MASTER GEOTECHNICAL ENGINEERING STUDY, REPORT AND RECOMMENDATIONS

For:
Proposed New Structure/Home

RESIDENTIAL RESIDENTIAL
Yavapai-Apache Nation Tribal Housing Geotechnical
Helping Hands Geotechnical
Address: To-Be-Determined (Lot 119)
Camp Verde (Yavapai Apache Nation), AZ 86322
APN: 403-20-003C

Prepared For:
Yavapai-Apache Nation Tribal Housing
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MTI Project No. 25-214

May 20, 2025

Yavapai-Apache Nation Tribal Housing
PO Box 3310
Camp Verde (Yavapai Apache Nation), AZ 86322
(928) 568.4191

Attn.: Ms. Sharie Benson

RE: **GEOTECHNICAL/FOUNDATION/ENGINEERING STUDY**

Proposed Building Location:
Yavapai-Apache Nation Tribal Housing
Address: To-Be-Determined (Lot 119)
Camp Verde (Yavapai Apache Nation), AZ 86322
APN: 403-20-003C

Dear: Ms. Benson

MTI is pleased to present this Geotechnical Engineering Study for the referenced Building site.

The attached report describes our exploration procedures, summarizes existing site and subsurface conditions, and presents our geotechnical findings and recommendations.

MTI appreciates this opportunity to provide these services and looks forward to working with you on your project.

Sincerely,
Material Testing & Inspections, LLC (MTI)

Bruce Canavan, PE
Civil Engineer

Registered Professional Engineer (Civil)
CERTIFICATE NO. 24390
BRUCE R. CANAVAN
DATE SIGNED 5/19/25
ARIZONA, U.S.A.
EXPIRES 6/30/2026

Scott S. Mosley
Senior Engineering Geologist/CSM

5/20/2025

REPORT SUMMARY

Topic	Overview Statement
Project Description	This project scope consist of investigation of the insitu (inplace) soil characteristics, classify and generate our recommendation letter based upon our laboratory results for the new construction of the residential home.
General Geotechnical Soil Characterization & Classification	The insitu representative sampled soils generally consist of silty SANDS with trace clay and varying amounts of gravel & cobble, to a maximum depth of six (6.0) feet below existing grade, where MTI terminated our field exploration, defining the bottom of our test pits. No groundwater was discovered at the time of our investigation.
Earthwork	All existing topsoil, and vegetation should be removed from the construction areas. The on-site soils in from existing grade to approximately 60.0 inches below existing grade (B.E.G) are ***suitable*** for use as foundation backfill and slab-on-grade applications on the project. Some remediation is recommended. Required compaction requirements are outlined in the report.
Shallow Foundations, Turndown-Monolithic (Post-Tension / PT)	A minimum of ***eighteen (18.0) inch embedment*** footing is recommended. The Maximum allowable bearing pressure = 2,000 (processed native) psf with the above ***18-inch*** minimum embedment foundations. ***Refer to the "Turndown-Monolithic (Post-Tension / PT") Footing/Foundations" on page 4, Sec. 3.3 for details.***
Slab-On-Grade Turndown-Monolithic (Post-Tension / PT)	Slabs shall be placed upon processed (approved) subgrade underlying a 4.0 inch section of approved MAG ABC. Refer to the "Earthwork" section above regarding the remediation of the in-situ, native soils. ***Refer to the "Turndown-Monolithic (Post-Tension / PT") on page 7, Sec. 3.7. Additionally, MTI requires proof-rolling procedures upon the completion of the building pad. Please refer to Section 3.7 on page 7 for details.***
Fill & Backfill	Approved MAG Spec ABC fill shall be placed atop the subgrade which has been properly prepared/processed and approved by the Soils Engineer. The engineered fill shall be processed (wetted and thoroughly mixed) to achieve a uniform moisture content, ±2 percent optimum. All compaction percent's are minimum, unless noted. Any fill should be placed in horizontal lifts no greater than 8-inch thickness (or as dictated by compaction equipment) and compacted to the percent of maximum dry density per ASTM D-698 set forth in Section 3.9.
Seismic Site Classification	Site Class C in accordance with Chapter 20 ASCE as required by the 2018 International Building Code (IBC).
General Comments	This section contains important information about the limitations of MTI's geotechnical engineering report. This summary is for convenience and shall be applied to this report in full.

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1.0 INTRODUCTION

Ms. Benson (hereafter referred to as client) has retained MTI to provide geotechnical services for the development of foundation and site preparation recommendations for the proposed residential building/home located at an address; To-Be-Determined (TBD) in Camp Verde (Yavapai Apache Nation), AZ 86322. The residential structure will be a single-story, slab-on-grade (Post-Tension / PT) flooring system of stick-built construction. Structural loads are expected to be light to moderate (approximately 125 psf) and no special considerations regarding settlement tolerances are known at this time. Adjacent areas may be landscaped or paved.

If the details of the proposed construction differ from that described herein, MTI should be contacted to evaluate the potential impact on the recommendations provided in this report

Exploration for underlying geologic conditions or evaluation of potential geologic hazards, such as mining, landslides, seismic activity, faulting and/or ground subsidence/cracking potential due to groundwater withdrawal, were beyond the scope of this study. Potential for liquefaction is addressed in the Section 2.5

2.0 GENERAL SITE AND SOIL CONDITIONS

2.1 Site Conditions

Item	Description
Location	A semi-developed portion of Camp Verde (Yavapai Apache Nation), AZ 86322
Existing Conditions	Apparently cleared and grubbed.
Existing Improvements	The existing parcel will be split into three individual lots.
Surrounding Conditions	A semi-developed portion of Camp Verde, in a high desert environment, with residential homes and commercial/industrial development in the immerdiate area.
Current Ground Cover	Cleared & grubbed, w/exposed soils.
Topography	The parcel appears to have flat topography. An general increase in grade from the West, Southwest over the three proposed parcels.

2.2 Geologic Conditions

The project is located in the Transition Zone or Central Mountain Region (Nations and Stump[1]) physiographic province of Arizona. The central Mountain Region is a northwest trending structure between the Basin and Range physiographic province to the southwest and Colorado Plateau to the northeast. Landscape features of the Central Mountain Region include the Black Hills near Jerome and Prescott, the Mazatzal and Sierra Ancha Mountains near Roosevelt Lake, and the Salt River Canyon between Show Low and Globe. The Central Mountain Region is characterized by rugged mountains of igneous, metamorphic, and deformed sedimentary and volcanic rocks of Precambrian age, with erosional remnants of the Paleozoic age.

Based on review of U.S. Geological Survey (USGS) geological maps, surficial geologic conditions mapped at the site, beneath the existing fill material, consist of late to middle Miocene basaltic rocks in the northwest portion of the site. These deposits are described as mostly dark, mesa-forming basalt deposited as lava flows. Rocks of this unit are widely exposed south of Camp Verde (Hickey Formation basalts), in the Mohon Mountains north of Bagdad, "The Mesa" east of Parker, and at other scattered locations in western Arizona. Rocks of this unit were not tilted by middle-Tertiary normal faulting except in a narrow belt from north of Phoenix to the northwest corner of the state. Early Pleistocene to latest Pliocene surficial deposits, are mapped in the southeast portion of the site and expected nearer to the surface overlying the bedrock described above. This unit consist of coarse relict alluvial fan deposits that form rounded ridges or flat, isolated surfaces that are moderately to deeply incised by streams. These deposits are generally topographically high and have undergone substantial erosion. Deposits are moderately to strongly consolidated, and commonly contain coarser grained sediment than younger deposits in the same area.

2.3 Seismic Design Parameters

The project site is located in north-central Arizona which is an area of low seismic activity. The following values were developed using the Structural Engineers Association by Location (https://seismicmaps.org), the 2024 International Building Code (IBC) and are based on knowledge of local geologic conditions, and subsurface soils encountered during our study. Although borings were not advanced to 100 feet, based on the nature of the subsoils encountered in the borings and geology in the area, Site Class Definition, Class C may be used for design of the structures. In addition, the following seismic parameters may be used for design (based on 2008 USGS maps adopted by 2024 IBC):

SEISMIC DESIGN CONSIDERATIONS	
LATITUDE (Degrees)	34.563635 °N
LONGITUDE (Degrees)	-112.854317 °W
Ss – SPECTRAL ACCELERATION FOR SHORT PERIOD	0.289 g
S_1 – SPECTRAL ACCELERATION FOR A 1 SECOND PERIOD	0.091 g

2.4 Liquefaction

Soil liquefaction is the loss of soil strength during a significant seismic event. It occurs primarily in loose, fine-to-medium grained, granular soils lying below groundwater. Liquefaction occurs during rearrangement of soil particles into a denser condition, resulting in localized areas of settlement. Based on field tests performed in the test borings, groundwater observations, visual observations of soil samples and laboratory test results; it is our opinion that the potential for seismically induced liquefaction is unlikely.

2.5 Site Preparation

The entire area to be occupied by the proposed construction (and five feet outside the proposed footprint) shall be stripped of all vegetation, debris, rubble and obviously loose surface soils. During this process, any deleterious/organic material should be removed. ***The native soils should be scarified to a depth of eight (8.0) inches, moisture conditioned and compacted as recommended in section 3.8 of this report.*** As this is a "Means & Methods", this process may be completed during the "Earthwork" activities section of this report. This process will decrease the potential for differential settling when constant moisture and compaction is met.

A representative of the geotechnical engineer should examine the subgrade once subexcavation is complete and prior to backfilling to ensure removal of deleterious materials. Fill placement and quality should be as defined in the "3.8 Fill and Backfill" section of this report.

The exposed (when **cohesive** soils are encountered) bottom of footing grade should be scarified to a depth of 8 inches, moisture-conditioned to optimum to + 4% of optimum (and compacted to minimum of 90-95 percent of maximum dry density as determined by ASTM D-698). Non-building areas should also be scarified to a depth of 8 inches, moisture-conditioned to +/- 2% of optimum moisture and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698. See Table 3.8, (Pg. 8 of this report) for additional moisture/compaction criteria.

The exposed (when **cohesionless** soils are encountered) bottom of footing grade should be scarified to a depth of 8 inches, moisture-conditioned to +/- 2% of optimum moisture and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698. Non-building areas should also be scarified to a depth of 8 inches, moisture-conditioned to +/- 2% of optimum moisture and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698. See Table 3.8, (Pg. 8 of this report) for additional moisture/compaction criteria.

All cut areas (if present) and areas above footing bottom elevation that are to receive floor slab only, fill should be scarified 8 inches, moisture-conditioned from as seen above per matieral type as determined by ASTM D-698).

2.6 General Subsurface Conditions

Soil conditions encountered at the boring locations are indicated on the boring/test logs as seen in the Appendix of this report. Lithology boundaries on the boring/test pit logs represent the approximate location of changes in soil types; in-situ, soil conditions and the transition between materials were distinct. Subsurface soils extending to the full depth of our exploration were silty SANDS with trace clay, and varying amounts of gravel. All soils contained trace amounts of cobbles. No groundwater was encountered during our investigation. Maximum depth terminated at approximately at 6.0 feet B.E.G., defining the bottom of the test pit. Based on visual and tactile observation, the soils were in a 'low moist' state at the time of investigation. Soil conditions are seen as follows:

Table 2.6 General Conditions

Boring/Test Pit 1				
Description	**Sample Depth (Inches)**	**Approximate Depth to Bottom of Stratum (Inches)**	**Material (Abbreviated) Description**	**Relative Density / Consistency**
Stratum / Layer 2	60.0	72.0	Lt. (Tan) Brown silty-SANDS (SM)	Firm-Stiff
See MTI Test Pit Logs for complete insitu soil descriptions and properties.				

2.7 Summary of Laboratory Results

Field testing indicates in-situ dry densities of the upper soils ranging from 114.1-122.0 pcf with moisture contents between 1.9-4.5 percent at the time of investigation. A maximum Plasticity Index (P.I.) of 3 was present, with a maximum Expansive (E.I.) Index of less than 2 was discovered in our representative field samples. Please see Summary of Laboratory Results below.

Laboratory Results					
Test Pit/Sample No.	**- 200 (%)**	**Moisture Content (%)**	**Liquid Limit (LL)**	**Plastic Index (PI)**	**Expansive Index (EI)**
1/ G-5501B	***22.5****	4.5	20	3	2
NV=No Value, NP=Non Plastic, NE=Non Expansive					
****Denotes Out Of Yavapai County/IBC Tolerances***					

3.0 ANALYSIS AND RECOMMENDATIONS

3.1 Earthwork

The following presents recommendations for excavation, subgrade preparation and placement of engineered fills on the project. The recommendations presented for design and construction of earth supported elements including foundations are contingent upon following the recommendations outlined in this section.

Earthwork on the project should be observed and evaluated by MTI. The evaluation of earthwork should include observation and testing of native materials, engineered fill/aggregate base course (ABC), subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

3.2 Analysis

Analysis of the field and laboratory data indicates that on-site soils are suitable for use as foundation and slab applications, as well as suitable for backfill of utilities, retaining wall, and any applications where soils are used.

A total of one (1) soil test/exploration pit was excavated by MTI. Laboratory and field testing indicate that the material within the full profile are of compact-dense, where soils, were encountered. Construction of standard shallow-spread footing, piers/columns, slab-on-grade and post-tension (PT) is recommended as seen in Section 3.8 Fill and Backfill. Though not identified in MTI's field exploration, if present, the in-situ bedrock may be utilized as accepted/competent footings per 2018 IBC, Section 1803.5.6. Please contact MTI if rock strata is contacted in the proposed footings.

3.3 Conventional Spread Footing/Foundations

Upon removal of any/all topsoil, and organic (deleterious) should be removed from below the structure areas. Per MTI's client, shallow-spread foundation system will be utilized. They shall bear on ***8-inches*** of approved, processed, native soils at a minimum embedded depth of ***eighteen (18.0) inches*** below lowest adjacent grade or approved insitu bedrock if present. The soils shall be processed (scarified, wetted and thoroughly mixed) to achieve a uniform moisture content, (± 2 percent of optimum moisture) and re-compacted to a minimum of 95.0 percent of maximum dry density per ASTMD-698 set forth as follows Section 3.8 Fill and Backfill on page 8 of this report. When encountered, the insitu bedrock shall perform to the minimum approved requirement per the approved concrete footing design.

3.3A Post Tension (PT) Footing/Foundations

Post-tensioning is a method of reinforcing (strengthening) concrete with high-strength steel strands or bars, typically referred to as tendons. Post tensioned slabs are primarily suitable for soils having moderate to high shrink-swell potentials, but have been successfully used in all soil types.

The on-site soils may be used as structural fill beneath the post-tensioned slabs. All fill soils should be compacted to a minimum of 95% of ASTM D-698 Standard Proctor. As most of the on-site soils have low expansive properties, we recommend that compaction should be done at moisture contents of +/- 2 of Optimum-Moisture-Content (OMC).

The post-tensioned slab geotechnical recommendations provided below assume that the post-tensioned slab turndown extends down a minimum of 18 inches below outside grades in order to account for frost depth. It should be noted that the minimum foundation embedment depth is measured from exterior finished grades. Therefore, the minimum depth of the perimeter turn down will be closer to 24 inches when measured from the top of the finish floor elevation.

3.4 Foundation Design

The following bearing capacities may be utilized for design:

Table 3.4 Foundation Bearing Capacities

Structure Type	Foundation Type	Bearing Media	Embedded (Min.) Foundation Depth (ft.)	Allowable Bearing Capacity (psf)	Notes
Residential Structure	Spread Foundations	Approved ***(8-Inches)*** Processed Native Soils	18.0	2,000	1, 2, 3, 4
Residential Structure	Post Tension (PT)	Approved ***(8-Inches)*** Processed Native Soils	18.0	2,500	1, 2, 3, 4

Foundation Notes:

1. Foundation Depth refers to bottom of footing elevation below lowest adjacent finished grade, or finished floor for interior footings.

2. For all structures such as screen walls, planter walls, etc. not connected to any main structure. The bottom of footing excavation should be compacted to at least **95.0%** of maximum dry density as determined by ASTM D-698.

3. ***In both cases, shallow spread / isolated footings bearing on at least eight (8.0) inches of approved (processed), scarified, moisture conditioned, compacted native, insitu soils, extending to the footing edges within all footing areas. The above 18-inch concrete embedment, shall be placed upon approved, native soils. All soils shall be processed, moisture conditioned to optimum moisture and compacted to 95.0% of the Proctor. As seen above, the above -inch concrete embedment, shall be placed upon approved, native soils. All soils shall be processed, moisture conditioned to optimum moisture and compacted to 95.0% of the Proctor.*** Though not encountered, competent, approved bedrock may be utilized as a portion of the footing when its compression strength meets the minimum approved concrete mix (footing) design strength. ***Please refer to the following detail 3.4 above.***

4. Allowable (maximum) Load Bearing Capacity classifications are categorized by soil types and refers to the general soils classified under "Unified Soil Classification System". Below are IBC's Presumptive Load-Bearing Values.

Table 1806.2 Presumptive Load-Bearing Values (*)

Class Of Material	Vertical Foundation Pressure (psf)	Lateral Bearing Pressure (psf/ft below natural grade	Lateral Sliding Resistance	
			Coefficient of friction	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	——
2. Sedimentary and foliated rock	4,000	400	0.35	——
3. Sandy gravel and gravel (GW and GP)	3000[c]	200	0.35	——
4. Sand, silty sand, clayey sand, silty gravel, and clayey gravel (SW, SM, SC, GM, and GC)	2000[c]	150	0.25	——
5. Clay, sandy clay, silty clay, clayey silt, silt, and sandy silt (CL, ML, MH, and CH)	1500[c]	100	——	130

For SI: 1 pound per square foot = 0.0479 kPa, 1 pound per square foot = 0.157 kPa,/m

a. Coefficient to be multiplied by the dead load.

b. Cohesion value to be multiplied by the contact area, as limited by IBC, Section 1806.3.2.

c. Values refer to unprocessed materials.

* Ref. 2024 International Building Code (IBC)

The above Foundation Bearing Capacities, (Table 3.4), refer to the total of all loads, dead and live, and are net pressures. They may be increased one-third for wind, seismic or other loads of short duration. These values may be increased by one-third as the allowable toe pressure for retaining walls. All footing excavations should be level and cleaned of all loose or disturbed materials. Positive drainage away from the proposed buildings must be maintained at all times.

3.5 Foundation Detail

The following shall be adhered as a minimum guideline. Continuous wall footings and isolated rectangular footings should be designed with minimum widths of 16 and 24 inches respectively, regardless of the resultant bearing pressure. Lightly loaded interior partitions (less than 800 plf) may be supported on reinforced thickened slab sections (minimum 12 inches of bearing width). MTI recommends becoming acquainted with Yavapai County's minimum standard footing details. If bedrock is encountered, contact your structural design team.

Estimated settlements under design loads are on the order of ½ to 1-inch, virtually all of which will occur during construction. Post-construction differential settlements will be on the order of one-half the total settlement, under existing and compacted moisture contents. Additional localized settlements of the same magnitude could occur if native supporting soils were to experience a significant increase in moisture content. **Positive drainage away from structures and controlled routing of roof runoff must be provided and maintained to prevent ponding adjacent to perimeter walls.** Planters requiring heavy watering should not be placed adjacent to or within 5 feet of the building. Care should be taken in design and construction to ensure that domestic and interior storm drain water is contained to prevent seepage. Roof drainage should be directed to paved areas or storm drains with discharge as noted in Section 3.9 Site & Building Drainage on page 8 of this report. They should not discharge into planters adjacent to the structures.

Continuous footings and stem walls should be reinforced to distribute stresses arising from small differential movements, and long walls should be provided with control joints to accommodate these movements. Reinforcement and frequent control joints are suggested to allow slight movement and prevent minor floor slab cracking especially in floor areas to be covered with hard tile.

3.6 Lateral Pressures

The following lateral pressure values may be utilized for the proposed construction:

Design Parameter		Design Value (pcf)
Foundation Toe Pressure [1]:		1.33 x Allowable Bearing Pressure
Active Pressures [2]: Unrestrained Walls		35 pcf
At-Rest Pressures [2]: Restrained Walls		57 pcf
Passive Pressures: Continuous Footings Spread Footings or Drilled Piers		300 pcf 350 pcf
Coefficient of Base Friction (w/passive pressure)**:**		0.35
Coefficient of Base Friction (w/out passive pressure)**:**		0.45

NOTES:

[1] The entire footing-bearing surface shall remain in compression. Increase in allowable foundation bearing pressure regarding toe pressure due to eccentric or lateral loading.

[2] Equivalent fluid pressures for vertical walls and horizontal backfill surfaces (maximum 12-foot height). Pressures do not include temporary forces imposed during compaction of the backfill, swelling pressures developed by over compacted clayey backfill, hydrostatic pressures from inundation or saturation of backfill, or surcharge loads. Walls should be suitably braced during backfilling to prevent damage and deflection.

All backfill shall be compacted to not less than 95 percent (ASTM D-698) of standard proctor (except where noted) to mobilize these passive values at low strain. No expansive soils should be used as retaining wall backfill, except as a surface seal to limit infiltration of storm/irrigation water. The expansive pressures could greatly increase active pressures. Drainage shall be provide behind and through the retaining wall to limit potential hydrostatic pressures.

The performance of the foundation system for the proposed structure will be dependent upon the quality of construction. Thus, we recommend that the foundation installation be monitored by MTI to identify the proper bearing strata and depths have been followed, as well as, sample and test the concrete to ensure ACI and local municipality specifications are met We would be pleased to develop a plan for foundation monitoring to be incorporated in the overall quality control program.

3.7 Slabs-On-Grade (Conventional)

Analysis of the field and laboratory data indicates the native/insitu on-site soils were found to be suitable for general use as interior and exterior concrete slab applications.

3.7.1 Slabs-On-Grade (Conventional) Design Recommendations

Item	Description/Recommendations
Floor Type	Slab-On-Grade
Bearing Material	Approved, Processed Native Soils
Bearing Material Min. Thickness	***8.0 Inches of Approved, Processed Native Soils***
Base Material	Approved MAG Spec. ABC **
Base Material Min. Thickness	***4.0 Inches Approved, Processed MAG Spec. ABC ****

** Base Material Requirements as seen on Page 9, "D" MAG Spec. ABC

3.7.1(A) Conventional (Exterior) Design Recommendations

Item	Description/Recommendations
Exterior Concrete Slabs, Drives, Walkways	Slab-On-Grade
Bearing Material	Approved, Processed Native Soils
Bearing Material Min. Thickness	8.0 Inch Approved, Processed Native Soils
Bearing Material	Approved MAG Spec. ABC **
Bearing Material Min. Thickness	4.0 Inches Approved, Processed MAG Spec. ABC **

** Base Material Requirements as seen on Page 9, "D" MAG Spec. ABC

The in-situ (inplace) soils shall be moisture-conditioned to +/- 2.0% of optimum moisture and compacted to minimum of 95.0 percent of maximum dry density as determined by ASTM D-698). Upon approval of the subgrade, as noted above, a minimum 4-inch thick layer of base course should be placed and approved prior to the placement of the concrete floors. For design of interior slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 250 pounds per cubic inch (pci) for engineered fill material where applicable. The native soils are capable of storing little (11-20 percent) amount of moisture, which could increase the natural vapor drive through the slab. The use of vapor retarders is desirable for any slab-on-grade where the floor will be covered by products using water based adhesives, wood, vinyl backed carpet, impermeable floor coatings (urethane, epoxy, acrylic terrazzo, etc.) or where the floor will be in contact with moisture sensitive equipment or product. When used, the design and installation should be in accordance with the guidance provided in ACI 302.1R and 302.2R.

It is worth noting, vapor barriers do increase the potential for slab curling and water entrapment under the slab. Accordingly, if a vapor barrier is used, additional precautions such as low slump concrete, frequent jointing and proper curing will be required to reduce curling potential and detailed to prevent the entrapment of outside water sources. Final determination on the use of a vapor retarder should be left to the slab designer.

After subgrade and ABC has been placed and approved and prior to any underground utilities, rebar & concrete placement, the building pad (and 5.0' over) shall be proofrolled to detect any soft spots and, if exposed, corrected. Proofrolling shall be performed using a heavy pneumatic tired roller, loaded dump truck, or similar piece of equipment weighing approximately 10 tons. Please Note: The Proofrolling operations shall be observed by the geotechnical engineer-of-record, or his representative. ***This procedure is paramount in functionality and shall not be overlooked. MTI will not certify building pad without this step.*** The subgrade/ABC shall be firm and able to support the construction equipment without displacement. Soft or yielding subgrade/ABC shall be corrected and made stable before construction proceeds. The depth and extent of the undercut operations at the site should be established by this office during earthwork construction activities.

In addition to the recommendations seen above, exterior slabs-on-grade, frequent jointing is recommended to control cracking and reduce tripping hazards should differential movement occur. It is also recommended to pin the landing slab to the building floor/stem wall. This will reduce the potential for the exterior slab lifting and blocking the operation of out-swinging doors. Pinning typically consists of 24-inch long No. 4 reinforcing steel dowels placed at 12-inch centers or approved minimum municipal specifications.

3.8 Post Tension, Slab-On-Grade Design Parameters

The following design values are based on the turndowns extending down to a depth of 18 inches below outside grades. It must be re-emphasized that proper drainage, away from the perimeter of the buildings, is critical for the successful performance of the post-tensioned slabs. A minimum of four (4) inches of approved Maricopa Association of Governments (MAG) Specification for Aggregate Base Course (ABC) should be placed beneath the concrete slab and compacted the a minimum of 95 percent of standard Proctor.

- Edge Moisture Variation Distance (e_m):
- Center Lift…...............................9.0 ft.
- Edge Lift…..................................4.7 ft.

- Estimated Differential Swell (ym):
- Center Lift…................................0.13 in.
- Edge Lift…..................................0.50 in.

- Soil Subgrade Modulus (k):….........100 pci

- Soil Bearing Capacity (*).. . . . . 1,200 psf
Asterisk (*) denotes: At Ground Surface

3.8.1 Post Tension, Slab-on-Grade Design Recommendations

Item	Description/Recommendations
Floor Type	Post Tension
Bearing Material	Approved, Processed Native Soils
Bearing Material Min. Thickness	***8.0 Inches of Approved, Processed Native Soils***
Base Material	Approved MAG Spec. ABC **
Base Material Min. Thickness	***4.0 Inches Approved, Processed MAG Spec. ABC *****

*** Base Material Requirements as seen on Page 9, "D" MAG Spec. ABC*

3.8.1(A) Conventional (Exterior) Design Recommendations

Item	Description/Recommendations
Exterior Concrete Slabs, Drives, Walkways	Slab-On-Grade
Bearing Material	Approved, Processed Native Soils
Bearing Material Min. Thickness	8.0 Inch Approved, Processed Native Soils
Bearing Material	Approved MAG Spec. ABC **
Bearing Material Min. Thickness	4.0 Inches Approved, Processed MAG Spec. ABC **

*** Base Material Requirements as seen on Page 9, "D" MAG Spec. ABC*

The in-situ (inplace) soils shall be moisture-conditioned to +/- 2.0% of optimum moisture and compacted to minimum of 95.0 percent of maximum dry density as determined by ASTM D-698). Upon approval of the subgrade, as noted above, a minimum 4-inch thick layer of base course should be placed and approved prior to the placement of the concrete floors. For design of interior Post Tensioned, slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 100 pounds per cubic inch (pci) for engineered fill material where applicable. The native soils are capable of storing little (11-20 percent) amount of moisture, which could increase the natural vapor drive through the slab. The use of vapor retarders is desirable for any slab-on-grade where the floor will be covered by products using water based adhesives, wood, vinyl backed carpet, impermeable floor coatings (urethane, epoxy, acrylic terrazzo, etc.) or where the floor will be in contact with moisture sensitive equipment or product. When used, the design and installation should be in accordance with the guidance provided in ACI 302.1R and 302.2R.

After subgrade and ABC has been placed and approved and prior to any underground utilities, rebar & concrete placement, the building pad (and 5.0' over) shall be proofrolled to detect any soft spots and, if exposed, corrected. Proofrolling shall be performed using a heavy pneumatic tired roller, loaded dump truck, or similar piece of equipment weighing approximately 10 tons. Please Note: The Proofrolling operations shall be observed by the geotechnical engineer-of-record, or his representative. ***This procedure is paramount in functionality and shall not be overlooked. MTI will not certify building pad without this step.*** The subgrade/ABC shall be firm and able to support the construction equipment without displacement. Soft or yielding subgrade/ABC shall be corrected and made stable before construction proceeds. The depth and extent of the undercut operations at the site should be established by this office during earthwork construction activities.

In addition to the recommendations seen above, exterior slabs-on-grade, frequent jointing is recommended to control cracking and reduce tripping hazards should differential movement occur. It is also recommended to pin the landing slab to the building floor/stem wall. This will reduce the potential for the exterior slab lifting and blocking the operation of out-swinging doors. Pinning typically consists of 24-inch long No. 4 reinforcing steel dowels placed at 12-inch centers or approved minimum municipal specifications.

3.9 Asphaltic Concrete Pavement

If earthwork in paved areas is carried out to finish subgrade elevation as set forth herein, the subgrade will provide adequate support for pavements. The location designation is for reference only. The designer/owner should choose the appropriate sections to meet the anticipated traffic volume and life expectancy. The section capacity is reported as daily ESALs, Equivalent 18 kip Single Axle Loads. Typical heavy trucks impart 1.0 to 2.5 ESALs per truck depending on load. It takes approximately 1,200 passenger cars to impart 1 ESAL.

Table 3.9 Pavement Sections

Area of Placement	Flexible (AC Pavement)	Rigid (PCC Pavement)	Prepared MAG ABC	Prepared Subgrade
	Thickness (In.)	Thickness (In.)	Thickness (In.)	Thickness (In.)
	AC	PCC		
Auto Access	**3.0**	**4.0**	**6.0**	**8.0**
Heavy Truck Access	**4.0**	**5.0**	**6.0**	**8.0**
Parking	**3.0**	**4.0**	**6.0**	**8.0**

1. Designs are based on AASHTO design equations and ADOT correlated R-Values.
2. The PCCP thickness is increased to provide better load transfer, and reduce potential for joint & edge failures. Design PCCP per ACI 330R-87.
3. Full depth asphalt or increased asphalt thickness may be increased by adding 1.0-inch asphalt for each 3 inches of base course replaced.

Pavement Design Parameters:

- **Assume:**	One 18 kip Equivalent Single Axle Load
- **Life:**	20 Years
Subgrade Soil Profile:	
- **Average Percent Passing #200 Sieve:**	25.4
- **Plasticity Index (PI):**	14
- **k:**	200 pci (Assumed)
- **R_C value:**	41 (per ADOT Tables)
- **M_R:**	14,560 (per AASHTO Design)

These designs assume that all subgrades are prepared in accordance with the recommendations contained in the "Site Preparation" and "Fill and Backfill" sections of this report, and paving operations are carried out in a proper manner. If pavement subgrade preparation is not carried out immediately prior to paving, the entire area should be proof-rolled at that time with a heavy pneumatic-tired roller to identify locally unstable areas for repair.

Pavement base course material should be aggregate base per M.A.G. Section 702 Specifications. Asphalt concrete materials and mix design should conform to M.A.G. 710 using the Marshall mix design criteria for low volume traffic and PG 64-22 for the asphalt grade. It is recommended that a ½-inch or ¾-inch mix designation be used for the pavements with up to 15.0% RAP. The actual mix design may be dependent on the selected pavement section and the specified minimum lift thicknesses for the different types of mixes.

3.10 Fill and Backfill

Native soils are considered ***suitable*** (and some remediation is recommended) for use in general grading fills and may be used in the footings, slab-on-grade (sidewalks, patios or any exterior concrete pad placement) or as retaining wall backfill. All backfill materials should be inorganic soils free of vegetation, debris, and fragments larger than four inches in size. All backfill operations shall be in accordance with Section 601 of the 2024 Maricopa Association of Governments (MAG) Uniform Standard Specifications and governing (County Building Officials) municipalities.

Where recommended, imported engineered fill should be examined by the Soils Engineer to ensure that it is of low swell potential and free of organic or otherwise deleterious material. In general, the fill should have no material larger than 6-inchs, 85-100 percent passing the 3-inch sieve. For the fine fraction (passing the 40 sieve), no less than 50 percent passing the 40 screen and no more than 40 percent passing the 200 sieve. The liquid limit and plasticity index should not exceed 30 percent and 10 percent, respectively. It should exhibit less than 1.5 percent swell potential when compacted to 95 percent of maximum dry density (ASTM D-698) at a moisture content of 2 percent below optimum, confined under a 100 psf surcharge, and inundated.

MTI should observe and verify when fill is placed on subgrade which has been properly prepared and approved by the Soils Engineer. All fill shall be processed (wetted and thoroughly mixed) to achieve a uniform optimum moisture content as seen below. All compaction percent's are minimum, unless noted. The fill should be placed in horizontal lifts no greater than 8-inch thickness (or as dictated by compaction equipment) and compacted to the percent of maximum dry density per ASTM D-698 set forth as follows:

Table 3.10 Soil/Aggregate Moisture/Compaction Criteria

Material Type/Structure Type	Compaction degree[1] (%)	Moisture (Compacted) Range[1] (%)
Cohesive/Below Foundation Grade	95 Min.	Optimum to + 4 of Optimum
Cohesive/Above Foundation Grade	90-95	Optimum to + 4 of Optimum
Cohesive/Below Pavements	90 Min.	Optimum to + 4 of Optimum
Cohesionless/Below Foundation Grade	95 Min.	+/- 2 of Optimum
Cohesionless/Above Foundation Grade	95 Min.	+/- 2 of Optimum
Cohesionless/Below Pavements	95 Min.	+/- 2 of Optimum
Engineered Fill/All Structures	95 Min.	+/- 2 of Optimum
MAG ABC/Below Interior Concrete Slabs	98 Min.	+/- 2 of Optimum
Exterior, Non-Structural	95 Min.	+/- 2 of Optimum
Landscape Areas	90 Min.	+/- 2 of Optimum

[1] The moisture content and percent compaction should be measured for each lift during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

3.10 Slope Stability

The stability of cut and fill slopes are dependent on the physical properties of the in-situ, representative, sampled soils. Below are the recommended slope values. Steep slopes shall be protected utilizing rock, benched and/or covered with landscaping to minimize erosion and reduce maintenance. Where requested, 1H : 1V slopes may require additional geotechnical services.

Cut Slopes:		Compacted Slopes:	
Non-Cemented Soils 2H : 1V	Cemented Soils 1.5H : 1V	silty-SANDS 2.5H : 1V	clayey-SANDS 2H : 1V

D. MAG Spec ABC

Sieve Size	Gradation (ASTM C136):	Percent Passing
3.0"		100
1.5"		100
1.0"		90-100
No. 4		38-65
No. 8		25-60
No. 30		10-40
No. 200		3-12

E. Engineered Backfill

Sieve Size	Gradation (ASTM C136):	Percent Passing
6.0"		100
3.0"		85-100
3/4"		70-100
No. 4 Sieve		50-100
No. 200 Sieve		40 (Max)

	Expansion Index (ASTM D4829)	Percent
Maximum Expansive Potential		1.5

Soluble Materials	Corrosive Potential (AZ 733 & AZ 736) [1]	ppm, Max.
Sulfates		1000
Chlorides		500

[1] American Concrete Institute (ACI) 318 Section 4.3, Table 4.3.1,

3.11 Site & Building Drainage

For standard, conventional foundations to perform as expected, attention must be paid to provide and maintain proper drainage to limit the potential for water infiltration of deeper soils. It is assumed that the landscape plan will use mostly low water use or "green" desert type plants (xeriscape). It is preferred to keep irrigated plants at least 5 feet away from structures with irrigation schedules set and maintained to run intermittingly. Unpaved planter areas should be sloped at least 5 percent for a distance of at least 10 feet away from the building. It is understood that this may not be possible due to ADA maximum slope requirements for the adjacent sidewalks and patios. The slope may be reduced to 2 percent provided extra care is taken to ensure sidewalks and other hardscape features do not create a “dam” that prevents positive drainage away from the buildings, creating a "pond" adjacent to the building. Roof drainage should also be directed away from the building in paved scuppers. Pre-cast loose splash blocks should not be used as they can be dislodged and/or eroded. Roof drains should not be allowed to discharge into planters adjacent to the structure. It is preferred that they be directed to discharge to pavement, retention basins or discharge points located at least 10 feet away from the building.

It is reiterated that shallow spread footings are recommended for the exterior walls and other light interior columns since this is the most economical system available. However, this shallow system relies on the dry strength of the unsaturated native (or imported granular) soils. A limited depth of re-compaction is recommended to increase density of the near surface soils that are more likely to encounter seasonal moisture changes, or deeper foundations. The deeper native soils, though not encountered, may become moisture sensitive and could experience differential settlement if subjected to significant surface water infiltration. Recognizing the need to minimize significant water penetration adjacent to the building perimeter that could detrimentally impact the building foundation, the following additional recommendations are made to protect foundations:

1.) Take extra precaution to backfill and compact native soil fill as seen above for all exterior wall locations.

2.) Avoid utility trenches passing through retention basins leading to the building. If unavoidable, backfill the trench with MAG Section 728 ½-sack CLSM to cut off preferred drainage paths.

3.) Create and maintain positive drainage away from the exterior wall for a minimum of 10 feet

4.) Avoid sidewalks, curbs or other elements that create a dam that could cause water to pond within 5 feet of the perimeter wall.

5.) Include no irrigated landscape materials in the first 3 feet next to the building.

6.) Between 3 feet and 5 feet, include only landscape materials that can be irrigated with a maximum of 1 gallon per hour emitter heads. Set and maintain irrigation controllers to prevent 24/7 flows.

7.) Any landscape materials requiring greater than 1 gallon per hour irrigation, including turf, shall be at least 5 feet from the outside face of the building.

8.) All irrigation feeder lines, other than those that supply individual emitters, shall not be placed closer than 5 feet to the building.

3.12 Earthwork Construction Considerations

It is anticipated that shallow excavations for the proposed construction can be accomplished with conventional earthmoving equipment. Excavations penetrating very dense soils or bedrock may require additional effort or the use of specialized heavy-duty equipment.

Surface water should not be allowed to pond on the site and soak into the soil during construction. Construction staging should provide drainage of surface water and precipitation away from the project site. Any water that collects over or adjacent to construction areas should be promptly removed, along with any softened or disturbed soils.

Surface water control in the form of sloping surfaces, drainage ditches and trenches, and sump pits and pumps will be important to avoid ponding and associated delays due to precipitation and seepage. When applicable, (as a minimum) excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, state, and federal safety regulations. When applicable, the contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties.

Construction site safety is the sole responsibility of the contractor who controls the means, methods and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean that MTI is assuming any responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

3.13 Utilities Installation

Trench excavations for very shallow utilities can be accomplished by conventional trenching equipment, though deeper utility excavations may require heavier equipment. Trench walls should stand near-vertical for the short periods of time required to install shallow utilities although some sloughing may occur in looser and/or sandier soils requiring laying back of side slopes and/or temporary shoring. Adequate precautions must be taken to protect the workforce in accordance with all current governmental regulations.

Backfill of trenches may be carried out with material meeting previously (Section 3.8 Fill and Backfill.) discussed specifications. This material should be moisture-conditioned, placed in 8-inch lifts and mechanically compacted. Water settling is not recommended and shall not be utilized. Compaction requirements are summarized in the "Fill and Backfill" section of this report.

4.0 LIMITATIONS

We prepared this report as an aid to the designers of the proposed project. The comments, statements, recommendations and conclusions set forth in this report reflect the opinions of the authors. These opinions are based upon conditions at the location of specific tests, observations and data developed to satisfy the scope of services defined by the contract documents. MTI's services on your project were performed in accordance with generally accepted industry standards and practices by professionals providing similar services in this locality. No other warranty, express or implied, is made.

In the event that changes in the proposed project occur, the conclusions and recommendations contained in this report should be reviewed and the report should be modified or supplemented as necessary. Variations from the field conditions represented by the borings and/or excavation may become evident during construction. If variations appear, we should be contacted to reevaluate our recommendations. We believe the findings in our report address the requirements for this project and are responsive to your concerns.

The comments and recommendations contained herein are not intended to dictate construction means, methods or sequences outside the governing agency. Any contractor/structural engineer (architect) reviewing this report must draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

5.0 CLOSURE

This report was prepared under the direction of MTI’s Registered Civil Engineer and MTI’s Senior Engineering Geologist. No warranty, express or implied, is made as to conclusions and professional advice included in this report. MTI, LLC disclaim responsibility and liability for problems that may occur if recommendations presented herein are not followed.

This report was prepared for MTI's Client and their design consultants solely for design and construction of the project described herein. It may not contain sufficient information for other uses or the purposes of other parties. Though MTI's services as seen in the above report, are to be used as a guideline per local municipalities minimum requirements, these recommendations are to be adhered to if and/or when clients design firm elects to not employ their structural foundation design. These recommendations should not be extrapolated to other areas or used for other facilities without consulting MTI, LLC.

Recommendations herein are based on interpretations of the subsurface conditions concluded from the scope of services performed as outlined herein. These interpretations may differ from actual subsurface conditions, which can vary horizontally and vertically across the site. Therefore, persons using this report for bidding or construction purposes should perform such independent evaluations, as they deem necessary.

Grading and construction work at the site should be performed per the current local building officials. Due to possible subsurface variations, all aspects of field construction addressed in this report should be observed by this office.

The scope of the services provided by MTI, LLC and its staff, excludes responsibility and/or liability for work conducted by others. Such work includes, but is not limited to, means and methods of work performance, quality control of the work, superintendence, sequencing of construction and safety in, on, or about the jobsite.

6.0 FIELD AND LABORATORY INVESTIGATION

On April 24, 2025, one (1) test pit was excavated at the approximate locations shown on the attached Soil Boring Location sheet. All field exploration services were carried out by MTI's client/client rep. MTI logged and recorded subsurface conditions and obtained samples for laboratory testing under the supervision and direction of MTI's registered engineer and/or senior engineering geologist.

Detailed information regarding the borings and samples obtained can be found on an individual Log of Test Boring/Test Pit prepared for each excavation location.

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 (PI)

Atterberg Limits tests were performed to aid in soil classification and to evaluate the plasticity characteristics of the material. Additionally, test results were correlated to published data to evaluate the shrink/swell potential of near-surface site soils. 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.

Expansion Index (EI)

Expansion index tests were 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.

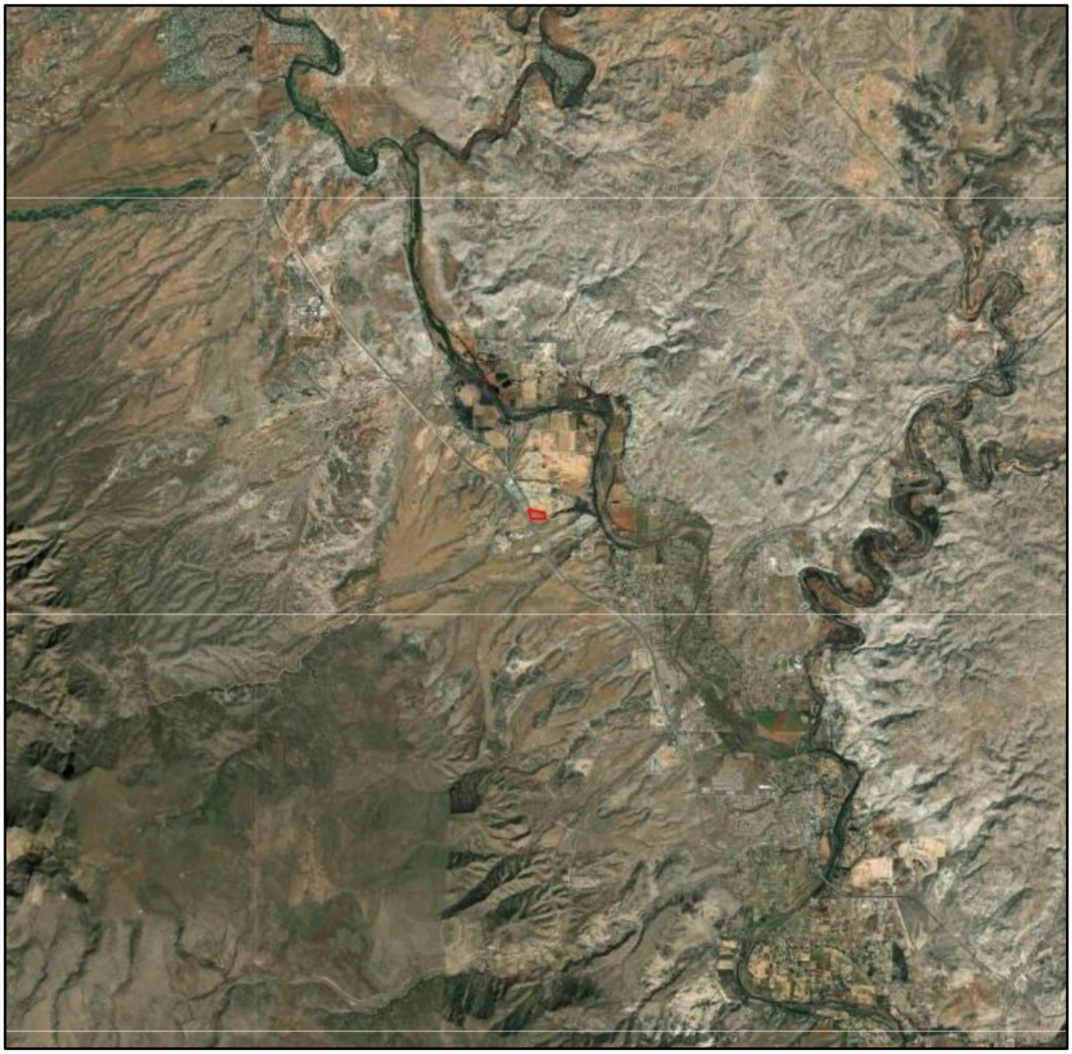
Sulfate Content (Test may be performed On Import/Engineered Material in contact with concrete). Sulfate content tests performed to evaluate the corrosion potential of the on-site soils. Tests are to be performed in general accordance with ARIZ 733.

Chloride Content (Test may be performed On Import/Engineered Material in contact with concrete). Chloride content tests performed to evaluate the corrosion potential of the on-site soils. Tests are to be performed in general accordance with ARIZ 736.

7.0 YAVAPAI COUNTY/IBC TOLERANCES

1803.5.3 Expansive Soil (2018 IBC)		
Test Method		**Max. Allowable**
Plastic Index (PI) ASTM D4318		15
Percent - 200 Sieve (75µm), ASTM D422		10%
Percent - 5 microns (5µm), ASTM D422		10%
Expansion Index (PI) ASTM D4321		20

7.0 APPENDIX



YAVAPAI-APACHE NATION TRIBAL HOUSING GEOTECHNIC
ADDRESS: TO-BE-DETERMINED (LOT 119)
CAMP VERDE (YAVAPAI APACHE NATION), AZ 86322

Subject Site and General Vicinity

N

MTI
MTI PROJECT NO. 25-214

YAVAPAI-APACHE NATION TRIBAL HOUSING GEOTECHNIC
ADDRESS: TO-BE-DETERMINED (LOT 119)
CAMP VERDE (YAVAPAI APACHE NATION), AZ 86322

Approximate Test Pit Locations

MTI PROJECT NO. 25-214

TEST/EXPLORATION LOG SHEET

Client:	Yavapai-Apache Nation Tribal Housing	**TP/Boring No.:**	TP-1
Project Name:	Yavapai-Apache Nation Tribal Housing Geotechnical	**Project No.:**	MTI PROJECT NO. 25-214
Project Location:	Address: To-Be-Determined (Lot 119)	**Performed By:**	R. Brinkley/MTI
EXCAVATION & SAMPLING INFORMATION			
Date Begin:	4/24/2025	**Sample Type:**	Bulk
Date Complete:	4/24/2025	**General Soil Type:**	Sands
Operator:	Client	**Municipality:**	Yavapai-Apache Nation (Yavapai County)

Depth (Ft.)	USCS SYMBOL	Subsurface Conditions	Lab No.	# -200 (%)	MC (%)	LL	PL	PI	EI
1		**silty-SANDS** Lt. (Tan) Brown, firm, fined, dry, with trace gravel & cobble							
2		Increase gravel, decrease cobble							
3									
4	SM	Firm-stiff, some fines, trace moisture, slighty Plastic (PI), very low Expansion potential (EI), with, gravel & ocassional cobble	G-5501B	***22.5****	4.5	20	17	3	2
5									
6		Stiff, fine, dry with little gravel and cobble							
7		Bottom Of Excavation, No Ground Water Encountered							
8									
9									
10									

Notes:

Bold, Italicized * indicates out of Yavapai County's (and 2018 IBC) Specifications. N/A=Not Applicable, NT (-) =Not Tested, NV=No Value, NP=Non-Plastic, NE=Non-Expansive, MC=Moisture Content, LL=Liquid Limit, PL=Plastic Limit, PI=Plastic Index, EI=Expansive Index

KEY TO SOIL SYMBOLS AND CLASSIFICATIONS

The abbreviations commonly used on each "Boring/Test Pit Log", as seen on the figures and within the text of the report, are as follows:

1. SOIL DESCRIPTION

Cohesionless Soils:

Relative Density	**N. Blows/Ft.**
-Very Loose	0-4
-Loose	5-10
-Compact	11-30
-Dense	31-50
-Very Dense	50+

Cohesive Soils:

Consistency	**Qu, TSF**
-Very Soft	< 0.25
-Soft	0.25-0.50
-Firm	0.50-1.00
-Stiff	1.00-2.00
-Very Stiff	2.00-4.00
-Hard	4.00+

2. PLASTICITY

Degree Of Plasticity	**Plasticity Index**
-None to Slight	0-4
-Slight	5-10
-Medium	11-30
-High to Very High	30 +

3. RELATIVE PROPORTIONS

Descriptive Term	**Percent**
-Trace	1 to 10
-Little	11 to 20
-Some	21 to 35
-And	36 to 50

4. PARTICLE SIZE IDENTIFICATION

-Boulders:	8 In. Diameter or more
-Cobbles:	3 - 8 In. Diameter
-Gravel:	- Course: 3/4 - 3 In.
	- Fine: 5.0mm - 3/4 In.
- Sand:	- Course: 2.0mm - 5.0mm
	- Medium: 0.5mm - 2.0mm
	- Fine: 0.07mm - 0.5mm
-Silt:	- 0.002mm - 0.07mm
-Clay:	< 0.002mm

5. SOIL PROPERTY SYMBOLS

N:	Standard Penetration Resistance Number of blows by a 140 lb. hammer dropped 30 inches, Required to drive a 2 inch OD split spoon sampler 1 ft.
Qu:	Unconfined Compressive Strength, TSF
Qp:	Pocket Penetrometer Unconfined Compressive Strength, TSF
Dd:	Natural Dry Unit Weight, PCF
∇	Apparent Groundwater Level at Time Noted
Mc:	Moisture & Water Content, %
LL:	Liquid Limit
PL:	Plastic Limit
LI:	Liquidity Index (Mc-PL/PI)
E:	Void Ratio
Gs:	Specific Gravity of Solid Particles
k:	Coefficient of Permeability
i:	Hydraulic Gradient
q:	Rate of Discharge
h:	Hydraulic Gradient
TSF:	Tons per Square Foot
PSF:	Pounds per Square Foot
KSF	Kips per Square Foot
PCF:	Pounds per Cubic Foot

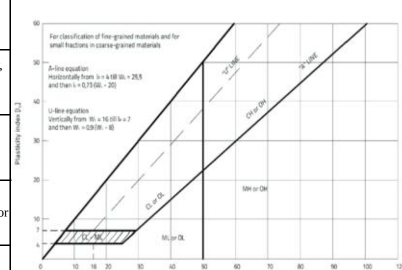
6. DRILLING/EXCAVATION AND SAMPLING SYMBOLS

N:	Standard Penetration Resistance Number of blows by a 140 lb. hammer dropped 30 inches, Required to drive a 2 inch OD split spoon sampler 1 ft.
Qu:	Unconfined Compressive Strength, TSF
Qp:	Pocket Penetrometer Unconfined Compressive Strength, TSF
Dd:	Natural Dry Unit Weight, PCF
∇	Apparent Groundwater Level at Time Noted
Mc:	Moisture & Water Content, %
LL:	Liquid Limit
PL:	Plastic Limit
LI:	Liquidity Index (Mc-PL/PI)
E:	Void Ratio
Gs:	Specific Gravity of Solid Particles
k:	Coefficient of Permeability
i:	Hydraulic Gradient
q:	Rate of Discharge

NOTE: SOILS ARE CLASSIFIED IN GENERAL ACCORDANCE WITH THE UNIFIED SOIL CLASSIFICATION SYSTEM.

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			Group Symbols	Typical Names	Laboratory Classification Criteria		
Coarse Grained Soils More than 50% retained the No. 200 Sieve	**Gravels** 50% or more of coarse fraction retained on No. 4 Sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain size curve Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse grained soils are classified as follows: Less than 5% ....GW, GP, SW, SP More than 12%..............GM, GC, SM, SC 5% to 12%...Borderline cases requiring dual symbols	$Cu = \frac{D_{60}}{D_{10}} > 4$; $1 < Cc = \frac{D_{30}^2}{D_{10} D_{60}} < 3$	
			GP	Poorly graded gravel and gravel-sand mixtures, little or no fines		Not meeting all gradation requirements of GW	
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line with PI less than 4	Above "A" line with PI between 4 and 7 are border line cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line with PI greater than 7	
	Sands More than 50% of coarse fraction passes No. 4 Sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines		$Cu = \frac{D_{60}}{D_{10}} > 4$; $1 < Cc = \frac{D_{30}^2}{D_{10} D_{60}} < 3$	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with Fines	SM	Silty sands, sand-silt mixtures		Atterberg limits below "A" line with PI less than 4	Above "A" line with PI between 4 and 7 are border line cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line with PI greater than 7	
Fine Grained Soils More than 50% passes the No. 200 Sieve	**Silts and Clays** Liquid Limit 50% or Less		ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and Clays Liquid Limit grater than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts	OTHER SYMBOLS		
			CH	Inorganic clays of high plasticity, fat clays	Groundwater	Undisturbed Soils	
			OH	Organic clays of medium to high plasticity			
Highly Organic Soils			PT	Peat, muck, and other highly organic soils	Bulk Samples	SPT Samples	



3"		3/4"	#4	#10	#40	#200

Unified Soil Classification	Cobbles	Gravel		Sand			Silts or Clays
		Coarse	Fine	Coarse	Medium	Fine	