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REPORT ON GEOTECHNICAL INVESTIGATION

DESIGNATION: Scottsdale Road Widening

LOCATION: Thompson Peak Parkway to Henkel Way
Scottsdale, Arizona

CLIENT: Wood/Patel

PROJECT NO: 222164SA

DATE: December 23, 2022

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1.0 INTRODUCTION

This report presents the results of a subsoil investigation carried out at the site of the proposed road widening to Scottsdale Road from Thompson Peak Parkway to Henkel Way, in Scottsdale, Arizona.

We understand that construction will consist of an approximate 2,600 linear foot widening to southbound Scottsdale Road, between Thompson Peak Parkway and Henkel Way. The widening will increase the southbound roadway from two lanes to three lanes. The roadway will be designed to support high volumes of passenger traffic and moderate heavy truck traffic. A detailed traffic study was not provided, however based on the City of Scottsdale published traffic counts, this section of Scottsdale Road experiences 32,000 vehicles per day (two direction).

Based on the provided information it is assumed that this roadway will be classified as a Major Arterial road by the City of Scottsdale. Adjacent areas will be landscaped or remain as undisturbed desert. It is assumed that the modifications to existing utilities may be required depending on the final selected pavement section. The approximate limits of the project are shown in Figure 1.0.1.

Figure 1.0.1 – General Project Limits

2.0 GENERAL SITE AND SOIL CONDITIONS

2.1 Site Conditions

The proposed widening is located along the west side of Scottsdale Road. This portion of Scottsdale Road is generally bounded on the west by native desert land and on the east by mostly newly developed commercial properties (north of Legacy Boulevard) and a vacant lot (south of Legacy Boulevard). Legacy Boulevard extends east from Scottsdale Road, near the center portion of the proposed widening. A culvert is present along the western side of Scottsdale Road, near the central portion of the project, allowing for storm water to pass below the roadway. There are numerous utilities present in the western shoulder of Scottsdale Road within the project limits. Based on the utilities marked as part of the field investigation, utilities include sewer, electrical, gas, and communications. Refer to the following figures showing the general conditions.

Figure 2.1.1 Shoulder and Utilities

Figure 2.1.2 Culvert Crossing

Based on cursory review of historical aerial photographs, it is believed that Scottsdale Road has been present since at least 1969, although historical aerials prior to 1969 were not readily available. The roadway appears to have gone through numerous improvements over the years, including a widening prior to 1996, and a subsequent widening to the eastern side of Scottsdale Road in 2007/2008. Refer to the following historical aerial photos:

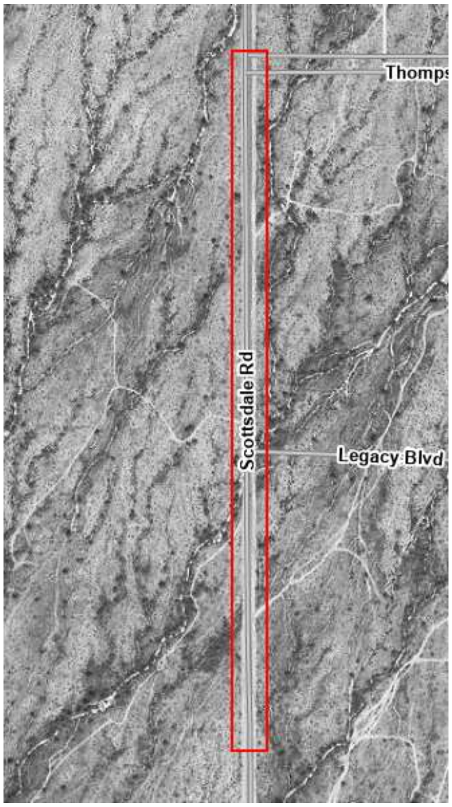

Figure 2.1.3 Dated 1976 **Figure 2.1.4 Dated 2007** **Figure 2.1.5 Dated 2021**

"Historical Aerial Photography," *ArcGIS Web Application*. [Online]. Available: https://gis.maricopa.gov [Accessed: 20-Dec-2022].

2.2 Geologic Conditions

The site is **not** located near areas that have undergone considerable subsidence due to groundwater removal. Areas of subsidence are known to produce earth fissuring. Fissure gullies form over subsurface irregularities such as bedrock highs, which cause tensional stresses and differential subsidence. Where such anomalies are not present, subsidence tends to be uniform over a wide area, this having minimal effect on surficial structures. The closest known earth fissures are located near the intersection of North 40th Street and East Lupine Avenue and near the CAP Canal and Frank Lloyd Wright, several miles to the southwest and southeast, respectively. **No evidence of earth fissures was observed on the site.**

2.3 Field Exploration and Soil Conditions

A total of three borings were selected to evaluate the existing soil conditions along the west side of Scottsdale Road and to gather samples for laboratory testing and analysis. The approximate boring locations are shown on the Soil Boring Location Plan in the Appendix of this report. Although not noted in the boring logs a thin layer of asphalt millings can be seen along portions of the unpaved shoulder. Native subsoil conditions at the site consist primarily of silty sand and silty/clayey sand with subordinate amounts of gravel to the maximum termination depths of the borings at 3 to 5 feet below existing grades. No groundwater was encountered during this investigation. Based on visual and tactile observation, the soils were in a 'dry to moist' state at the time of investigation. Detailed information from each boring location is included in the Log of Test Borings, attached in the Appendix.

2.4 Laboratory Testing

Due to the dense and sandy nature of the soils, in-situ dry densities of the upper soils were not possible. Liquid limits ranged from 21 to 25 percent while the plasticity indices range from 3 to 7 percent with 15 to 22 percent passing the #200 sieve. The upper lean clay soils exhibit a volume increase (**swell**) due to wetting of **less than 1 percent** when compacted to moisture and density levels normally expected during construction. Correlated R-values (R_c) range from 58 to 70 and an R_{mean} of 63 was calculated using the procedures outlined in the ADOT Pavement Design Manual (PDM). Based on the ADOT PDM and the Scottsdale Design Standards & Policies Manual, a subgrade resilient modulus (M_R) of 26,000 is assumed. This value is the maximum recommended based on the ADOT PDM. A design R-value (R_d) of 42 was selected and used for the design of the new pavements. This assumes that the existing native soils or import that is equal to or better the native soils will be used to support the new roadway pavement.

3.0 ANALYSIS AND RECOMMENDATIONS

3.1 Analysis

Analysis of the field and laboratory data indicates data subsoils at the site are favorable for the support of the proposed new roadway pavements and any required utility improvements. Coarse grained soil conditions were encountered in the soil borings, with the possibility of cemented soils at shallow depth. Any small structures (such as screen walls, monument signs, or manhole structures) can be supported on shallow spread foundations or mat foundations bearing on undisturbed native soils or compacted subgrade.

It is our understanding that the project will include widening the existing roadway with an additional lane. The roadway falls under the jurisdiction of the City of Scottsdale (COS). The pavement design procedures and our analysis generally follow the guidelines presented by COS and the Design Standards & Policies Manual.

The swell potential of the fine portion of the upper clayey soils is generally not a concern for the anticipated roadway construction on this project. The laboratory tested values indicate a negligible swell potential. While the swell potential is relatively low on this property, to maintain good performance of the new pavement it is still recommended to provide proper drainage to limit the potential for water infiltrating under the pavements, which could result in loss of support. City of Scottsdale guidelines for crowning/sloping of the road should be followed. For any unpaved/landscaped areas adjacent to the roadway a minimum slope of at least 5 percent for a distance of 10 feet is recommended.

Groundwater is not expected to be a factor in the design or construction of the roadway and any shallow foundations or underground utilities. Bedding, haunching, and initial backfill should be selected per the requirements of the pipe materials used and the trench loading conditions (refer to Section 3.5). Shallow excavation operations should be relatively straightforward although some sloughing is possible in the upper sandy soils requiring additional shoring protection. In addition, deeper excavations may encounter cemented soils, which may impede progress and possibly require the use of heavier equipment.

It should be noted that all new asphalt pavements will eventually crack. Cracking in asphalt pavement is typical and should be expected over the life of the pavement. In fact, it has been our experience of late that the new asphalt binders that are available, we are seeing the onset or earlier aging and cracking. These require routine maintenance to prevent accelerated deterioration. Accordingly, it is recommended that a maintenance program be followed so that cracks are routinely filled as they appear and the surface is protected from the aging process (oxidation). This will ensure that the pavement reaches or exceeds its intended design life. Additional discussion on pavement general pavement management is included in Section 3.8 of this report.

3.2 Site Preparation

In general the roadway subgrade should be prepared in accordance with MAG Standard Specification Section 301 and any additional City of Scottsdale requirements. In addition, the following recommendations are provided for preparation of the roadway subgrade.

The entire area to be occupied by the proposed construction should be stripped of all vegetation, debris, rubble, and obviously loose surface soils. Care should be taken during excavation not to endanger nearby elements such as roadways, utilities, etc. **Depending on proximity**, existing elements may require shoring, bracing or underpinning to provide structural stability and protect personnel working in any deeper excavations. The need for shoring or bracing is a means and methods decision by the contractor. As noted above, there are numerous utilities within the area. A detailed survey of utility location and depth should be conducted, as some excavation may be required to make room for the proposed new pavement structure.

In pavement areas, the exposed subgrade should be scarified to a **depth of 8 inches**, moisture conditioned to optimum (±2 percent) and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698.

If **isolated zones** of unstable or soft subgrade are found during site grading and proof rolling, there are several options available to help stabilize these conditions. The first option would be to remove the unstable soils to a depth on the order of 2 feet below the finished subgrade; deeper excavations may be required if the loose areas extend deeper. The soils may be set aside to dry (if necessary) and be re-compacted once they have dried sufficiently, or other local soils or asphalt millings may be used.

As an alternate to complete removal of the unstable soils, the soils can be mixed with dry cement. Since using cement is only to dry and stabilize the soils, not part of the structural design, it is recommended to generally follow MAG 311, Soil Cement. It is recommended that a minimum of 8 inches of cement stabilized soils be used below the pavement structural section. If very soft soils are encountered, increase this depth as needed to stabilize unstable soil conditions. Another option is to use a high-quality geogrid such as Tensar TX5 or equal installed per manufacture recommendations and MAG Standard Specifications 306 and 796 for geogrid combined with a minimum of 12 inches aggregate base on top of the geogrid, in addition to the pavement structural section.

Under sidewalks (if any), the exposed grade should be scarified to a depth of 8 inches, moisture conditioned to optimum to 3 percent above and compacted to at least 90 but not more than 95 percent of maximum dry density as determined by ASTM D-698.

Backfill of trenches above pipe bedding zones may be carried out with native excavated material. This material should be moisture-conditioned, placed in 8-inch lifts and mechanically compacted. Water settling is not allowed. Compaction requirements are summarized in the "Bedding, Backfill, and Fill" section of this report.

3.3 Foundation Design

It is recommended that any vault/manhole structures be founded on a mat type foundation bearing on medium to dense native soils (or 12 inches of compacted bedding material or Aggregate Base, crushed stone or 1½ sack MAG Spec 728 Controlled Low Strength Material (CLSM) for any loose/soft zones) at an invert depth on the order of 8 feet below grade. Minor structures such as screen walls can be founded on shallow spread footings bearing on compacted subgrade. The following bearing capacities can be used for design:

Table 3.3.1 Foundation Bearing Capacities

Structure	Foundation Type	Foundation Depth (1)	Bearing Medium	Bearing Capacity	Comments
Screen Walls & Minor Structures	Spread	1.5 ft.	Compacted Subgrade	1,000 psf	2
Manhole Structures	Mat	8.0 ft.	Undisturbed Native	k=125 pci	3

Comments:
1. Foundation Depth refers to minimum depth below lowest finished exterior grade within 5 feet of the structure.
2. Minor structures such as screen walls, monument signs, etc. the bottom of footing excavation should be moisture-conditioned to optimum (±2 percent) and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698.
3. For manhole structures a thickened (6 inch) concrete mat slab can be used. If a structural slab is desired a subgrade modulus k=125 pci can be used for design with a net bearing pressure of 2,000 psf based on a minimum depth of 8 feet below existing grade.

These bearing capacities 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. All footing excavations should be level and cleaned of all loose or disturbed materials. **Positive drainage away from the proposed structures must be maintained at all times**.

A representative of the Geotechnical Engineer should examine the subgrade once the footing excavation is complete and prior to placing concrete to ensure the soils are dense. If loose soils still exist at this depth some over-excavation may be required.

Mat foundations should be designed and reinforced to withstand any potential overturning moments from the equipment that is placed on the mat. Loading should be evenly distributed and concentrated near the center of the mat.

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 should be provided to prevent ponding adjacent to perimeter walls**.

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 control joints are suggested to allow slight movement and prevent minor floor slab cracking.

3.4 Lateral Pressures

The following **static** equivalent fluid lateral pressure values may be utilized for the proposed construction:

Active Pressures	
Unrestrained Walls	35 pcf
Restrained Walls	60 pcf
Passive Pressures	
Continuous Footings	300 pcf
Spread Footings	350 pcf
Coefficient of Friction (w/ passive pressure)	0.35
Coefficient of Friction (w/out passive pressure)	0.45

All backfill must be compacted to not less than 95 percent (ASTM D-698) to mobilize these passive values at low strain.

3.5 Bedding, Backfill, and Fill

The native soils are suitable for trench backfill (above any required bedding) and roadway fill provided oversize rock (plus 3 inches) is removed. The trench backfill should be moisture conditioned, placed in suitable lifts and mechanically compacted as specified. **Water settling is not recommended.** Pipe bedding should meet the project specifications as specified by the governing municipality. Special granular pipe bedding or cementitious slurry meeting MAG Standard Specifications Section 728 for Controlled Low Strength Material (CLSM) may be required depending on the pipe materials and trench loading conditions.

As noted above, it is recommended that for any section where loose/soft soils are encountered at the bottom of the trench, the loose/soft soils be over-excavated down to at least 12 inches below the pipe. The over-excavated zone should then be replaced with compacted bedding material. This process will require close inspection during trenching to identify any loose soils and to permit any necessary over-excavation to be performed during the initial excavation process.

The silty fine sand soils and clayey soils may be sensitive to excessive moisture content and will become unstable at elevated moisture content. Accordingly, it may be necessary to compact soils on the dry side of optimum.

If imported common fill for use in site grading is required, it should be examined by a 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 100 percent passing the 3-inch sieve and no more than 40 percent passing the #200 sieve. For the fine fraction (passing the #40 sieve), the liquid limit and plasticity index should not exceed 25 percent and 8 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.

Import borrow within the roadway prism should comply with MAG 210. In addition, it should have a minimum R-value of 42 or better, which is the basis for the pavement design.

Fill should be placed on subgrade which has been properly prepared and approved by a Soils Engineer. Fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±2 percent (optimum to 3 percent above under curb, gutter, and sidewalks). Fill should be placed in horizontal lifts of 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:

A.	Culvert, Manhole, and Minor Structures Footing level	95
B.	Pavement Subgrade or Fill	95
C.	Sidewalk Subgrade	90 min - 95 max
D.	Utility Trench Backfill	95 (full depth)
E.	Aggregate Base Course	100

Under any roadways, the backfill above the top of any pipe shall meet the requirements of MAG Standard Specification Section 601, Type I backfill or City of Scottsdale requirements. **In order to reduce trench settlement potential, all fill under roadways should be compacted to 95 percent full depth.**

Accurate prediction of the amount of construction water necessary for compaction is not possible due to the varying factors. These include variable natural soil moisture, seasonal changes in moisture content, air temperature and wind speed that impact evaporation. The optimum moisture contents reported on the moisture-density relations data is based on the minus #4 materials. It will be corrected downward depending on the percentage of rock (plus #4 fraction) in the matrix. For initial estimating purposes, a range of 80 to 100 gallons per cubic yard, for winter to summer months respectively, is typically recommended.

3.6 Excavations

Trench excavations for very shallow utilities can be accomplished by conventional trenching equipment. Trench walls will likely stand near-vertical requiring laying back of side slopes and/or temporary shoring. Adequate precautions must be taken to protect workmen in accordance with all current OSHA regulations. The contractor must determine means and methods required to excavate deeper trenches.

Excavations to the levels expected will likely terminate within similar soil types. All excavations must comply with current governmental regulations including the current OSHA Excavation and Trench Safety Standards. Based on this limited soil data, the soils would be classified as Type C. This will require side slopes for open-cut excavation to cut back at 1.5:1 (horizontal to vertical). It is recommended that a representative of the Geotechnical Engineer or the Contractor Qualified party examine the cut slope during excavation to reduce the risks posed by unstable conditions. The slopes should be protected from erosion due to run-off or long-term surcharge at the slope crest. Construction equipment, building materials, excavated soil and vehicular traffic should not be allowed within 10 feet or one-third the slope height, whichever is greater, from the top of slope. Adjustments to the recommended slopes may be necessary due to wet zones, loose strata and other conditions not observed in the borings. Shotcrete or soil stabilizer on the slope face may be useful in preventing erosion due to run-off and/or drying of the slope.

3.7 Asphalt 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 the proposed new pavements. It is assumed that Scottsdale Road will be classified as a Major Collector, based on the City of Scottsdale standards. A detailed traffic study was not provided for the proposed widening project. For initial analysis, traffic data was estimated based on 2020, two direction, City of Scottsdale traffic counts for Scottsdale Road. No indication of the percent of heavy trucks was provided, therefore the truck estimates were based on typical values assigned for this classification of roadway.

The primary purpose of this project is the addition of a third southbound lane to Scottsdale Road. The existing pavement sections for Scottsdale Road are unknown at this time. It is recommended to review as-built information for the existing pavement. In general, if the existing pavement section is greater than any of the provided recommendations below, then primary recommendations are to match the thicker section. In addition, it is recommended to match the aggregate base thickness of the existing pavement section (if thicker) to help improve subsurface drainage below the pavement.

The published City of Scottsdale traffic data is based on average daily traffic (ADTs). Available data indicates that approximately 32,300 two-direction ADTs for the subject segment of Scottsdale Road. This value was used as the baseline for evaluating the new pavement sections and was converted to 18-kip equivalent single axel loads (ESALs) to allow for analysis of proposed roadway sections. Typical heavy trucks impart 1.0 to 2.5 ESALs per truck depending on load. It takes approximately 1,200 passenger cars to impart 1.0 ESAL. The road is assumed to be classified as a Major Arterial road. Table 3.7.1 and Table 3.7.2 present the inputs used in analyzing the pavement sections and to estimate the traffic volumes.

The roadway pavement sections provided in this report are based on the average soil conditions observed in the borings, therefore if lower quality material is used, the pavement capacity may be slightly diminished. Lacking a project specific traffic study, the designer/owner should choose the appropriate sections to meet the anticipated traffic volume and life expectancy and be approved by the City of Scottsdale. The provided traffic analysis is based on general assumptions and limited traffic data. Consideration should be given to the section and any potential future developments on adjacent parcels.

Table 3.7.1 Pavement Design Parameters

Input	Value
Regional Factor	1.0
Initial Serviceability	5.0
Terminal Serviceability	2.5
Reliability	0.95
Overall Standard Deviation	0.45
Percent Passing #200 Sieve	46
Plasticity Index	2
Asphalt Layer Coefficient	0.39
Aggregate Base Layer Coefficient	0.12
Correlated R-Value (R_c)	63
Design R-Value (R_d)	42 (1)
Resilient Modulus (M_R)	26,000 psi (2)

1. Design R-value based on correlated R-values and capped M_R at 26,000 psi.
2. Value capped at 26,000 psi per ADOT.

Table 3.7.2 Arterial Road Traffic Estimates

Input	Value
Estimated ADTs (2 direction)	32,300
Directional Distribution Factor	60%
Lane Distribution Factor	70%
Estimated Trucks (%)	8%
ESALs/Truck	1.2
Estimated Growth Rate (%)	2%
Analysis Period	20 years
Estimated Total ESALs (design lane)	11,638,367
Estimated Daily ESALs (design lane)	1,594

The minimum pavement section for arterial streets pavement is 7-inches asphaltic concrete (AC) on varying thicknesses of aggregate base course (ABC), depending on the R-values encountered. Per the City of Scottsdale design standard, the minimum section for this portion of Scottsdale Road is 7-inches of AC on 9-inches of ABC. Based on calculations, this will provide a daily ESAL of 6,160, which exceeds the required daily ESALs of 1,594. For value engineering purposes, alternate pavement sections have been provided. The following pavement sections are available for consideration based on the initial field testing; the selected option should be approved by the City:

Table 3.7.1 Pavement Sections for Scottsdale Road

Alternate	Flexible (AC Pavement)					
	Layer Thickness [2]				Structural Number (SN)	Daily 18-kip ESALs [1]
	AC ½ Mix Rubberized [5]	AC ¾ Mix	AC ¾ Mix	ABC		
1	**1.0”**	**3.0”**	**3.0”**	**9.0”**	**3.81**	**6,160**
2	1.0”	3.0”	3.0”	7.0”	3.57	3,864
3	1.0”	3.0”	3.0”	6.0”	3.45	3,032

Notes:
1. Calculations are based on AASHTO design equations and ADOT correlated R-Values.
2. Adjust lift thicknesses depending on final mix design approval to meet MAG Spec Section 710 Table 710-1.
3. The minimum design thickness for a Major Arterial is 7 inches of AC on 9 inches of ABC per the City of Scottsdale Design Standards & Policy Manual (Alternate 1). This exceeds the calculated capacity based on the traffic data. Sections with reduced ABC layer are provided for Value engineering.
4. A tack coat should be applied between the AC layers.
5. Reference City of Phoenix specifications as noted in the City of Scottsdale Design Standards & Policy Manual.

These designs assume that all subgrades are prepared in accordance with the recommendations contained in the "Site Preparation" and "Bedding, Backfill, and Fill" 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 MAG Section 702 Specifications. Asphalt concrete materials and mix design should conform to MAG 710 and be a City of Scottsdale approved supplier/mix design. Pavement installation should be carried out under applicable portions of MAG Section

321 and 325. For sidewalks and other areas not subjective to vehicular traffic a 4-inch section of concrete will be sufficient.

3.8 Pavement Maintenance Plan

In order to achieve an extended life in the pavement it is highly recommended that a maintenance plan be used to address the aging process of the pavement. This will allow for a lower operational cost, while extending the life of the pavement.

It has been well documented that proper pavement maintenance will prolong the life of the pavement at a lower cost than letting the pavement age with no maintenance. Figure 3.8.1 shows how spending money on pavement preservation at the correct time will be a more cost effective means for extending the life of the pavement. As long as the pavement remains in a fair to excellent state, the cost of pavement preservation is relatively small, however as the pavement deteriorates into the fair to poor range, the pavement life becomes significantly shorter and there is a change from preservation to pavement rehabilitation and reconstruction (at a significantly higher cost).

Once the pavement enters into this middle zone, light pavement preservation techniques, such as seal coats, crack sealing, etc. become a poor use of funds and the process results in just chasing the distress. This will result in the owner spending more money just to maintain the current pavement condition. The following figure provides a Pavement Condition Index (PCI) rating, which is a visual condition scale rating from 0 to 100, with 100 being a brand new pavement and 0 being a completely failed pavement. The PCI is one of several standardized methods for rating a pavement based on a visual condition survey of the pavement. The rating procedure uses the pavement distress type and severity to calculate a PCI value for the pavement.

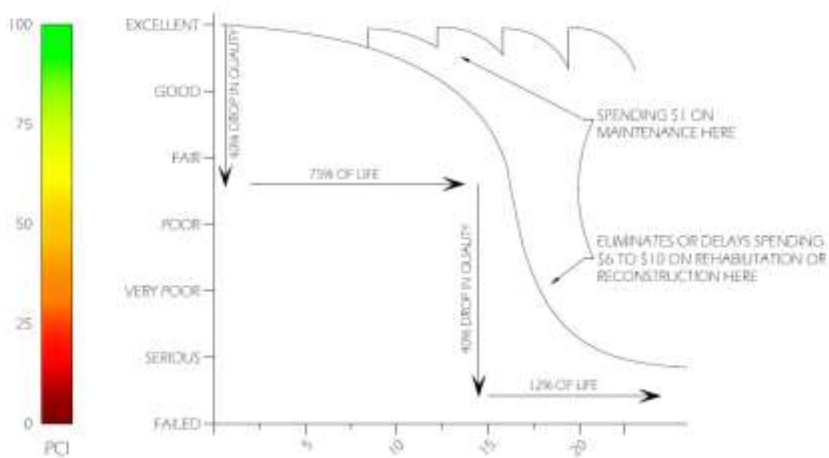

Figure 3.8.1 – Pavement Maintenance Cycle.

As discussed, all new asphalt pavements will eventually crack. Cracking in asphalt pavement is typical and should be expected over the life of the pavement. All pavements will age at different rates dues to numerous variables, including factors such as loading condition, environmental conditions, material placement and quality, and moisture infiltration or drainage issues. Accordingly, it is highly recommended to establish a maintenance program that addresses this aging process. In general terms, it is recommended that the cracks are routinely filled as they appear. Cracking will typical begin to appear around the 2nd to 3rd year of life. So the maintenance program should include a budget item to conduct crack sealing of the pavement every year or two. The amount of crack sealing that is required will depend on how the pavement is aging. Once cracks are sealed, they will not need to be sealed for another 4 to 5 years. Therefore, the budget estimates should assume that approximately 25 percent of the pavement areas will need isolated crack sealing every year. It is also recommended that surface fog seal coats be considered beginning at about year 5 and every 5 years after. This will help preserve the pavements surface as well as minimize the effects from moisture infiltration. Depending on the progression of the aging, more costly surface treatments such as thin overlays or slurry seals should be anticipated at the 15 to 20 year point of the pavement's life.

4.0 GENERAL

The scope of this investigation and report includes only regional published considerations for seismic activity and ground fissures resulting from subsidence due to groundwater withdrawal, not any site-specific studies. The scope does not include any considerations of hazardous releases or toxic contamination of any type.

Our analysis of data and the recommendations presented herein assume that soil conditions do not vary significantly from those found at specific sample locations. Our work has been performed in accordance with generally accepted engineering principles and practice; this warranty is in lieu of all other warranties expressed or implied.

We recommend that a representative of the Geotechnical Engineer observe and test the earthwork and paving portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this report. If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented herein are to apply.

Respectfully submitted,
SPEEDIE & ASSOCIATES, LLC

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APPENDIX

FIELD AND LABORATORY INVESTIGATION

SOIL BORING LOCATION PLAN

SOIL LEGEND

LOG OF TEST BORINGS

TABULATION OF TEST DATA

MOISTURE-DENSITY RELATIONS

SWELL TEST DATA

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FIELD AND LABORATORY INVESTIGATION

On November 15, 2022, soil test borings were drilled at the approximate locations shown on the attached Soil Boring Location Plan. All exploration work was carried out under the full-time supervision of our staff engineer, who recorded subsurface conditions and obtained samples for laboratory testing. The soil borings were advanced with a jeep-mounted drill rig using a 12-inch diameter solid stem flight auger. Detailed information regarding the borings and samples obtained can be found on an individual Log of Test Boring prepared for each drilling location.

Laboratory testing consisted of grain-size distribution and plasticity (Atterberg Limits) tests for classification and pavement design parameters. Remolded swell test was performed on samples compacted to densities and moisture contents expected during construction. All field and laboratory data are presented in these appendices.

- APPROXIMATE SOIL BORING LOCATIONS

N

DR: JS | CHK: NJV | DATE: 10/12/22 | PROJECT NO.: 222164SA | SHEET: 1 OF 1

SOIL BORING LOCATION PLAN

SCOTTSDALE ROAD WIDENING
THOMPSON PEAK PARKWAY TO HENKEL WAY
SCOTTSDALE, ARIZONA

SPEEDIE AND ASSOCIATES
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SOIL LEGEND

SAMPLE DESIGNATION	DESCRIPTION	
AS	**Auger Sample**	A grab sample taken directly from auger flights.
BS	**Large Bulk Sample**	A grab sample taken from auger spoils or from bucket of backhoe.
S	**Spoon Sample**	Standard Penetration Test (ASTM D-1586) Driving a 2.0 inch outside diameter split spoon sampler into undisturbed soil for three successive 6-inch increments by means of a 140 lb. weight free falling through a distance of 30 inches. The cumulative number of blows for the final 12 inches of penetration is the Standard Penetration Resistance.
RS	**Ring Sample**	Driving a 3.0 inch outside diameter spoon equipped with a series of 2.42-inch inside diameter, 1-inch long brass rings, into undisturbed soil for one 12-inch increment by the same means of the Spoon Sample. The blows required for the 12 inches of penetration are recorded.
LS	**Liner Sample**	Standard Penetration Test driving a 2.0-inch outside diameter split spoon equipped with two 3-inch long, 3/8-inch inside diameter brass liners, separated by a 1-inch long spacer, into undisturbed soil by the same means of the Spoon Sample.
ST	**Shelby Tube**	A 3.0-inch outside diameter thin-walled tube continuously pushed into the undisturbed soil by a rapid motion, without impact or twisting (ASTM D-1587).
--	**Continuous Penetration Resistance**	Driving a 2.0-inch outside diameter "Bullnose Penetrometer" continuously into undisturbed soil by the same means of the spoon sample. The blows for each successive 12-inch increment are recorded.

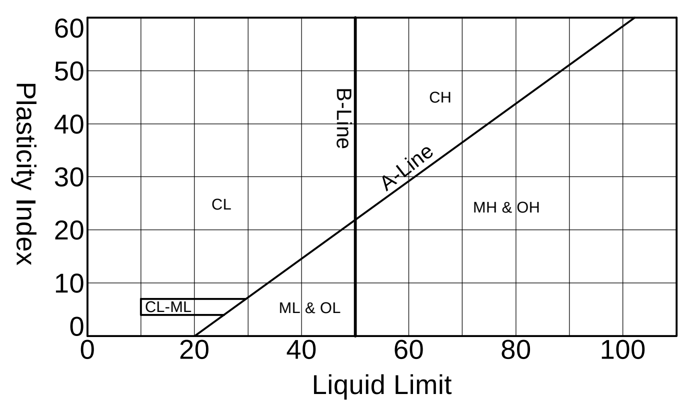
CONSISTENCY			RELATIVE DENSITY	
Clays & Silts	Blows/Foot	Strength (tons/sq ft)	Sands & Gravels	Blows/Foot
Very Soft	0 - 2	0 - 0.25	Very Loose	0 - 4
Soft	2 - 4	0.25 - 0.5	Loose	5 - 10
Firm	5 - 8	0.5 - 1.0	Medium Dense	11 - 30
Stiff	9 - 15	1 - 2	Dense	31 - 50
Very Stiff	16 - 30	2 - 4	Very Dense	> 50
Hard	> 30	> 4		

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				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
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL OR MODIFIED SYMBOLS MAY BE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS OR TO PROVIDE A BETTER GRAPHICAL PRESENTATION OF THE SOIL

MATERIAL SIZE	PARTICLE SIZE			
	Lower Limit		Upper Limit	
	mm	Sieve Size ◆	mm	Sieve Size ◆
SANDS				
Fine	0.075	#200	0.42	#40
Medium	0.420	#40	2.00	#10
Coarse	2.000	#10	4.75	#4
GRAVELS				
Fine	4.75	#4	19	0.75" ×
Coarse	19	0.75" ×	75	3" ×
COBBLES	75	3" ×	300	12" ×
BOULDERS	300	12" ×	900	36" ×

◆U.S. Standard ×Clear Square Openings



Depth (feet)	Graphic Log	Rig Type: **Jeep Mounted** Boring Type: **Solid Stem Auger** Surface Elevation: **N/A** Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 / 25 / 50)
0		Brown SILTY, CLAYEY SAND (SC/SM-Dry to Moist) with Gravel					
		3.0	AS-1	3.0	NT	NT	
		End of Boring					
5							

Boring Date: **11-15-22**
Field Engineer/Technician: **N. Vitale**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **SG-1**

Scottsdale Road Widening

Thompson Peak Parkway to Henkel Way

Scottsdale, Arizona

Project No.: **222164SA**

_SPEEDIE 222164SA.GPJ GENGEO.GDT 12/20/22

Depth (feet)	Graphic Log	Rig Type: **Jeep Mounted** Boring Type: **Solid Stem Auger** Surface Elevation: **N/A** Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 25 50)
0		Brown SILTY SAND (SM-Dry to Moist) with Little Gravel					
			BS-1	4.0	NT	NT	
5		5.0 End of Boring					

Boring Date: **11-15-22**
Field Engineer/Technician: **N. Vitale**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **SG-2**

Scottsdale Road Widening

Thompson Peak Parkway to Henkel Way

Scottsdale, Arizona

Project No.: **222164SA**

Depth (feet)	Graphic Log	Rig Type: **Jeep Mounted** Boring Type: **Solid Stem Auger** Surface Elevation: **N/A** Visual Classification		Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 – 25 – 50)
0		Brown SILTY, CLAYEY SAND (SC/SM-Dry to Moist) with Little Gravel	3.0	AS-1	3.0	NT	NT	
		End of Boring						
5								

Boring Date: **11-15-22**
Field Engineer/Technician: **N. Vitale**
Driller: **Cameron**
Contractor: **Hurricane Holes**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **SG-3**

Scottsdale Road Widening

Thompson Peak Parkway to Henkel Way

Scottsdale, Arizona

Project No.: **222164SA**

_SPEEDIE 222164SA.GPJ GENGEO.GDT 12/20/22

TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
SG-1	AS-1	AS	1.0 - 3.0	NT	NT	14.9	27	51	68	100	24	17	7	SC-SM	SILTY, CLAYEY SAND with GRAVEL
SG-2	BS-1	BULK	0.0 - 4.0	NT	NT	16.9	36	70	84	100	21	18	3	SM	SILTY SAND with GRAVEL
SG-3	AS-1	AS	1.0 - 3.0	NT	NT	21.8	35	61	87	100	25	19	6	SC-SM	SILTY, CLAYEY SAND

Sieve analysis results do not include material greater than 3". Refer to the actual boring logs for the possibility of cobble and boulder sized materials.

NT=Not Tested

Sheet 1 of 1

Scottsdale Road Widening
Thompson Peak Parkway to Henkel Way
Scottsdale, Arizona
Project No. 222164SA

SPEEDIE AND ASSOCIATES

MOISTURE-DENSITY RELATIONS

PROJECT: Scottsdale Road Widening **PROJECT NO.:** 222164SA

LOCATION: Thompson Peak Parkway to Henkel Way **DATE:** 11/15/22

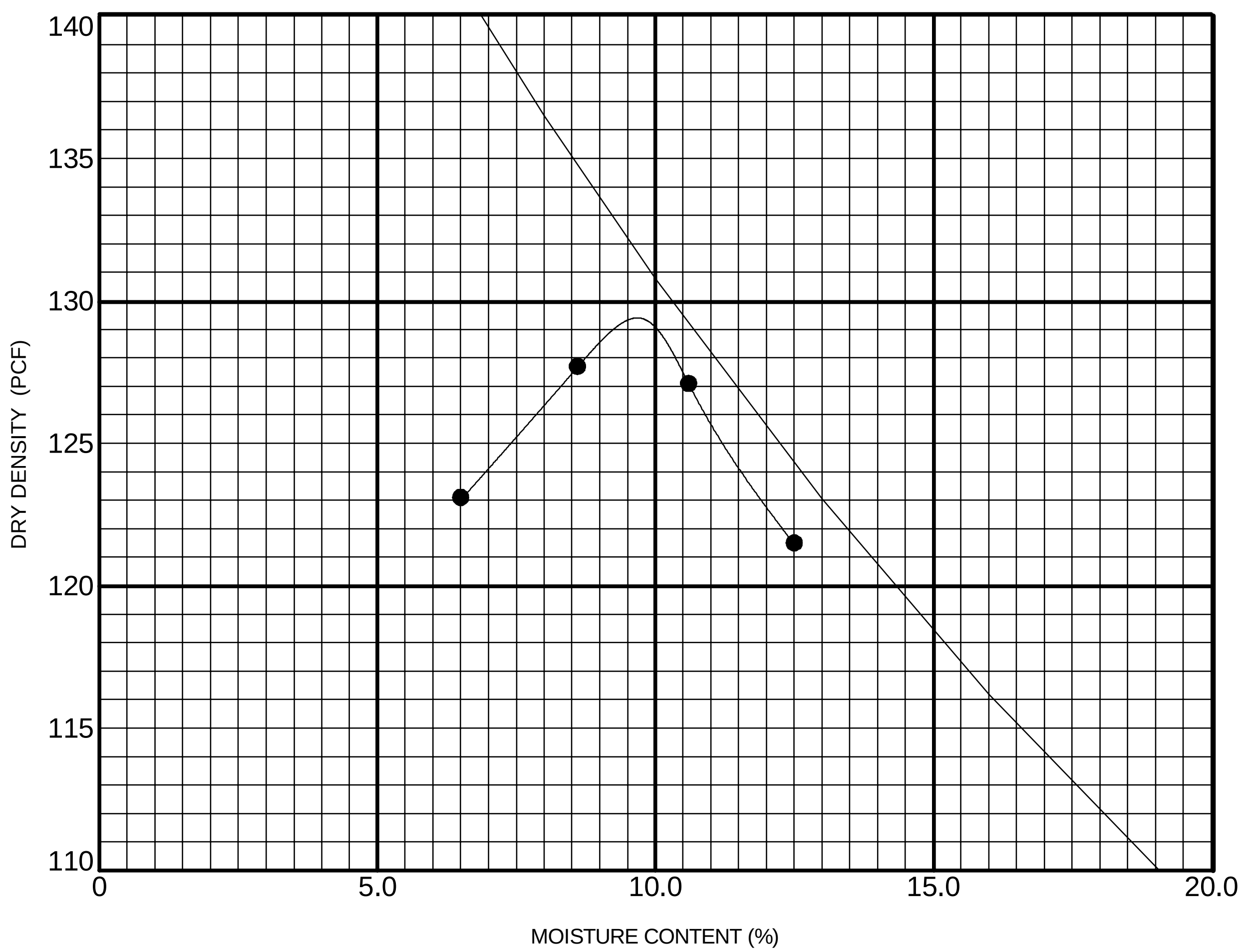
BORING NO.: SG-2 **SAMPLE NO.:** BS-1 **SAMPLE DEPTH:** 0 to 4 **LABORATORY NO.:**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 21 **PLASTIC LIMIT:** 18 **PLASTICITY INDEX:** 3

CLASSIFICATION: SM **ASTM SOIL DESCRIPTION:** SILTY SAND with GRAVEL

MAXIMUM DRY DENSITY: **129.4 PCF** OPTIMUM MOISTURE CONTENT: **9.7%**



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SWELL TEST DATA

BORING or TEST PIT No.	SAMPLE DEPTH, ft	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)	REMOLDED DRY DENSITY (pcf)	INITIAL MOISTURE CONTENT (%)	PERCENT COMPACTION	FINAL MOISTURE CONTENT (%)	CONFINING LOAD (psf)	TOTAL SWELL (%)
SG-2, BS-1	4.0	129.4	9.7	122.9	7.9	95.0	11.2	100	0.0

Scottsdale Road Widening
Thompson Peak Parkway to Henkel Way
Scottsdale, Arizona
Project No. 222164SA

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