and silty and clayey granular soils.

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

2. Terms for description of coarse grain soils. (FHWA NHI-06-088)

N	Relative Density
0-4	Very loose
5-10	Loose
11-30	Medium dense
31-50	Dense
51+	Very dense

3. Terms for description of fine grain soils. (FHWA NHI-06-088)

N	Relative Consistency
0-2	Very soft
3-4	Soft
5-8	Medium stiff
9-15	Stiff
16-30	Very stiff
31+	Hard

Project Name: Hoh Dah Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-1		Driller: Southlands	Logger: Amador Miramontes
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 6/4/25	Date Finished: 6/4/25

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				20.4		51	14	36	SM		SILTY SAND WITH GRAVEL (SM), 12% fine graded gravel, 52% fine to coarse grained sand, 36% fines, dense, medium plasticity, dark brown with light brown spots, slightly moist, no cementation, no reaction to HCl		
			14-22										
5												5	
			3-4-3						GC		CLAYEY GRAVEL WITH SAND (GC), loose, medium plasticity, dark brown with light brown spots, slightly moist, no cementation, no reaction to HCl		
10												10	
			3-2-4					8	GP-GC		POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC), 54% fine to coarse graded gravel, 38% fine to coarse grained sand, 8% fines, loose, low to medium plasticity, dark brown with light brown spots, moist, no cementation, no reaction to HCl		
15													
			2-3-2								Brown, wet	16.5	

Bottom of auger @ 15.0 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250013

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-1

Fig. 1

250013 FINAL LOGS.GPJ ` 7-29-25 ` A Miramontes ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Hoh Dah Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-2		Driller: Southlands	Logger: Amador Miramontes
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 6/4/25	Date Finished: 6/4/25

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			4-6-16						CL		SANDY LEAN CLAY (CL), very stiff, medium plasticity, dark brown, slightly moist, no cementation, no reaction to HCl Low plasticity		
5			7-11										
10			3-4-8						GP		POORLY GRADED GRAVEL WITH SAND (GP), medium dense, no plasticity, dark brown with brown spots, moist, no cementation, no reaction to HCl	10	
15			3-2-3						GC		CLAYEY GRAVEL WITH SAND (GC), loose, medium plasticity, dark brown with brown spots, moist, no cementation, no reaction to HCl	15 16.5	

Bottom of auger @ 15.0 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250013

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-2

Fig. 2

250013 FINAL LOGS.GPJ ` 7-29-25 ` A Miramontes ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Hoh Dah Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-3		Driller: Southlands	Logger: Amador Miramontes
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 6/4/25	Date Finished: 6/4/25

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				19		47	14	33	SM		SILTY SAND WITH GRAVEL (SM), 22% fine graded gravel, 45% fine to coarse grained sand, 33% fines, medium dense, medium plasticity, dark brown, slightly moist, no cementation, no reaction to HCl		Swell Potential of Soil = 2.5%
			7-12										
5			4-3-3						GC		CLAYEY GRAVEL (GC), loose, medium plasticity, dark brown and brown spots, moist, no cementation, no reaction to HCl	5	
10			4-4-4						GP		POORLY GRADED GRAVEL WITH SAND (GP), loose, no plasticity, dark brown and brown spots, moist, no cementation, no reaction to HCl	10	
15			3-3-3						GC		CLAYEY GRAVEL (GC), loose, low plasticity, dark brown and brown spots, wet, no cementation, no reaction to HCl	15	
												16.5	

Bottom of auger @ 15.0 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250013

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-3

Fig. 3

250013 FINAL LOGS.GPJ ` 7-29-25 ` A Miramontes ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Hoh Dah Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-4		Driller: Southlands	Logger: Amador Miramontes
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 6/4/25	Date Finished: 6/4/25

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
				18.3		47	14	44	SM		SILTY SAND WITH GRAVEL (SM), 16% fine graded gravel, 40% fine to coarse grained sand, 44% fines, medium dense, medium plasticity, dark brown, slightly moist, no cementation, no reaction to HCl		
			3-5-10										
5			6-5						GC		CLAYEY GRAVEL WITH SAND (GC), medium dense, low plasticity, dark brown, slightly moist, no cementation, no reaction to HCl	5	
10			4-6								Loose, moist		
15			2-4-4								Medium plasticity		
20			3-4-4								Low to medium plasticity, reddish yellow, wet Perched water was encountered @ 20 feet and boring was terminated at this depth.	21.5	

Bottom of auger @ 20.0 feet bgs.
Bottom of sampler @ 21.5 feet bgs.
Groundwater (Perched water) encountered @ 20.0 feet bgs

Sampler Types: Split Spoon; Penetrometer; Shelby; Vane Shear; Bulk Sample; California; Grab Sample

Operation Types: Auger Hollow Stem; Hand Auger; Bullnose; ODEX; Core Barrel; Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250013

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-4

Fig. 4

250013 FINAL LOGS.GPJ ` 7-29-25 ` A Miramontes ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

Project Name: Hoh Dah Wastewater Treatment Plant		Client: Mabbet and Associates, Inc.	
Borehole Location: See Location Plan			Sheet 1 of 1
Borehole Number: B-5		Driller: Southlands	Logger: Amador Miramontes
Drilling Equipment: CME-75	Borehole Diameter (in.): 7.25 HSA	Date Started: 6/4/25	Date Finished: 6/4/25

Elevation (ft)

Notes:

DEPTH (ft)	DRILL OPERATION	SAMPLE	STANDARD PENETRATION TEST SPT	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	LIQUID LIMIT LL	PLASTICITY INDEX PI	-200 (%)	USCS CLASSIFICATION	GRAPHIC LOG	MATERIAL DESCRIPTION	DEPTH (ft)	REMARKS
			12-12-8						CL		SANDY LEAN CLAY WITH GRAVEL (CL), very stiff, medium plasticity, dark brown, slightly moist, no cementation, no reaction to HCl		
5			7-10						GM		CLAYEY GRAVEL WITH SAND (GM), medium dense, medium plasticity, dark brown and light brown spots, slightly moist, no cementation, no reaction to HCl	5	
10			7-9										
15			3-3-3					8	GP-GC		POORLY GRADED GRAVEL GRAVEL WITH CLAY AND SAND (GC), 59% fine to coarse graded gravel, 33% fine to coarse grained sand, 8% fines, loose, low plasticity, dark brown, moist, no cementation, no reaction to HCl	15 16.5	

Bottom of auger @ 15.0 feet bgs.
Bottom of sampler @ 16.5 feet bgs.
No groundwater encountered.

Sampler Types: Split Spoon, Penetrometer, Shelby, Vane Shear, Bulk Sample, California, Grab Sample

Operation Types: Auger Hollow Stem, Hand Auger, Bullnose, ODEX, Core Barrel, Excavated Pit

WATER LEVEL OBSERVATIONS

While Drilling ▽ N/A ft	Upon Completion of Drilling ▼ N/A ft			
Time After Drilling	N/A	N/A	N/A	N/A
Depth To Water (ft)	N/A	N/A	N/A	N/A ▼

Remarks: Not Encountered

ATEK Project Number: 250013

atek ENGINEERING CONSULTANTS

LOG OF EXPLORATORY BORING B-5

Fig. 4

250013 FINAL LOGS.GPJ ` 7-29-25 ` A Miramontes ` ATEK BORING (W/REMARKS-SH#-SAME FIG#) `

Revised 10-14-11 (MAT)

APPENDIX D
Laboratory Test

atek
ENGINEERING CONSULTANTS

APPENDIX D
LABORATORY TESTING

LABORATORY TESTS
Laboratory tests were performed on selected samples to aid in soil classification and to evaluate physical properties of the soils, which may affect the Geotechnical aspects of project design and construction. A description of the laboratory testing program is presented below.

Sieve Analysis
Sieve analyses were performed to evaluate the gradation characteristics of the material and to aid in soil classification. Tests were performed in general accordance with ASTM Test Method C 136 and D 2487.

Atterberg Limits
Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Tests were performed in general accordance with ASTM Test Method D 4318.

Moisture Content
Moisture content tests were performed to evaluate moisture-conditioning requirements during site preparation and earthwork grading. Moisture content was evaluated in general accordance with ASTM Test Method D 2216.

One-Dimensional Consolidation
A one-dimensional consolidation test was performed on a ring samples to evaluate consolidation potential of the site soil. Test procedure was in general accordance with ASTM Test Method D 2435.

Undisturbed Ring Density
Undisturbed ring density tests were performed on ring samples to evaluate the in-situ density and moisture content of the site soils. Test procedures were in general accordance with ASTM Test Method D 2937.

Standard Proctor
Standard Proctor tests were performed on bulk soil samples to evaluate the maximum dry density and optimum moisture of the site soils. Test procedures were in general accordance with ASTM Test Method D 698A.

Swell Test
Swell test was performed on bulk soil samples to evaluate the expansion potential of the site soils. Test procedures were in general accordance with ASTM Test Method D 4829.

pH and Resistivity
pH and resistivity tests were performed on the bulk soil sample to evaluate the site soil corrosion potential. Test procedure was in general accordance with Arizona Test Method 236.

Organic Content
Organic content tests were performed to evaluate the ratio of the organic material in the on-site soils. Tests were performed in general accordance with ASTM Test Method D 2974.

Sulfate Content
Sulfate content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 733.

Chloride Content
Chloride content tests were performed to evaluate the corrosion potential of the on-site soils. Tests were performed in general accordance with ARIZ 736.

atek
ENGINEERING CONSULTANTS

PROJECT:	Hon Dah Wastewater Treatment Plant	**PROJECT NO:**	250013
LOCATION:	Pinetop, Arizona	**WORK ORDER NO:**	2500182
DATE SAMPLED:	6/4/2025	**REVIEWED BY:**	A Miramontes

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

					COBBLES		GRAVEL									SAND								Silt or Clay	
							Coarse					Fine				Coarse		Medium			Fine				
Location & Depth	**USCS**	**LL**	**PL**	**PI**	**6"**	**4"**	**3"**	**2"**	**1 1/2"**	**1 1/4"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**1/4"**	**#4**	**#8**	**#10**	**#16**	**#30**	**#40**	**#50**	**#100**	**#200**	**Lab #**
PERCENT PASSING BY WEIGHT																									
Bulk, B-1 @ 0.0'-5.0'	SM	51	37	14	100	100	100	100	100	100	100	100	100	99	94	88	74	68	62	57	55	53	49	36	1
Bulk, B-4 @ 0.0'-5.0'	SM	47	33	14	100	100	100	100	100	100	100	100	99	97	91	84	72	69	64	60	58	56	52	44	18

This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

atek
ENGINEERING CONSULTANTS

PROJECT: Hon Dah Wastewater Treatment Plant
LOCATION: Pinetop, Arizona
DATE SAMPLED: 6/4/2025

PROJECT NO: 250013
WORK ORDER NO: 2500182
REVIEWED BY: A Miramontes

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)

SIEVE SIZES

	COBBLES		GRAVEL									SAND								Silt or Clay	
			Coarse					Fine				Coarse		Medium			Fine				
Location & Depth	6"	4"	3"	2"	1 1/2"	1 1/4"	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#10	#16	#30	#40	#50	#100	#200	Lab #

PERCENT PASSING BY WEIGHT

SPT, B-1 @ 10.0'-11.5'	100	100	100	100	100	100	100	100	100	100	100	46	26	23	16	13	12	11	9	8	5
SPT, B-5 @ 15.0'-16.5'	100	100	100	100	100	100	100	100	100	100	100	41	25	22	16	13	12	11	9	7.9	28

This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

111 South Weber Drive, Suite1
Chandler, AZ 85226

www.atekec.com

p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT: Hon Dah Wastewater Treatment Plant
LOCATION: Pinetop, Arizona
SAMPLE DATE: 6/4/2025

PROJECT: 250013
WORK ORDER: 2500182
REVIEWED BY: A Miramontes

MOISTURE CONTENT OF SOIL -- ASTM D 2216

LAB #	SAMPLE SOURCE	MOISTURE		
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT
1	Bulk, B-1 @ 0.0'-5.0'	568.0	471.6	20.4%
12	Bulk, B-3 @ 0.0'-5.0'	524.7	440.8	19.0%
18	Bulk, B-4 @ 0.0'-5.0'	512.3	432.9	18.3%

atek
ENGINEERING CONSULTANTS

PROJECT: Hon Dah Wastewater Treatment Plant
LOCATION: Pinetop, Arizona
SAMPLE DATE: 6/4/2025

PROJECT: 250013
WORK ORDER: 2500182
REVIEWED BY: A Miramontes

DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD -- ASTM D 2937

LAB #	SAMPLE SOURCE	MOISTURE			# OF RINGS	WET WEIGHT + RINGS (g)	WEIGHT OF RINGS (g)	DRY DENSITY (pcf)
		WET WEIGHT (g)	DRY WEIGHT (g)	MOISTURE CONTENT				
9	Ring, B-2 @ 5.0'-6.0'	754.8	583.6	29.3%	6	1012.7	257.9	80.5
21	Ring, B-4 @ 10.0'-11.0'	726.8	474.0	53.3%	6	992.4	265.6	65.4
26	Ring, B-5 @ 5.0'-6.0'	597.8	474.3	26.0%	6	870.4	272.6	65.5

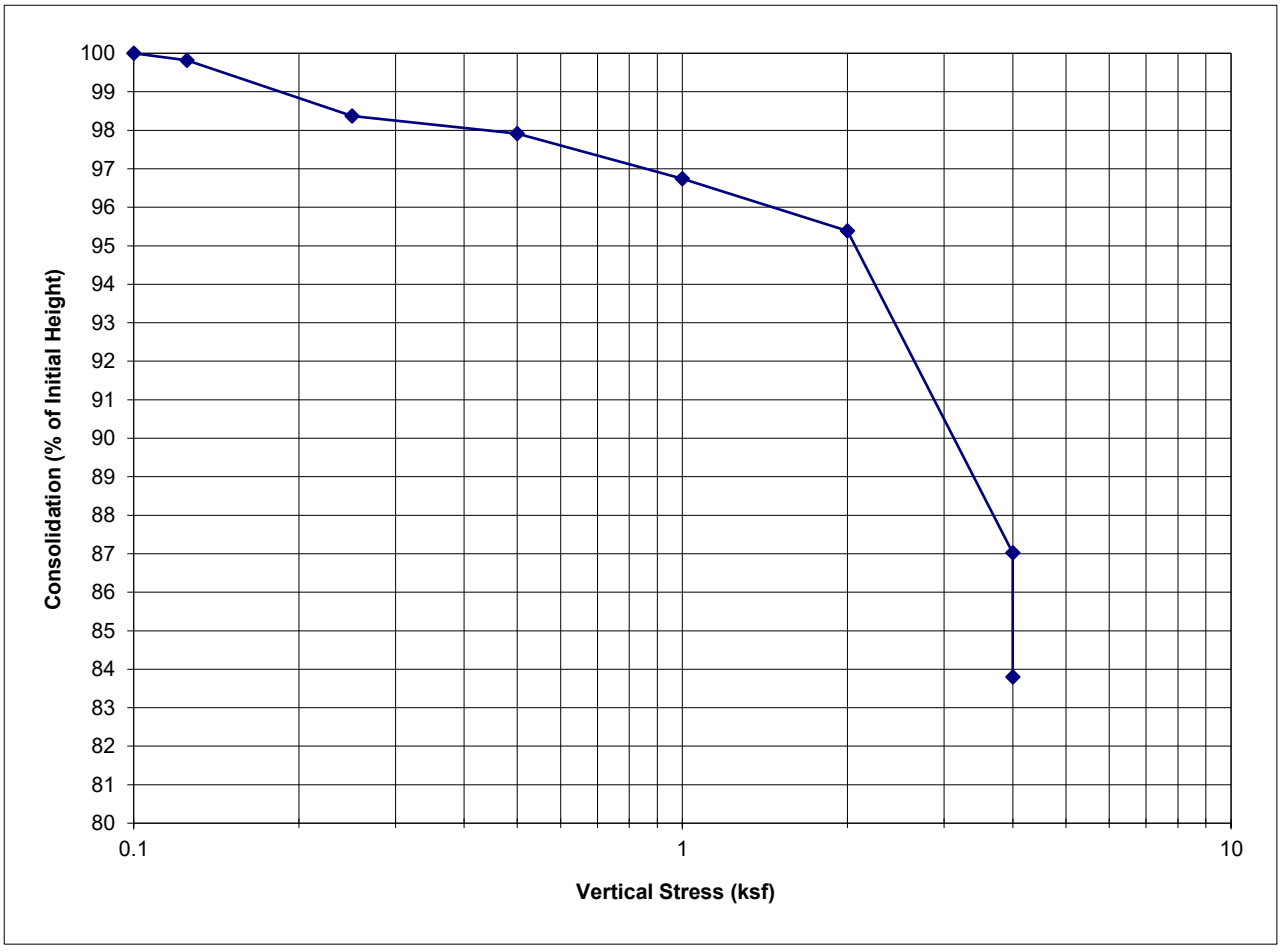
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Hon Dah Wastewater Treatment Plant	**Project Number:**	250013
Project Location:	Pinetop, Arizona	**Work Order Number:**	2500182
Client:	Mabbet and Associates, Inc.	**Lab Number:**	14
Material:	Native	**Date Sampled:**	06/04/25
Sample Source:	Ring Sample B-3 @ 2.5'-3.5'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	3.86
Initial Moisture Content	16.3%	Final Moisture Content	37.4%
Initial Dry Density(pcf)	69.7	Final Dry Density(pcf)	83.1
Initial Degree of Saturation	31%	Final Degree of Saturation	100%
Initial Void Ratio	1.4	Final Void Ratio	1.0
Estimated Specific Gravity	2.65	Saturated at	4 ksf
		Hydro Collapse Potential	3.22%



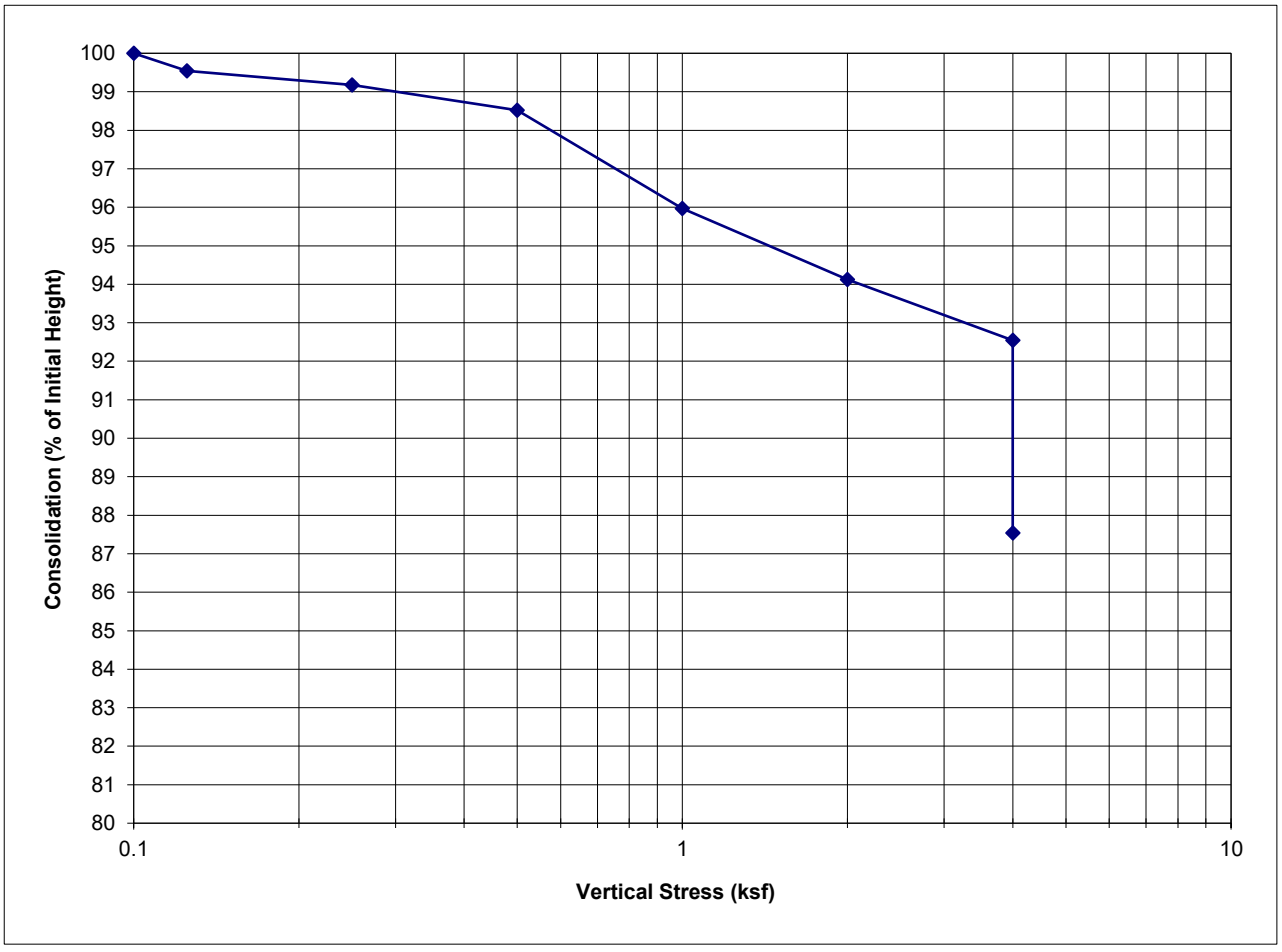
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Hon Dah Wastewater Treatment Plant	**Project Number:**	250013
Project Location:	Pinetop, Arizona	**Work Order Number:**	2500182
Client:	Mabbet and Associates, Inc.	**Lab Number:**	20
Material:	Native	**Date Sampled:**	06/04/25
Sample Source:	Ring Sample B-4 @ 5.0'-6.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.03
Initial Moisture Content	39.3%	Final Moisture Content	48.4%
Initial Dry Density(pcf)	55.8	Final Dry Density(pcf)	63.8
Initial Degree of Saturation	53%	Final Degree of Saturation	81%
Initial Void Ratio	2.0	Final Void Ratio	1.6
Estimated Specific Gravity	2.65	Saturated at	4 ksf
		Hydro Collapse Potential	5.00%



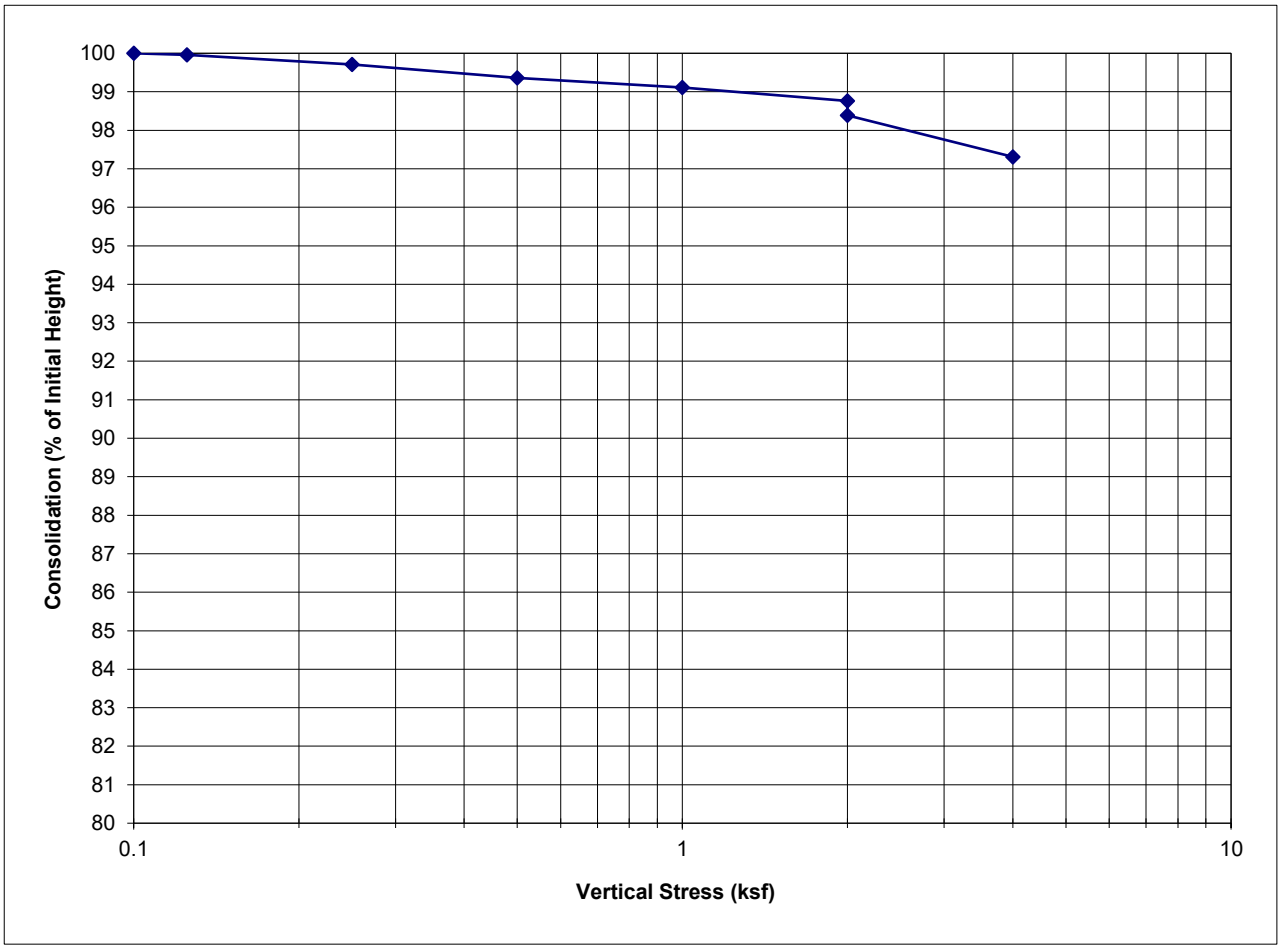
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Hon Dah Wastewater Treatment Plant	**Project Number:**	250013
Project Location:	Pinetop, Arizona	**Work Order Number:**	2500182
Client:	Mabbet and Associates, Inc.	**Lab Number:**	27
Material:	Native	**Date Sampled:**	06/04/25
Sample Source:	Ring Sample B-5 @ 10.0'-11.0'		
Sample Prep:	In-Situ		

One-Dimensional Consolidation Properties of Soils (ASTM D2435)

Initial Volume (cu.in)	4.60	Final Volume (cu.in)	4.48
Initial Moisture Content	32.1%	Final Moisture Content	37.0%
Initial Dry Density(pcf)	65.4	Final Dry Density(pcf)	67.2
Initial Degree of Saturation	56%	Final Degree of Saturation	67%
Initial Void Ratio	1.5	Final Void Ratio	1.5
Estimated Specific Gravity	2.65	Saturated at	2 ksf
		Hydro Collapse Potential	0.37%



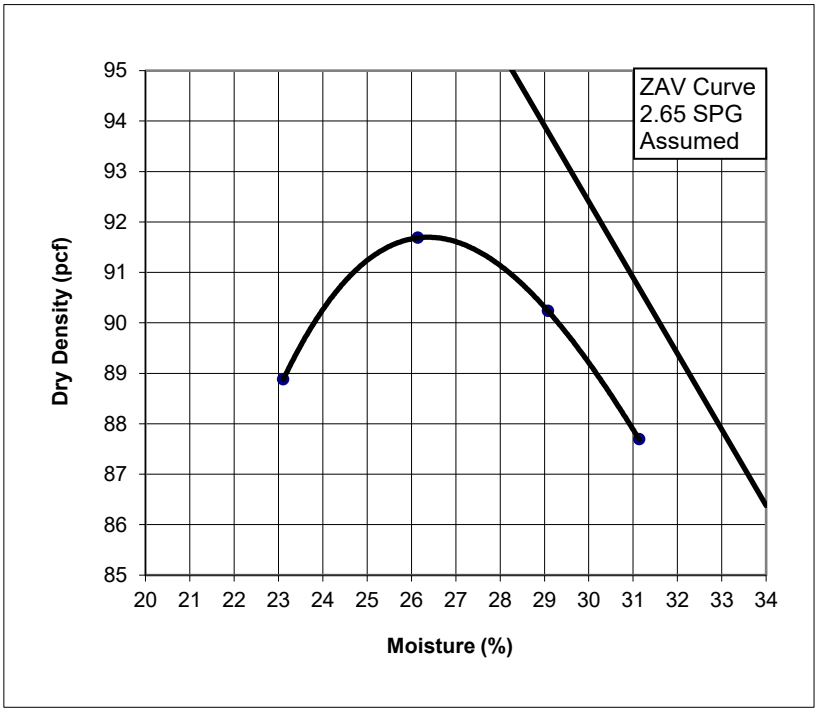
111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

PROJECT:	Hon Dah Wastewater Treatment Plant	**PROJECT NO:**	250013
LOCATION:	Pinetop, Arizona	**WORK ORDER NO:**	2500182
MATERIAL:	Native	**LAB NO:**	12
SAMPLE SOURCE:	Bulk, B-3 @ 0.0'-5.0'	**SAMPLE DATE:**	6/4/2025

LABORATORY COMPACTION CHARACTERISTICS OF SOILS USING
STANDARD EFFORT (12,400ft-lb-ft/cu.ft) (ASTM D698A)
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES (ASTM C136/C117)
LIQUID LIMIT, PLASTIC LIMIT, AND PLASTICITY INDEX OF SOILS (ASTM D4318) (DRY PREP)

	English (pcf)	Metric (kg / cu.m.)
Maximum dry density:	91.7	1469
Optimum moisture (%):	26.4	26.4



SIEVE SIZE	PERCENT PASSING
6 in / 152mm	100
4 in / 100mm	100
3 in / 75mm	100
2 in / 50mm	100
1 1/2 in / 37.5mm	100
1 1/4 in / 32 mm	100
1 in / 25 mm	100
3/4 in / 19 mm	99
1/2 in / 12.5 mm	97
3/8 in / 9.5 mm	94
1/4 in / 6.4 mm	86
#4, 4.75mm	78
#8, 2.36mm	66
#10, 2.00mm	60
#16, 1.18mm	54
#30, 0.60mm	48
#40, .425mm	46
#50, .300mm	43
#100, .150mm	42
#200, .075mm	33

LL:	47
PL:	33
PI:	14
USCS:	SM
AASHTO:	A-2-7(0)

NOTES:

AASHTO Description:

- The zero air void curve represents a specific gravity of: 2.65 assumed, (also used in the 'Rock Correction Calculation)
- This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at clients request.

Reviewed by: A Miramontes

111 S. Weber Dr., Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

atek
ENGINEERING CONSULTANTS

Project:	Hon Dah Wastewater Treatment Plant	**Project Number:**	250013
Location:	Pinetop, Arizona	**Work Order Number:**	2500182
Client:	Mabbet and Associates, Inc.	**Lab Number:**	See Below
Material:	Native	**Date Sampled:**	06/04/25
Sample Source:	See Below		

Swell Potential of Soil ASTM D4546

Sample Number	Sample Source	Swell (%)	Target Compaction (%)	Actual Compaction (%)	Target Moisture (%)	Actual Moisture (%)
12	Bulk, B-3 @ 0.0'-5.0'	2.5	95.0	95.1	23.4	23.7

Note: Ring Samples were subjected to a 100 psf surcharge.

atek
ENGINEERING CONSULTANTS

Project:	Hon Dah Wastewater Treatment Plant	**Project Number:**	250013
Location:	Pinetop, Arizona	**Work Order Number:**	2500182
Client:	Mabbet and Associates, Inc.	**Lab Number:**	See Below
Material:	See Below	**Date Sampled:**	06/04/25
Sample Source:	See Below		

pH & Resistivity (AZ 236)

Sample Number	Sample Source	Resistivity (Ohm-cm)	pH
1	Bulk, B-1 @ 0.0'-5.0'	1,180	5.6
18	Bulk, B-4 @ 0.0'-5.0'	2,380	5.7
24	Bulk, B-5 @ 0.0'-5.0'	2,130	5.9

111 South Weber Drive, Suite 1
Chandler, AZ 85226
www.atekec.com
p 480.659.8065
f 480.656.9658

PROJECT: ATEK
LOCATION: Job #250013 WO#2500182
MATERIAL: Soil
SAMPLE SOURCE: See Below

JOB NO: US-EI-1920111087
WORK ORDER NO: 335
LAB NO: See Below
DATE RECEIVED: 06/12/25

DETERMINING THE MOISTURE CONTENT, ASH CONTENT, AND ORGANIC MATTER OF PEAT AND OTHER ORGANIC SOILS
ASTM D2974

LAB #	BORING & DEPTH	Weight Container (grams)	Weight Sample (grams)	Weight Cont & Sample (initial) (grams)	Weight Cont & Sample (after burn) (grams)	% of Organic Matter
25-0912	B-1 @ 0.0' - 1.0'	107.72	60.27	167.99	162.72	8.74
25-0913	B-3 @ 0.0' - 1.0'	112.88	57.07	169.95	164.85	8.94

WSP USA
3630 E Wier Ave.
Phoenix, AZ 85040

Reviewed by: _____

MOTZZ LABORATORY, INC.

Report: 956121
Reported: 6/18/2025
Received: 6/16/2025
PO: 2500182

Laboratory Analysis Report

Atek Engineering Consultants
Antonio Lopez
111 South Weber Dr Suite 1
Chandler, AZ 85226

Project: 250013

Lab Number	Sample ID	
956121-1	1) Bulk, B-1	(0.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Sulfate	ARIZ 733b	37	ppm
Chloride	ARIZ 736b	9	ppm

Lab Number	Sample ID	
956121-2	18) Bulk, B-4	(0.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Free Sulfide	Sodium Azide	Negative	
Redox Potential	ASTM G200-09	359	(Eo) mV
Sulfate	ARIZ 733b	38	ppm
Chloride	ARIZ 736b	9	ppm

Lab Number	Sample ID	
956121-3	24) Bulk, B-5	(0.0-5.0')

Test Parameter

Test	*Method*	*Result*	*Units*
Free Sulfide	Sodium Azide	Negative	
Redox Potential	ASTM G200-09	377	(Eo) mV

KLEINFELDER
Bright People. Right Solutions.

April 4, 2025
Kleinfelder Project No: 25004546.001A

Mr. Armando Ortega
Principal
ATEK Engineering Consultants
111 S. Weber Drive, Suite 1
Chandler, Arizona 85226

Subject: Site-Specific Ground Motion Hazard Analysis
Proposed Whiteriver Indian Hospital Addition
200 W. Hospital Drive
Whiteriver, Arizona 85941

Dear Mr. Ortega,

This letter report presents the results of Kleinfelder's site-specific ground motion hazard analysis performed for the project site located south of the existing Whiteriver Indian Hospital at 200 W. Hospital Drive in Whiteriver, Arizona. The results of our analysis include site classification, site-specific seismic design values, design earthquake response spectrum and risk-targeted (MCE_R) response spectrum. The site-specific GMHA was performed in accordance with the 2021 International Building Code (IBC), which references 2016 American Society of Civil Engineer (ASCE) Standard 7 (ASCE 7-16). This report relies upon data from the field and laboratory investigations completed for the subject project and provided to Kleinfelder via email by ATEK Engineering Consultants (2024).

INTRODUCTION

As requested, we performed a site-specific ground motion hazard analysis (GMHA) in accordance with the guidelines set forth in IBC 2021/ASCE 7-16. This site-specific ground motion hazard analysis is for the design of the proposed design and construction of the proposed addition to the Whiteriver Indian Hospital campus. Site characterization was completed using the shear-wave velocity measurements presented in the "Supplemental Subsurface Site Characterization" report by Geolines, LLC (2024), who was subcontracted to ATEK. The report utilized the measured shear-wave velocities, associated subsurface velocity layers, and the weighted harmonic mean in accordance with the requirements of Chapter 20 of ASCE 7-16 to determine $V_{s,30}$ (average shear wave velocity in the upper 100 feet) for site classification. The results of the analyses indicate that the average shear wave velocity of the upper 30 m (100 ft) below the ground surface (i.e., $V_{S,30}$) of approximately 500 m/s (1640 ft/s), which was utilized in our site-specific analyses.

Based on the value of $V_{S,30}$ obtained from the exploration correlations, subsurface characteristics of the site reported in the exploration logs by ATEK, and the site classification methods of ASCE 7-16 Chapter 20, the project site is classified as **Site Class C.**

© 2025 Kleinfelder

24411 Ridge Route Dr., Suite 225, Laguna Hills, CA 92653 p | 949.727.4466 f | 949.727.9242

Detailed Scope of Services

The purpose of the GMHA is to develop site-specific ground motion criteria in terms of seismic design parameters and response spectral accelerations by utilizing data obtained from the geotechnical data package provided by ATEK (2024). Specifically, our scope of services for the site-specific GMHA included:

- Review of readily available geologic and seismic data including review of the geotechnical explorations performed at the site by ATEK and others, the regional geologic and seismic setting, faulting locations with respect to the site, and historical seismicity.
- Development of a current seismic source model, based on the ASCE 7-16 requirements, accounting for the site's proximity to active faults, data from major historical earthquakes, and regional seismicity.
- Perform a site-specific ground motion hazard analysis (both probabilistic and deterministic seismic hazard analysis) for a hazard level of 2-percent probability of exceedance in 50 years (i.e., the MCE_R per ASCE 7-16) and two-thirds of the 2-percent probability of exceedance in 50 years (i.e., the DE per ASCE 7-16). The analyses utilize seismic source models and applicable ground motion prediction equations (GMPEs) in accordance with ASCE 7-16.
- Develop site-specific uniform hazard response spectra for the Design Earthquake (DE) and the Risk-Targeted Maximum Considered Earthquake (MCE_R) from the results of probabilistic and deterministic seismic hazard analysis.
- Preparation of this letter report presenting the results of the site-specific ground motion hazard analysis.

Project Location

The site is located at approximately 200 W Hospital Drive in Whiteriver, Arizona. The approximate site coordinates used for the site-specific GMHA were taken at the approximate coordinates for the site as follows:

Latitude: 33.8754° N
Longitude: 109.9604 ° W

SITE DESCRIPTION AND CONDITIONS

Regional Faulting

The site is located in Whiteriver, Arizona, and is part of the Fort Apache Indian Reservation. The reservation lies in the Central Highlands Transition Zone, which is the transition between the Colorado Plateau and Basin and Range provinces. The Colorado consists of layers of consolidated sedimentary rock, which form broad plateaus and mesas separated by canyons. The Basin and Range is typically characterized by northwest-southeast trending elongated and subparallel uplifted mountain blocks separated by intervening down dropped basins or valleys. The Central Highlands form the transition between these two provinces and is generally formed by erosion after the Colorado Plateau was uplifted. The region exhibits geologic characteristics intermediate to the two provinces and includes large volcanoes (Artiola & Uhlman, 2009).

The project site and vicinity are located in an area traditionally characterized by low seismic activity with no mapped active faults within the USGS quaternary fault and fold database (USGS, 2025). The nearest

© 2025 Kleinfelder

KLEINFELDER 24411 Ridge Route Dr., Suite 225, Laguna Hills, CA 92653 p | 949.727.4466 f | 949.727.9242

mapped fault zone by the USGS is the Vernon Fault Zone, located approximately 48 km northeast of the site and estimated to have last ruptured in the middle to later quaternary (<750,000 years ago), as shown on Figure 1. This fault is not included as an independent seismogenic source by the 2014 United States National Seismic Hazard Maps (Petersen et al., 2014), shown in Figure 2. All other faults have been included in the background seismic sources.

Historical Seismicity

We used the United States Geological Survey (USGS) ANSS Comprehensive Earthquake Catalog (ComCat), along with various other publicly available catalogs and sources, to develop a comprehensive catalog of historic seismicity near the site as shown on Figure 1. Based on our review of these catalogs, only one historical earthquake has occurred in the site vicinity, located approximately 75 km southwest of the site. The epicenter is show on Figure 1.

SITE-SPECIFIC GROUND MOTION MODEL

Seismic Source Model

The probabilistic seismic source model was developed based the 2014 Update of the United States National Seismic Hazard Maps (Petersen et al., 2014). Faults within 300 km of the site were used. As previously discussed, no independent seismogenic sources were present within 100 km of the site. However, the potential for seismic activity remains and is likely to occur on undifferentiated or unknown faults. The National Seismic Hazard Maps includes the potential for these events using gridded background seismic sources and these have been included in our model.

SEISMIC HAZARDS ANALYSIS

According to the requirements of ASCE 7-16, both probabilistic seismic hazard analyses (PSHA) and deterministic seismic hazard analyses (DSHA) need to be performed to complete the site-specific ground motion hazards analysis and develop the site-specific design parameters, MCE_R, and DE response spectra. These analyses involve developing a seismic source model, selection of appropriate predictive relationships to estimate the ground motion parameters, and through probabilistic and deterministic methods, determination of response spectra for 5-percent damping.

Ground Motion Prediction Equations

Site-specific ground motions can be influenced by the type of faulting, site to source distance, magnitudes of the earthquakes, and local soil or rock conditions. The ground motion prediction equations (GMPE) used to estimate ground motion from an earthquake source need to consider these effects. GMPEs are empirical in nature using data from recorded earthquake time histories.

Many GMPEs have been developed to estimate the variation of peak ground and spectral accelerations with earthquake magnitude and distance from the Site to the source of an earthquake. Under a Pacific Earthquake Engineering Research (PEER) Center project entitled “Next Generation Attenuation of Ground Motions for the Western United States 2 (NGA-West2)” was completed wherein five developer teams updated the original NGA GMPEs. These new GMPEs are presented in Abrahamson et al. (2014), Boore et al. (2014), Campbell and Borzorgnia (2014), Chiou and Youngs (2014), and Idriss (2014). The NGA-West2 ground motion predictive equations include more recent important earthquakes (e.g., 2003 Bam, Iran earthquake, 2008 Wenchuan, China earthquake, and the 2010-2011 Canterbury, New Zealand earthquake sequence). The NGA-West2 GMPEs provide average or geometric mean values of horizontal ground

© 2025 Kleinfelder

motions. The uncertainty in the predicted ground motion is taken into consideration by including a standard error in the probabilistic analysis.

We have selected the most recent NGA-West2 GMPEs presented by Abrahamson et al. (2014), Boore et al. (2014), Campbell and Bozorgnia (2014), and Chiou and Youngs (2014) for our analyses with equal weights applied for all crustal faults (e.g. reverse, strike-slip, normal) included in the fault model. Idriss (2014) was not used as the relationship is not valid at the larger distances used in this study (e.g. more than 150 km, we used fault sources within 300 km) and the V_{S30} value for this site is outside the range of this relationship.

The above ground motion models generally require characterization of site parameters such as V_{S30}, $Z_{1.0}$, and $Z_{2.5}$ to account for site conditions. The average V_{S30} value of 500 m/s (1640 ft/s) was used from the provided data. Additionally, we have used published correlations from Abrahamson et. al. (2014) and Campbell and Bozorgnia (2014), to select the $Z_{1.0}$ and $Z_{2.5}$ values. The estimated $Z_{1.0}$ and $Z_{2.5}$ at a depth of 250 m (820 ft) and 980 m (3215 ft), respectively.

Probabilistic Seismic Hazard Analysis

The PSHA use ground motion prediction equations (GMPE) to empirically predict the influence of many parameters on ground motions. Our hazard results were obtained by averaging the computed hazard results from each of the previously discussed and selected GMPEs. The PSHA approach is based on the characteristics of the earthquake and of the causative fault associated with the earthquake and uses a logic tress approach to appropriately account for epistemic and aleatoric uncertainty in the model. The logic tree includes information about uncertainties in the source models, ground motion models, and other items impacting the results. These characteristics include such items as magnitude of maximum earthquake, distance from the site to the causative fault, length, and activity of the fault. The effects of site soil conditions and mechanism of faulting are accounted for in the GMPEs.

The theory behind the seismic risk analysis has been developed over many years (Cornell 1968, 1971; Merz and Cornell 1973; McGuire 2004) and is based on the "total probability theorem" and on the assumption that earthquakes are events that are independent of time and space from one another. According to this approach, the probability of exceeding PE(Z) at a given level of ground motion, Z, at the Site within a specified time period, T, is given by:

$$PE(Z) = 1 - e^{\vartheta(Z)T}$$

Where $\vartheta(Z)$ is the mean annual rate of exceedance of ground motion level Z. Different probabilities of exceedance may be selected, depending on the level of performance required.

The PSHA can be explained through a four-step procedure as follows:

1. The first step involves identification and characterization of seismic sources and probability distribution of potential rupture within the source. Usually, uniform probability distributions are assigned to each source. The probability distribution of site distance is obtained by combining potential rupture distributions with source geometry.

© 2025 Kleinfelder

2. The second step involves characterization of seismicity distribution of earthquake recurrence. An earthquake recurrence relationship such as Gutenberg-Richter recurrence is used to characterize the seismicity of each source.
3. The third step involves the use of predictive or attenuation relationships in assessing the ground motion produced at the site by considering the applicable sources and the distance of the sources to the site. The variability of attenuation relationships is also included in the analysis. The effects of site soil conditions and mechanism of faulting are accounted for in these attenuation relationships.
4. The fourth and last step involves combining all of these uncertainties to obtain the probability of ground motion exceedance during a particular time period.

A simplified mathematical expression for these steps is provided below:

$$\nu\ (Sa > z) = \sum_{i=1}^{Nsource} N_i(M_{\min}) \int_{r=0}^{\infty} \int_{m=M_{\min}}^{M_{\max_i}} f_{m_i}(M) f_{r_i}(r) P(Sa > z \mid M, r) dr dM$$

Where v (Sa>z) is the mean annual rate of a spectral acceleration (Sa) exceeding a test value (z); N_{source} is the number of seismic sources; $N_i(M_{min})$ is the rate of earthquakes with magnitude greater than M_{min} on the i^{th} seismic source; $f_{m,i}(M)$ is the probability distribution of earthquake magnitude (M) of the i^{th} source; $f_{r,i}(r)$ is the probability distribution of the fault rupture location (r); and P(Sa>z|M,r) is the probability that Sa is greater than the test value (z) given the M and r.

The PSHA was performed using the computer program HAZ (Powers, 2017). Elastic horizontal response spectral values for a probability of 2 percent in 50 years (2,475-year return period), assuming a damping factor of 5 percent, were calculated using the probabilistic analysis approach described above, in accordance with the requirements of ASCE 7-16.

Deterministic Seismic Hazards Analysis

In accordance with the exception listed in Section 21.2.3 of ASCE 7-16 Supplement 1, the site-specific MCE_R ground motion response spectrum shall be taken as the probabilistic response spectrum when the largest spectral response acceleration of the probabilistic spectrum is less than 1.2 times F_a. F_a is determined using Table 11.4-1 and a S_S = 0.26, which for Site Class C results in a F_a value of 1.3. For this site, the maximum spectral acceleration from the probabilistic results is 0.356 g, which is less than 1.2*F_a; therefore, a deterministic seismic hazard analysis is not required.

Determination of Site-Specific Horizontal MCE_R and DE Response Spectra

To develop the site-specific spectral response accelerations, we first obtained the general seismic design parameters based on the site class, site coordinates, and the risk category of the building using the OSHPD online tool (https:/seismicmaps.org). These values are summarized in Table 1.

© 2025 Kleinfelder

Table 1
General Procedure Ground Motion Parameters Based on ASCE 7-16

Parameter	Value[1]	ASCE 7-16 Reference
Latitude	33.875391 deg	N/A
Longitude	-109.960386 deg	N/A
S_S	0.261 g	Fig 22-1
S_1	0.082 g	Fig 22-2
Site Class	C	Table 20.3-1
F_a	1.3 g	Table 11.4-1
F_v	1.5 g	Table 11.4-2
T_L	6 sec	Fig 22-14
S_{MS}	0.339 g	Eq. 11.4-1
S_{M1}	0.123 g	Eq. 11.4-2
S_{DS}	0.226 g	Eq. 11.4-3
S_{D1}	0.082 g	Eq. 11.4-4
C_{RS}	0.918	Fig 22-18A
C_{R1}	0.924	Fig 22-19A

The 5-percent-damped MCE_R response spectrum is developed by comparing probabilistic and 80 percent of the code values. The NGA West 2 GMPEs present the spectral accelerations in terms of geometric mean values of the rotated two horizontal ground motions. To estimate the probabilistic spectral accelerations in the direction of the maximum horizontal response at each period from geometric mean values, we have used the scale factors from Shahi and Baker (2014). To obtain spectral acceleration values in the maximum direction, factors ranging from 1.19 at a period of 0.01 seconds to 1.26 at a period of 5 seconds were used as specified in Shahi and Baker (2014). In addition, the probabilistic spectrum was adjusted for targeted risk using risk coefficients C_{RS} and C_{R1}. C_{RS} and C_{R1} were estimated from Figures 22-18A and 22-19A of ASCE 7-16. C_{RS} is applied to spectral acceleration values for periods of 0.2 seconds and less and C_{R1} is applied for periods of 1.0 second and greater. Linear interpolation of the C_{RS} and C_{R1} values was used for periods between 0.2 seconds and 1.0 second.

Table 2
Comparison of Spectral Acceleration (g) based on ASCE 7-16 (5% Damping)

Period (s)	Probabilistic Max. Dir. Risk Adj. (g)	MCE_R (g)	2/3 of MCE_R (g)	80% Code DE (g)
PGA (0.01)	0.146	0.146	0.097	0.072
0.2	0.356	0.356	0.237	0.181
0.3	0.316	0.316	0.211	0.181
0.5	0.226	0.226	0.151	0.131
1.0	0.115	0.115	0.077	0.066
2.0	0.050	0.050	0.033	0.033
5.0	0.015	0.015	0.010	0.013

© 2025 Kleinfelder

As previously discussed, per the exception in Section 21.2.3 of ASCE 7-16, the 5-percent-damped site-specific MCE_R spectrum is taken as the site-specific probabilistic spectra. Comparison of two-thirds of the MCE_R spectrum with the 80 percent of the code spectrum is shown on Figure 3 and in Table 2 for some specific periods. The two-thirds of the 5-percent-damped MCE_R spectrum is higher than the 80 percent of the code spectrum at the PGA (0.01) and between 0.1 seconds and 2.0 seconds. Therefore, the recommended site-specific horizontal 5-percent-damped spectrum is controlled by two-thirds of the 5-percent-damped site-specific MCE_R spectrum and the 80 percent of code spectrum. According to ASCE 7-16, the DE spectra shall be taken as two-thirds of the site-specific MCE_R spectrum. Figure 4 shows the site-specific, 5-percent-damped DE and MCE_R spectra. Site-specific horizontal spectral acceleration values in units of g for the 5%-damped DE and MCE_R spectra are presented in Table 3.

Table 3
Site-Specific (5% Damping) Horizontal MCE_R and DE Spectral Accelerations (g) based on ASCE 7-16

Period (sec)	5% Damping	
	DE (g)	MCE_R (g)
0.01	0.097	0.146
0.02	0.102	0.154
0.03	0.117	0.176
0.05	0.147	0.221
0.0725	0.181	0.271
0.075	0.181	0.271
0.1	0.199	0.299
0.2	0.237	0.356
0.25	0.227	0.341
0.3	0.211	0.316
0.36251	0.189	0.284
0.4	0.176	0.264
0.5	0.151	0.226
1	0.077	0.115
1.5	0.048	0.072
2	0.033	0.050
3	0.022	0.033
4	0.016	0.025
5	0.013	0.020

Site-Specific Design Acceleration Parameters

Site-specific ground motion parameters for S_{DS} and S_{D1} were estimated using the site-specific 5-percent-damped response spectra presented in Table 3. According to Section 21.4 of ASCE 7-16, the S_{DS} value should be taken as 90 percent of the maximum spectral acceleration at any period between 0.2 and 5 seconds. Based on this, the S_{DS} values are governed by the spectral acceleration at 0.2 seconds as shown in Table 3. Additionally, since the site's V_{S30} value is greater than 1,200 ft/s (365 m/s), the S_{D1} value should be taken as the maximum value of $T*S_a$ between periods of 1 to 2 seconds, where T is the period and S_a is the corresponding spectral acceleration. Based on this, the S_{D1} values are governed by the spectral acceleration value at a period of 1 second as shown in Table 3. The parameters S_{MS} and S_{M1} shall be taken

© 2025 Kleinfelder

as 1.5 times S_{DS} and S_{D1}. These spectral accelerations shall not be taken as less than 80 percent of the code-based values as determined by Section 11.4.3 and 11.4.5 of ASCE 7-16. Site-specific S_{DS}, S_{D1}, S_{MS}, S_{M1} values for 5-percent damping are presented in Table 4.

Table 4
Site-Specific Design Acceleration Parameters

5%-Damped Site-Specific Design Acceleration Parameters (g)			
S_{DS} =	0.213	S_{MS} =	0.320
S_{D1} =	0.077	S_{M1} =	0.115

Site-specific maximum considered earthquake geometric mean (MCE_G) peak ground acceleration (PGA_M) values were estimated based on Section 21.5 of ASCE 7-16. According to Section 21.5 of ASCE 7-16, the site-specific PGA_M shall be taken as the lesser of the site-specific probabilistic geometric mean peak ground acceleration of Section 21.5.1 and the site-specific deterministic geometric mean peak ground acceleration of Section 21.5.2. Additionally, the site--specific- PGA_M shall not be taken as less than one-half the F_{PGA} value determined from Table 11.8-1 using a PGA value of 0.5 g or 80 percent of PGA_M determined from Eq. 11.8-1 (code-based). Based on this procedure, the 5%-damped site-specific PGA_M value is 0.133 g and is controlled by the probabilistic geometric mean peak ground acceleration. Since the PGA_M values are controlled by the probabilistic spectrum, the associated mean earthquake magnitude is M6.1 from the site deaggregation.

Seismic Design Category

Kleinfelder understand that given the proposed use of the facility, the project will be assigned a Risk Category IV per Table 1604.5 of the 2021 IBC. Based on the previously presented site-specific parameters in Table 4 and Table 11.6-1 of ASCE 7-16, the Seismic Design Category (SDC) for the project is C. The SDC should be confirmed by the structural engineer of record for the project.

LIMITATIONS

Kleinfelder's work presented in this letter report are based on the data provided by ATEK (2024) and our general experience in the geotechnical engineering field. Kleinfelder did not perform any field explorations. Kleinfelder is not the geotechnical engineer-of-record (GEOR) and does not guarantee the performance of the project in any respect, only that its engineering work and judgment rendered herein meet the standard of care of the geotechnical engineering profession at this time. ATEK Engineering Consultants, who is the GEOR for the project, remains the GEOR.

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

© 2025 Kleinfelder

KLEINFELDER 24411 Ridge Route Dr., Suite 225, Laguna Hills, CA 92653 p | 949.727.4466 f | 949.727.9242

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two years from the date of the report.

CLOSING

We appreciate the opportunity to be of professional service to you on this project. If you have any questions or require additional information, please do not hesitate to contact the undersigned.

Sincerely,

W. Troy Covill, PE*
Project Engineer
*Licensed in Utah

Zia Zafir, PhD, PE*, GE*
Senior Technical Manager
*Licensed in California

Expires June 30, 2027

Brian E. Crystal, PE, GE
Senior Principal Geotechnical Engineer

Attachments: References
Figure 1 – Regional Fault Map and Earthquake Epicenters
Figure 2 – NSHM Fault Source Model
Figure 3 – Comparison of DE and 80% of Modified Code-Based Spectra
Figure 4 – Final DE & MCER Spectra

© 2025 Kleinfelder

KLEINFELDER 24411 Ridge Route Dr., Suite 225, Laguna Hills, CA 92653 p | 949.727.4466 f | 949.727.9242

REFERENCES

Abrahamson, N.A., Silva, W.J., and Kamai, R. (2014). "Summary of the ASK14 Ground Motion Relation for Active Crustal Regions." *Earthquake Spectra*, Vol. 30, No. 3, pp. 1025-1056.

Artiola, J. and Uhlman, K. (2009). "Arizona Well Owner's Guide to Water Supply." *The University of Arizona.* Report No. AZ1485.

ASCE (2016). ASCE Standard 7-16 - Minimum Design Loads for Buildings and Associated Criteria for Other Structures. American Society of Civil Engineers/Structural Engineering Institute. Reston, VA.

ASCE (2018). ASCE Standard 7-16 - Minimum Design Loads for Buildings and Associated Criteria for Other Structures – Supplement 1 Effective December 12, 2018. American Society of Civil Engineers/Structural Engineering Institute. Reston, VA.

ASCE (2021). ASCE Standard 7-16 - Minimum Design Loads for Buildings and Associated Criteria for Other Structures – Supplement 3 Effective November 5, 2021. American Society of Civil Engineers/Structural Engineering Institute. Reston, VA.

ATEK Engineering Consultants (2024). "Data Package", Geotechnical Borings Logs and Lab Testing, dated October, 2024.

Boore, D.M., Stewart, J.P., Seyhan, E., and Atkinson, G. (2014). "NGA-West2 Equations for Predicting PGA, PGV, and 5% damped PSA for Shallow Crustal Earthquakes." *Earthquake Spectra*, Vol. 30, No. 3, pp. 1057-1086.

Campbell, K.W., and Bozorgnia, Y. (2014). "NGA-West2 Ground Motion Model for the Average Horizontal Component of PGA, PGV, PGD and 5% Damped Linear Elastic Response Spectra.", *Earthquake Spectra*, Vol. 30, No. 3, pp. 1087-1116.

Chiou, B S., and Youngs, R.R. (2014). "Update for the Chiou and Youngs NGA Model for the Average Horizontal Component of Peak Ground Motion and Response Spectra." *Earthquake Spectra*, Vol. 30, No. 3, pp. 1117-1154.

Cornell, C.A. (1968). "Engineering Seismic Risk Analysis", Bulletin of the Seismological Society of America, Vol. 58, No. 5.

Cornell, C.A. (1971). "Probabilistic Analysis of Damage to Structures Under Seismic Loading", Dynamic Waves in Civil Engineering, London, Interscience.

© 2025 Kleinfelder

Geological Consultants Inc. (2024). "Seismic Refraction Survey, Whiteriver Indian Hospital Addition, Whiteriver, Arizona." Geophysical Report, dated September 7, 2024.

Geolines, LLC (2024). "Supplemental Subsurface Site Characterization, Whiteriver Indian Hospital Addition, Whiteriver, Arizona." Geolines PN. NM-240013, dated August, 13, 2024.

Gutenberg, B., and Richter, C.F. (1956). “Earthquake Magnitude, Intensity, Energy, and Acceleration”, *Bulletin of the Seismological Society of America,* Vol. 46, No. 2, pp. 105-145.

Hanks, T.C., and Bakun, W.H. (2008), M–log A Observations of Recent Large Earthquakes. *Bulletin of the Seismological Society of America*, *98,* p. 490.

Hermann, R.B. (1977)**.** “Recurrence Relations”, *Earthquake Notes*, 48, 47-49.

IBC (2021). 2021 International Building Code. International Code Council. Country Club Hills, IL.

Idriss, I.M. (2014). “An NGA-West2 Empirical Model for Estimating the Horizontal Spectral Values Generated by Shallow Crustal Earthquakes.” *Earthquake Spectra*, Vol. 30, No. 3, pp. 1155-1178.

McGuire, R. (2004). “Seismic Hazard and Risk Analysis”, *Earthquake Engineering Research Institute*, Second Monograph Series MNO-10.

Merz, H.L. and Cornell, C.A. (1973), Seismic Risk Analysis Based on a Quadratic Magnitude-Frequency Law. *Bulletin of the Seismological Society of America, 63(6).*

Merz, H.L., and Cornell, C.A. (1973). “Seismic Risk Analysis Based on a Quadratic Magnitude-Frequency Law.” *Bulletin of the Seismological Society of America*, Vol. 63, No. 6.

Moore. R. T. (1968). Inderal Deposits of the Fort Apache Indian Reservation, Arizona.” *The Arizona Bureau of Mines.* Bulletin 177.

Office of Statewide Health Planning and Development (OSHPD) and Structural Engineers Association (SEA) of California, OSHPD Seismic Design Maps, accessed at https://seismicmaps.org/.

Pacific Earthquake Engineering Research Center (PEER), 2014, PEER NGA-West2 Database (PEER Report 2013/03), by: Timothy D. Ancheta, Robert B. Darragh, Jonathan P. Stewart, Emel Seyhan, Walter J. Silva, Brian S.J. Chiou, Katie E. Wooddell, Robert W. Graves, Albert R. Kottke, David M. Boore, Tadahiro Kishida, and Jennifer L. Donahue.

© 2025 Kleinfelder

Petersen, M.D., Moschetti, M.P., Powers, P.M., Mueller, C.S., Haller, K.M., Frankel, A.D., Zeng, Yuehua, Rezaeian, Sanaz, Harmsen, S.C., Boyd, O.S., Field, Ned, Chen, Rui, Rukstales, K.S., Luco, Nico, Wheeler, R.L., Williams, R.A., and Olsen, A.H. (2014). "Documentation for the 2014 update of the United States national seismic hazard maps." U.S. Geological Survey Open-File Report 2014–1091, 243 p., http://dx.doi.org/10.3133/ofr20141091.

Powers, P.M., 2017, National Seismic Hazard Model Project computer code (NSHMP-HAZ), software. Available at https://doi.org/10.5066/F7ZW1K31.

Richards, C.A. (2024). "Arizona Geology - Critical Materials and Minerals in Arizona." *Arizona Geological Survey.* Vol. 45, No. 1.

Schwartz, D.P., and Coppersmith, K.J., (1984). "Fault Behavior and Characteristic Earthquakes: Examples from the Wasatch and San Andreas Fault Zones", *Journal of Geophysical Research*, Vol. 89, Issue B7, pp. 5681-5689.

Shahi, S.K., and Baker, J.W. (2014). "NGA-West2 Models for Ground Motion Directionality". *Earthquake Spectra*, 30(3), pp. 1285-1300.

United States Geological Survey, (2025). "Quaternary Fault and Fold Database for the United States", from USGS website: https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

Weichert, D.H. (1980). "Estimation of Earthquake Recurrence Parameters for Unusual Observation Periods for Different Magnitudes", *Bull. Seismol. Soc. Amer*., 70, 1337-1356.

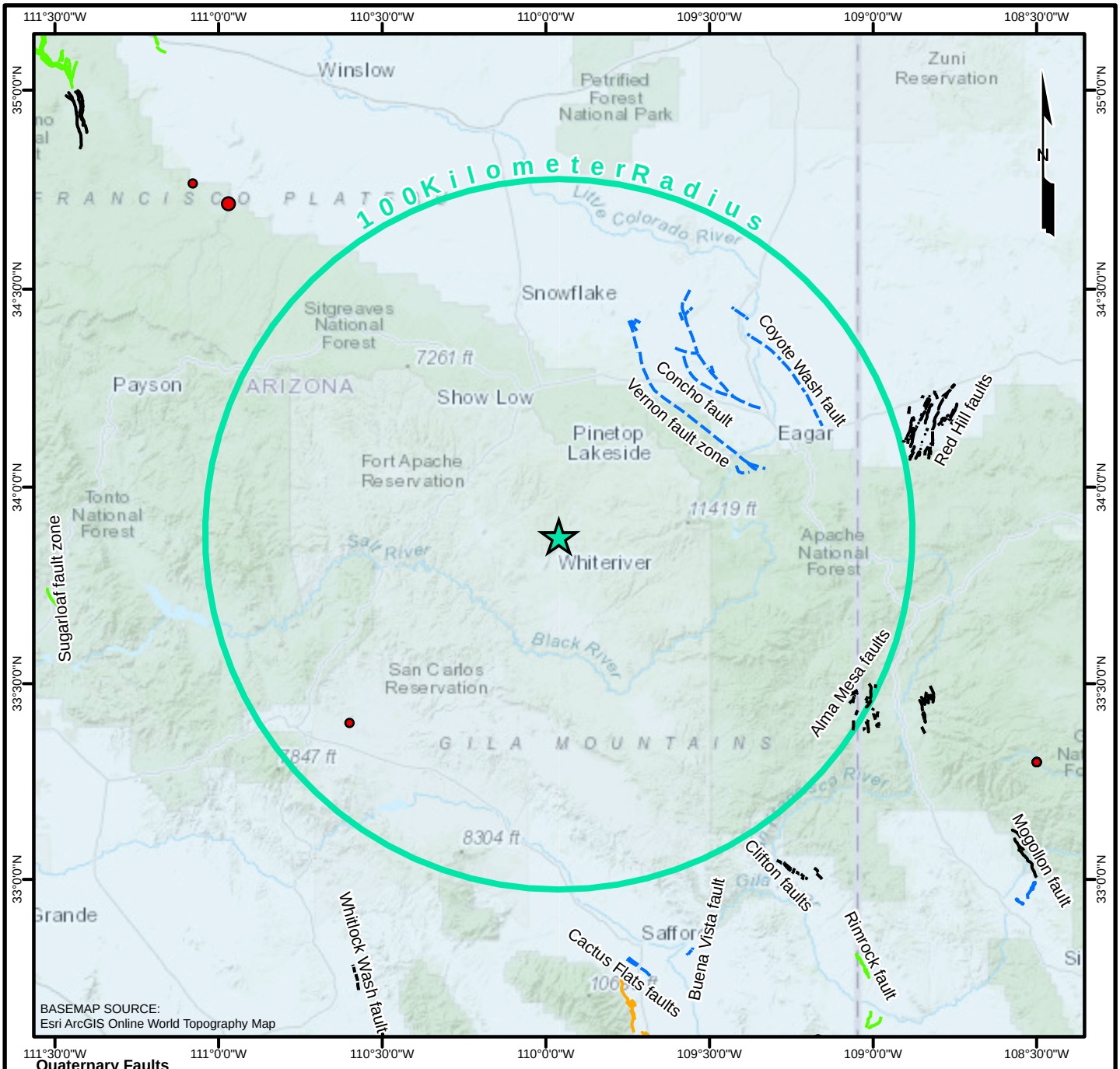
Wells, D.L., and Coppersmith, K.J. (1994). "New Empirical Relationships Among Magnitude, Rupture Length, Rupture Width, Rupture Area and Surface Displacement", *Bulletin of the Seismological Society of America*, Vol. 84, pp. 974-1002.

Wesnousky, S.G. (1994). "The Gutenberg-Richter or Characteristic Earthquake Distribution, Which Is It?" *Bull. of the Seismological Society of America*, Vol. 84, p. 1940-1959, December.

© 2025 Kleinfelder

FIGURES

© 2025 Kleinfelder



Quaternary Faults

Historic Displacement (< 150 years)
- Mapped Fault Location
- Dashed where Approximated
- Concealed

Middle and Late Quaternary (< 750,000 years)
- Mapped Fault Location
- Dashed where Approximated
- Concealed

Pre-Quaternary geologic structures
- Mapped Fault Location
- Dashed were Approximated
- Concealed

Holocene Displacement (< 15,000 years)
- Mapped Fault Location
- Dashed where Approximated
- Concealed

Undifferentiated Quaternary (< 1.6 milllion years)
- Mapped Fault Location
- Dashed where Approximated
- Concealed

ANSS Earthquakes
Magnitude
- 4.0 - 4.9
- 4.9 - 5.9
- 5.9 - 6.9
- 6.9 - 7.9
- 7.9 - 8.9

Late Quaternary Displacement (< 130,000 years)
- Mapped Fault Location
- Dashed where Approximated
- Concealed

Class B (various age)
- Mapped Fault Location
- Dashed where Approximated
- Concealed

0 25 50 100
Kilometers

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Date: 3/26/2025 User: ALeonard Path: \\azrgisstorp03\GIS_Projects\Client\ATEK\25004546_WhiteriverIndianHospital\25004546_WhiteriverIndianHospital.aprx

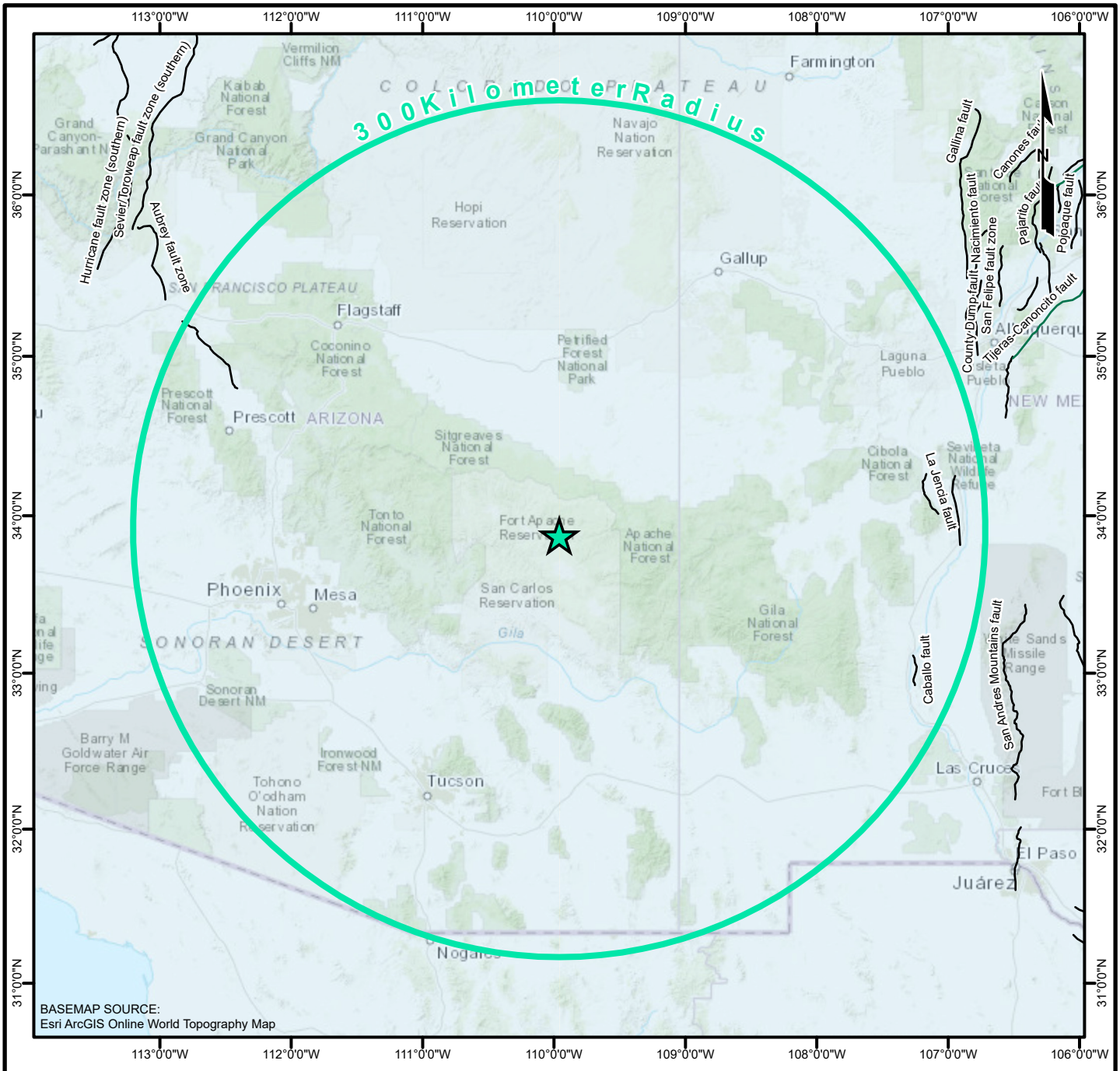
KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

PROJECT NO.	25004546.001A
CREATED:	3/26/2025
CREATED BY:	ALeonard
CHECKED BY:	TCovill
FILE NAME:	WhiteRiver_EQ_FaultMap_FAM_100km

REGIONAL FAULT MAP AND EARTHQUAKE EPICENTERS

SITE-SPECIFIC GROUND MOTION HAZARD ANALYSIS
PROPOSED WHITERIVER INDIAN HOSPITAL ADDITION
200 W HOSPITAL DRIVE
WHITERIVER, ARIZONA 85941

FIGURE
1



Faults, National Seismic Hazard Map (NSHM), 2014

- normal
- strike slip
- thrust
- unassigned

0 50 100 200

Kilometers

The information included on this graphic representation has been compiled from a variety of sources and is subject to change without notice. Kleinfelder makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. This document is not intended for use as a land survey product nor is it intended as a construction design document. The use or misuse of the information contained on this graphic representation is at the sole risk of the party using or misusing the information.

Date: 3/25/2025 User: ALeonard Path: \\azrgisstorp03\GIS_Projects\Client\ATEK\25004546_WhiteriverIndianHospital\25004546_WhiteriverIndianHospital.aprx

KLEINFELDER
Bright People. Right Solutions.
www.kleinfelder.com

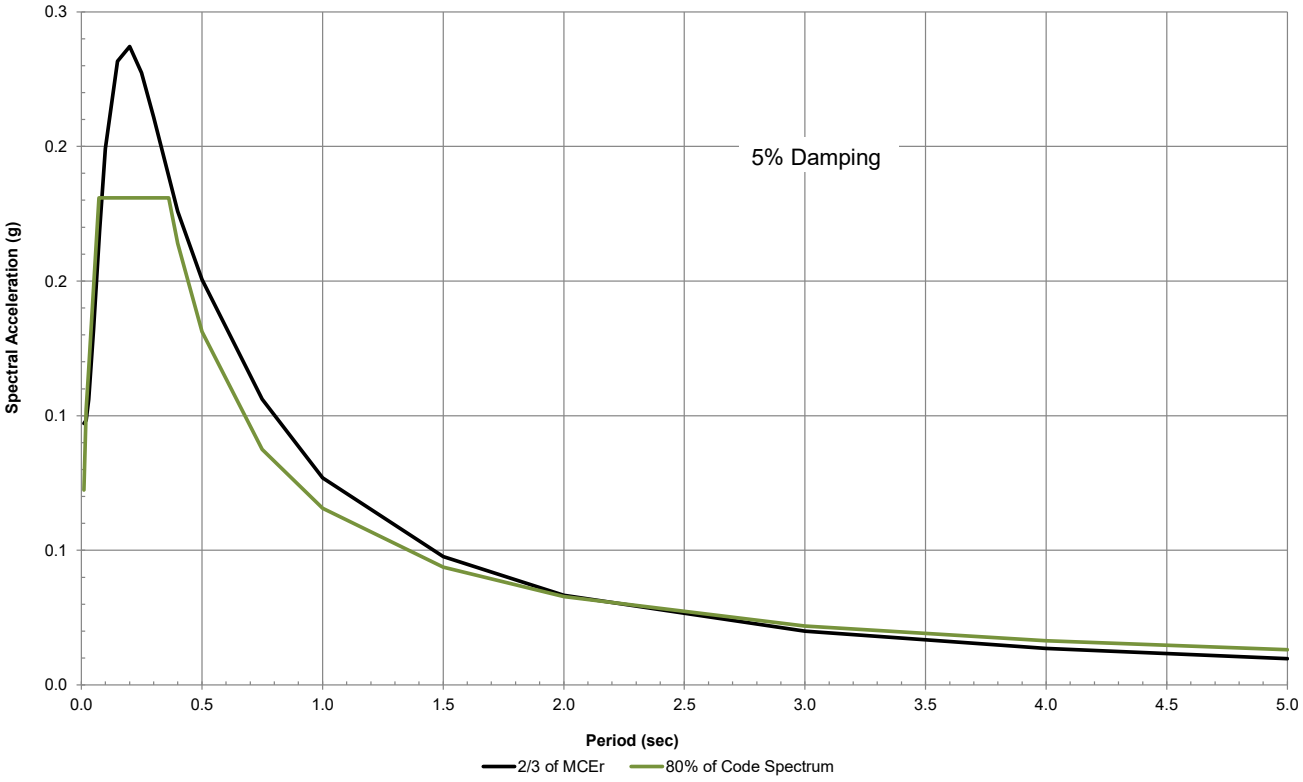
PROJECT NO.	25004546.001A
CREATED:	3/25/2025
CREATED BY:	ALeonard
CHECKED BY:	TCovill
FILE NAME:	WhiteRiver_EQ_FaultModel_300km

USGS NSHM (2014)
SEISMIC SOURCE MODEL

SITE-SPECIFIC GROUND MOTION HAZARD ANALYSIS
PROPOSED WHITERIVER INDIAN HOSPITAL ADDITION
200 W HOSPITAL DRIVE
WHITERIVER, ARIZONA 85941

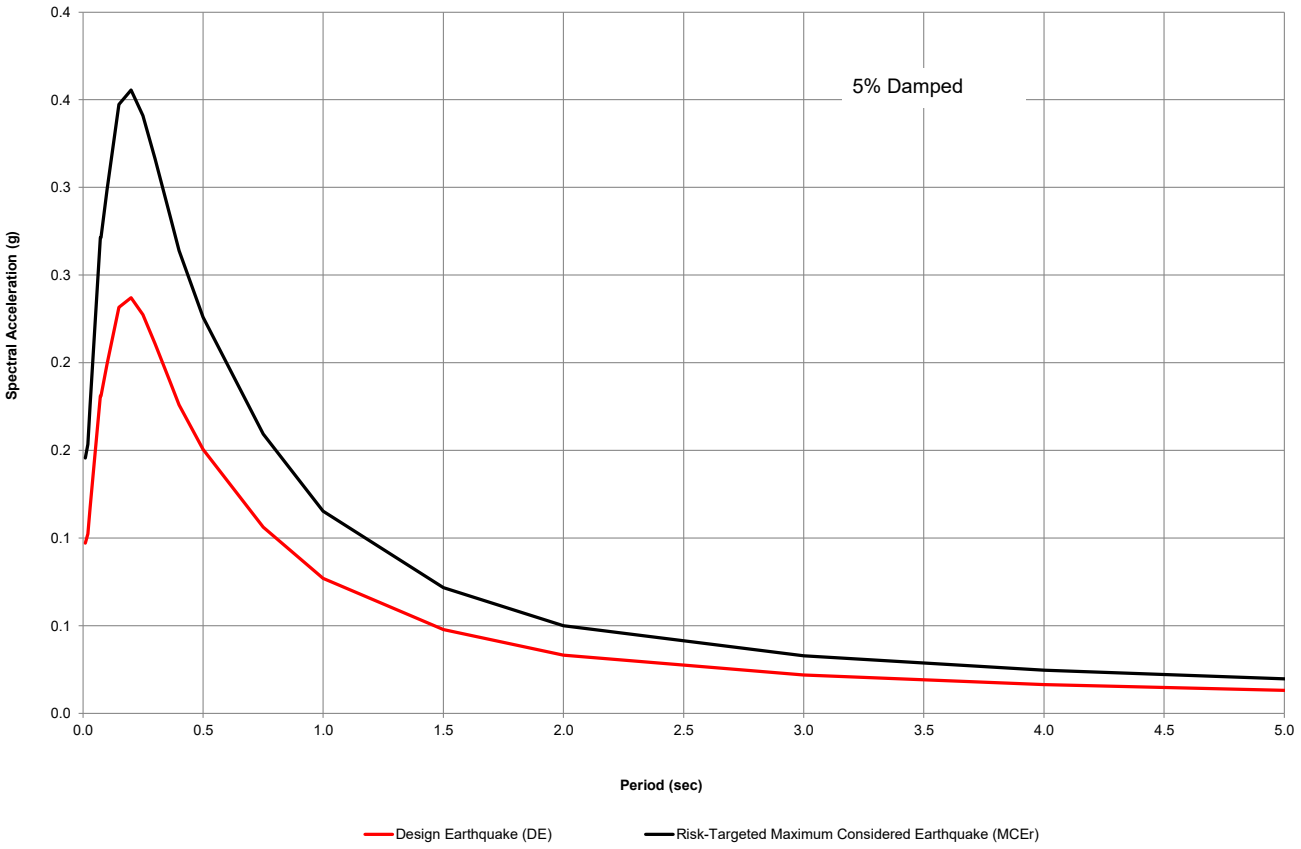
FIGURE
2

Comparison of 2/3 Site-Specific MCE_R Earthquake and 80% of Code Response Spectra



KLEINFELDER Bright People. Right Solutions.	Project No: 25004546.001A Date: 3/25/2025 Drawn By: WTC Checked By: ZZ File Name: GMHA-2019CBCv1.1_W	**COMPARISON OF 2/3 MCE_R AND 80% OF CODE SPECTRA** Site-Specific Ground Motion Hazard Analysis Proposed Whiteriver Indian Hospital Addition 200 W Hospital Drive Whiteriver, Arizona 85941	**FIGURE** **3**

Site-Specific DE and MCE_R Response Spectra



Period	5%-Damped Spectral	
	DE	MCE_R
0.01	0.097	0.146
0.02	0.102	0.154
0.03	0.117	0.176
0.05	0.147	0.221
0.0725	0.181	0.271
0.075	0.181	0.271
0.1	0.199	0.299
0.2	0.237	0.356
0.25	0.227	0.341
0.3	0.211	0.316
0.36251	0.189	0.284
0.4	0.176	0.264
0.5	0.151	0.226
1	0.077	0.115
1.5	0.048	0.072
2	0.033	0.050
3	0.022	0.033
4	0.016	0.025
5	0.013	0.020

5%-Damped Site-Specific Design Acceleration Parameters (g)			
S_{DS} =	0.213	S_{MS} =	0.320
S_{D1} =	0.077	S_{M1} =	0.115

KLEINFELDER
Bright People. Right Solutions.

Project No:	25004546.001A
Date:	3/25/2025
Drawn By:	WTC
Checked By:	ZZ
File Name:	GMHA-2019CBCv1.1_WRH GMHA.xlsx

SITE-SPECIFIC HORIZONTAL SPECTRA

Site-Specific Ground Motion Hazard Analysis
Proposed Whiteriver Indian Hospital Addition
200 W Hospital Drive
Whiteriver, Arizona 85941

FIGURE

4