Geotechnical Engineering Report
Scottsdale Road Bike Lane Continuation
Curry Road to Continental Drive
Tempe, Arizona
RAMM Project No. G27138
Project No. 0000 MA TMP T0260 01C
Federal Aid No. TMP-0(254)D
Revised May 5, 2023

For:
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R·A·M·M

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March 27, 2023
Revised April 10, 2023
Revised May 5, 2023

Attention: Sai Gundala, P.E.

Subject: Geotechnical Engineering Report
Scottsdale Road Bike Lane Continuation
Continental Drive to Curry Road
Tempe, Arizona

RAMM Project No. G27138

Attached to this letter is the Geotechnical Engineering Report for the proposed Scottsdale Road Improvements, located in Tempe, Arizona.

The proposed improvements will consist of widening sections of the existing roadway and reconstruction of medians, sidewalks, and intersection improvements to accommodate installation of bicycle lanes in either direction. Full width mill and overlay treatment of the existing pavements will be conducted for the length of the project.

The attached report was prepared based on project and site data available at this time and was prepared in a manner and to the standards of local geotechnical engineering practice. Our services did not include evaluations for the presence of hazardous materials, corrosion potential with respect to on-site soils, concrete durability and corrosion potential with respect to site use water sources, and area subsidence resulting from groundwater withdrawal or other geologic hazards.

If you have any questions, please do not hesitate to call.

Respectfully submitted,
RICKER • ATKINSON • McBEE • MORMAN & ASSOCIATES, INC.

Registered Professional Engineer (Civil) CERTIFICATE NO. 28182 DAVID A. THOMAS DATE SIGNED 5-5-23 ARIZONA U.S.A.

By: Andrew J. Schirmer AND David A. Thomas, P.E.

/ajs
Copies to: Addressee (sgundala@nfrainc.com)

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REPORT

R·A·M·M

INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Scottsdale Road Bike Lane Continuation from Curry Road to Continental Drive, located in Tempe, Arizona. The scope of our services included performing a field exploration program, laboratory analysis and geotechnical engineering evaluation, analysis and recommendations. The geotechnical recommendations presented herein include those for roadway improvements, pavement design, anticipated excavation conditions, earthwork factors, site development, and material use and requirements. We would be pleased to review project specifications and plans for conformance with our recommendations and discuss any additional recommendations you may require.

This firm should be notified for additional evaluation and recommendations if the project design parameters (locations, sections, alignments, etc.) are changed, and/or where site use or conditions encountered during construction differ from those presented herein.

PROPOSED CONSTRUCTION

The proposed improvements will consist of reconstruction of Scottsdale Road to facilitate new bicycle lanes and intersection improvements. Improvements will occur withing the existing Scottsdale Road pavements and right-of-way from just south of Curry Road at Station 27+00 to just north of Continental Drive at Station 96+18, in Tempe, Arizona. Widening of the roadway will consist of an average 7-foot section southbound from Station 30+33 to Station 43+51 for installation of a new 5.5-foot-wide bicycle lane, and an average 10-foot section northbound from Station 62+68 to Station 76+91 for installation of a 6.0-foot-wide bicycle lane. New concrete curbs, gutters and sidewalks will be installed in these sections. Intersection improvements occur at each intersection within the project limits consisting of adjusting (where necessary) and replacing existing concrete curb, gutter, sidewalk and ramp elements. Surfacing treatments to extend the pavement life of remaining roadway pavements for the length of the project will consist of a 2-inch mill and overlay and asphalt replacement. Curbs of existing raised median islands on Scottsdale Road will be removed and replaced to facilitate adjusted lane sizes and locations due to the installation of new bicycle lanes.

SITE CONDITIONS

North Scottsdale Road – East Curry Road to East Continental Drive

The roadway surface is divided into three lanes each direction, with dedicated left turn lanes at major intersections, and with curbs, gutters and attached sidewalks on either side. The center lane construction consists of landscaped raised median islands and honeycomb pattern paver center turn lanes. Various public roads, private drives, and business access entries/exits intersect with Scottsdale Road. The pavement is in moderate condition and exhibits light rutting, moderate transverse and longitudinal cracking, moderate block cracking, localized moderate alligator cracking, frequent patches and/or utility installation repair sections, and moderate surface wear.

No Ground Disturbance Zone:

An area from approximately 100 feet south of McKellips Road to approximately 100 feet north of Papago Drive has been designated as a protected zone due to the presence of a previously documented cultural resource. Ground disturbance (explorations) was prohibited in this area.

FIELD EXPLORATIONS

Subsurface conditions were explored by drilling eleven test borings within Scottsdale Road to depths of 6.0 feet through the existing pavement sections, at the locations shown on the attached Site Plans in Appendix A. The test borings were drilled with a CME 75 drill rig using seven-inch diameter, hollow-stem augers. The drilling equipment and crew were provided by Wildcat Drilling, Inc. The test boring locations were determined in the field by our field technician. During the field explorations, representative undisturbed and disturbed samples were obtained, the field explorations logged and soils field-classified by our field technician, who also directed the drill crew. The relatively undisturbed samples (ring samples) were obtained by driving a 3-inch diameter, ring-lined, open-end sampler driven into the soil with a 140-pound hammer dropping 30 inches. The results of our field explorations are presented in the Test Boring Logs in Appendix A.

LABORATORY ANALYSIS

Representative samples obtained during the field explorations were subjected to the following tests in our laboratory.

Type of Test	Type of Sample	Number of Samples Tested
Minus No. 200 Sieve & Plasticity Index	Representative	11
Standard Proctor (ASTM D698-A)	Representative	6
Swell	Remolded	3
Moisture Content/Dry Density *	Undisturbed	22
R-Value **	Representative	6
pH/Resistivity	Representative	3

* Reported in the test boring logs
** Laboratory analysis provided by Terracon, Inc.

The results of the laboratory analysis are presented in Appendix B.

EXISTING PAVEMENT AND SUBGRADE CONDITIONS

A summary of the results of the laboratory testing on the representative samples obtained from the test borings and thickness of existing pavement sections encountered in the test borings are tabulated below:

Pavement Subgrade				Existing Pavement		R-Value	
				Inches			
Test Boring	Present Retained No. 4 Sieve	Percent Passing No. 200 Sieve	Plasticity Index	AC	AB	Tested (Rt)	Correlated (Rc)
1	6	67	NP	5.0	9.0	70	49.2
2	17	45	NP	4.5	9.0		64.8
3	18	37	14	4.0	12.0	56	29.9
4	21	29	7	4.0	11.0		50.4
5	19	36	11	5.5	8.0	55	36.1
6	7	66	10	5.0	10.0		27.2
7	10	47	13	5.0	10.0		28.3
8	25	34	10	5.0	12.0	57	39.3
9	15	33	13	5.0	8.0		33.2
10	6	48	8	5.0	10.0	43	37.6
11	15	31	11	5.0	10.0	47	38.3

NP – Non-plastic

SURFACE AND SUBSURFACE CONDITIONS

The results of the test borings are presented in Appendix A in the Test Boring Logs. Along the alignment of the proposed improvements, the subsurface profiles below existing pavement sections were somewhat variable. In Test Borings 3 to 5, and 7 to 11, subgrade soils extending to

depths of 5 to 6 feet (maximum depth of exploration) consisted of clayey sand with trace to some gravel. These soils were loose to medium dense and contained medium plasticity fines. Underlying these soils in Test Boring 5 and underlying the pavement section in Test Boring 6, extending to a depth of 6 feet (maximum depth of exploration), sandy clay with trace to some gravel was encountered. These soils were firm to stiff and exhibited medium plasticity. Subgrade soils encountered in Test Borings 1 and 2 and extending to 6 feet (maximum depth of exploration) consisted of loose to medium dense, non-plastic sandy silt and silty sand with trace to some gravel. Soil moisture contents were described as very damp to damp throughout the depths of exploration. No groundwater was observed in the test borings during the field explorations.

DISCUSSION OF TEST RESULTS

Remolded samples of the subgrade soils from the site exhibited low swell potentials following wetting when tested in the laboratory.

PAVEMENT DESIGN

Standard Design Sections:

Scottsdale Road is designated as a Major Arterial Street. Roadway design for minimum pavement sections is presented in the Tempe Supplement to the MAG Uniform Standard Details and Specifications for Public Works Construction dated 2014. Minimum sections for arterial streets are presented on details T-306 and T-313 (see Appendix C) and consists of 6 inches of asphalt concrete (2 inches of A-12.5 on 4 inches of A-19) on 12 inches of base course. Traffic counts for this section is available on the "Traffic Counts and Maps" webpage presented by the City of Tempe Transportation department. A 2022 traffic count of 30,446 ADT for Continental Drive to McKellips Road and 30,657 ADT for McKellips Road to Curry Road were presented and a conservative 15 percent truck component was used. Using the procedures presented in the "AASHTO Interim Guide for Design of Flexible Structures" (see Appendix C) as used by City of Tempe, a structural number (SN) of 3.46, less than the minimum SN of 4.32, which shall govern and as such the minimum pavement section described above will apply.

Mill and Overlay:

Existing pavements within the project limits to remain will be subjected to a 2-inch depth mill and overlay. The milled surface will be thoroughly cleaned before applying any tack coat. A 2-inch section of EVAC A-12.5 shall be placed within seven days of milling operations. Any areas in which milling damages the remaining pavement section, full removal will be required. Existing

pavement sections are less than the City of Tempe minimum pavement section, therefore, a mill and overlay treatment will not provide a 20-year design life and may only provide pavement life extension to the existing section.

SITE DEVELOPMENT RECOMMENDATIONS

Concrete Slab-on-Grade Support:

The near surface soils are of medium plasticity to non-plastic and exhibit low swell potentials when compacted and wetted. These soils will provide adequate support for concrete slabs-on-grade provided these soils are placed and compacted at moisture contents as optimum plus or minus 2 percent. Exterior slabs should be placed on a prepared subgrade. A base course is also recommended for any large exterior pedestrian slabs to aid in concrete curing and reduce potentials for slab curling and shrinkage cracking, especially if slabs are unreinforced. All unreinforced slabs-on-grade should be jointed as per ACI (American Concrete Institute) or PCA (Patterned Cement Association) guidelines.

Surface Drainage:

Most soils will undergo some degree of volume change as a result of wetting. The site subgrade soils encountered below the existing pavement sections may exhibit moisture contents at or above optimum and the higher moisture content areas may be unstable during compaction. The degree of instability will depend on the type of soil, swell potential, natural soils structure or degree of compaction (if a fill). These volume changes could result in movements in overlying pavements and/or sidewalks, planters, medians, etc. Therefore, good site and surface drainage and away from these elements is required. In addition, water should not be allowed to pond within 5 feet of the pavement edges or elements which are sensitive to movement.

Excavatability:

The excavatability of site materials is difficult to evaluate based only on the exploration equipment used during this design report. Therefore, we recommend that the contractor evaluate the excavatability of site materials by performing test excavations with the size and type of equipment the contractor plans on using at the site. For design purposes, the following paragraph presents our best analysis as to the excavatability of site soils.

The soils to depths of 6 feet can likely be removed with conventional excavating equipment. OSHA requires all excavations over five feet in depth, in which personnel are to enter, be either braced or sloped in accordance with OSHA regulations.

Workability:

Wetting site soils such that moisture contents are at or above optimum could result in some to extensive soil pumping under dynamic loadings such as heavy construction equipment driving over the area. In flexible pavement areas where pumping has occurred, the area should be allowed to dry until soils are workable without pumping or the wetted areas removed and replaced with drier site soils.

Corrosion Potential:

As part of this investigation laboratory pH and Minimum Resistivity testing of site soils was conducted. The results of the laboratory testing are included in Appendix B. Based on these results and corrosion potential criteria presented in the Arizona Department of Transportation (ADOT) Preliminary Engineering and Design Manual, Figure 203.04-5 and National Association of Corrosion Engineers (NACE) International Corrosion Severity Ratings, there appears to be a high potential for corrosion to buried ferrous metal structures and pipelines. This potential is a function of soil type and moisture content, material type and/or composition, water chemistry and other factors. Accordingly, the results of the laboratory testing should be made available to material suppliers and corrosion experts for review.

MATERIALS SUITABILITY AND REQUIREMENTS

Site Materials:

The near surface soils may be in all areas provided these soils are free of organic materials, debris, rubble and material greater than 3 inches in size if placed within 12 inches of pavement subgrade and free of material greater than 8 inches in size if placed greater than 12 inches below pavement subgrade.

Imported Soils:

Fill required beyond that available from site sources should be imported soils which conform to the requirements of MAG Specifications for granular material (Section 601.3.5) or MAG Specifications for aggregate base (Section 702) and in roadway locations should have R-Value properties better than or equal to existing site soils. Imported soils should have a low corrosion

potential as determined by a corrosion expert and/or material supplier and should meet ACI 3/8 negligible sulfate exposure durability requirements for concrete.

Base Material:

Base material used below pavement should conform to the requirements of MAG Specifications for aggregate base (Section 702) as modified by the City of Tempe. Existing base material and pulverized asphaltic concrete may not be used as fill or base material in new pavement areas.

Asphalt Concrete Pavement:

Asphalt concrete pavement materials should conform to the requirements of MAG Specifications for Asphalt Concrete (Section 710) and should be East Valley Asphalt Committee (EVAC) and City of Tempe approved mixes.

SITE PREPERATION AND GRADING PROCEDURES

Curb, Gutter, Sidewalk, and New Pavement Areas:

Recommendations presented in the previous sections of this report are based upon the following site preparation and grading procedures. Therefore, all earthwork should be accomplished with observation and testing by a qualified technician under the direction of a registered geotechnical/ materials engineer. The following apply to sidewalk, curb, gutter, and pavement replacement areas.

1. Saw cut and remove pavement materials and existing developments as necessary (curbs, gutters, sidewalks, ramps, etc.). During removal, observe the surface for evidence of buried debris, vegetation, or disturbed materials which will require additional removal. If encountered, these materials should be removed. Areas steeper that 5H to 1V should be benched and depressions widened to accommodate compaction equipment.

2. Prepare the ground surface in at-grade areas, in fill areas and in areas cut to grade by scarifying, moisture conditioning and compacting the exposed surface soils to a depth of 10 inches.

3. Moisture condition and place all fill and backfill materials required to achieve specified grades. Fill materials should be moisture conditioned, placed and compacted in horizontal lifts of thicknesses compatible with the compaction equipment being used.

4. Compact subgrade, fill, backfill, subbase fill or base material to the following minimum percent compaction of the ASTM D698 maximum dry density in each lift:

Material	Minimum Percent Compaction
Soil (Trench Backfill and New Pavement Areas):	
Below pavement sections	95
Outside of pavement areas	90
Curbs, Gutters, Sidewalks	95
Base Material:	
Below pavement sections	100

5. Moisture content of soil and base materials at the time of compaction should be:

Type	Area of Use*	Moisture Content
On-Site	Trench Backfill/Pavement	Optimum plus or minus 2%
On-Site	Sidewalks (low to non-expansive)	Optimum to optimum plus 2%
Import	Trench Backfill/Pavement	Optimum plus or minus 2%
Import	Sidewalks	Optimum to optimum plus 3%
Base Material	Trench Backfill/Pavement	Optimum plus or minus 3%

* Includes upper 2 feet of trench backfill in pavement and pavement replacement areas.

6. Place asphalt concrete in accordance with MAG Specification Section 310 and 702, using materials which comply with MAG Specifications, as applicable and as modified by the City of Tempe.

LIMITATIONS

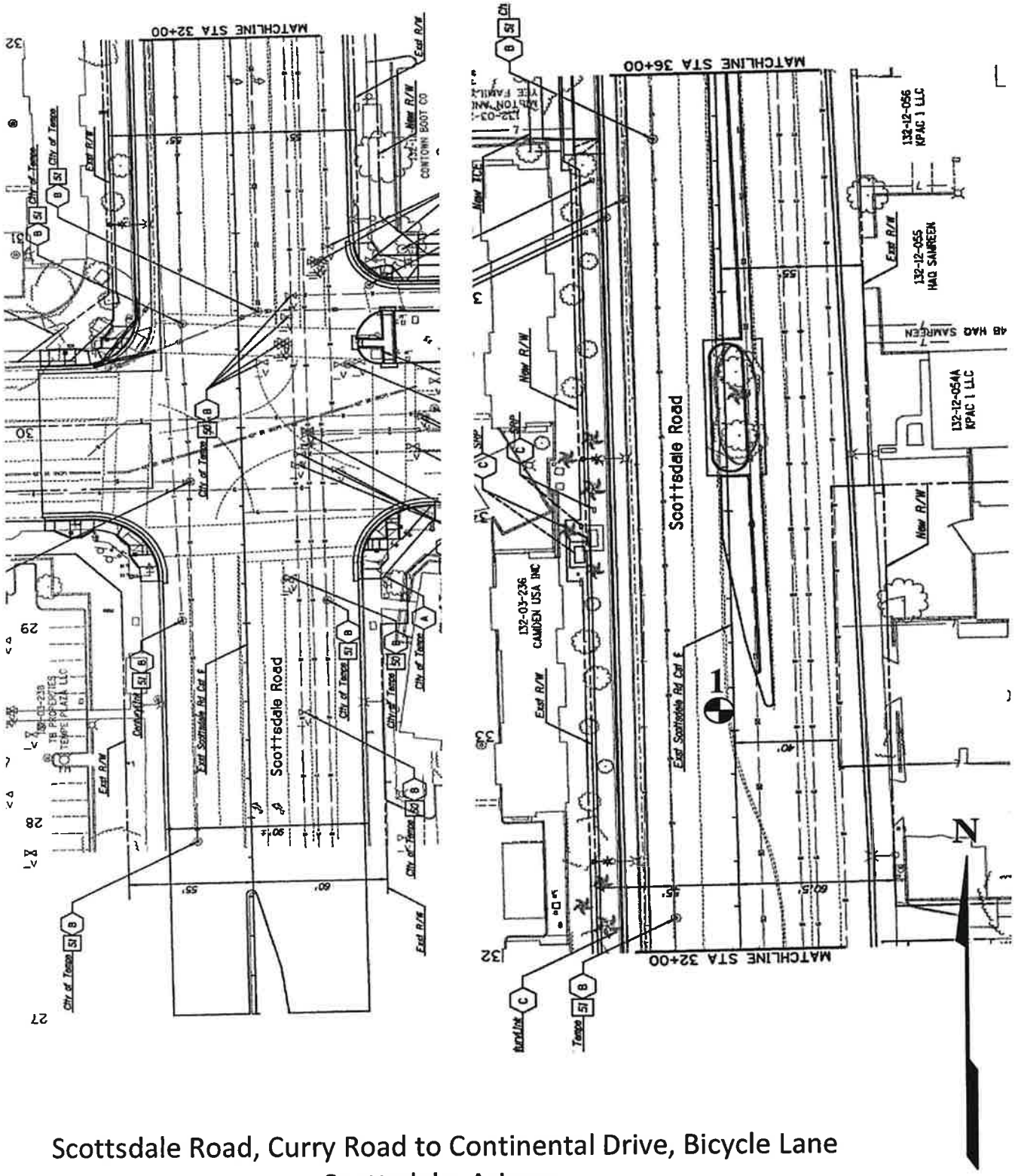
This report is an instrument of service of Ricker, Atkinson, McBee, Morman & Associates, Inc. (RAMM). The report has been prepared for the exclusive use of *NFra, Inc. and their assignees* for the specific application to the *Scottsdale Road: Curry Road to Continental Drive*. RAMM has employed commonly accepted geotechnical engineering, engineering geologic (if applicable) and hydrogeologic (if applicable) procedures, and our opinions and conclusions are made in accordance with generally accepted principles and practices of these professions common to the local area.

The contents of this report are valid as of the date of preparation. However, changes in the condition of the site can occur over time as a result of either natural processes or human activity. In

addition, advancements in the practice of geotechnical engineering, engineering geology and hydrogeology and changes in applicable practice codes may affect the validity of this report. The report's contents may not be relied upon by any other party without the express written permission of RAMM.

Although not anticipated at this site, we should note that our investigation did not include the evaluation or assessment of any potential environmental hazards or groundwater contamination that may be present. RAMM makes no warranty, either expressed or implied.

APPENDIX A
FIELD EXPLORATIONS



Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

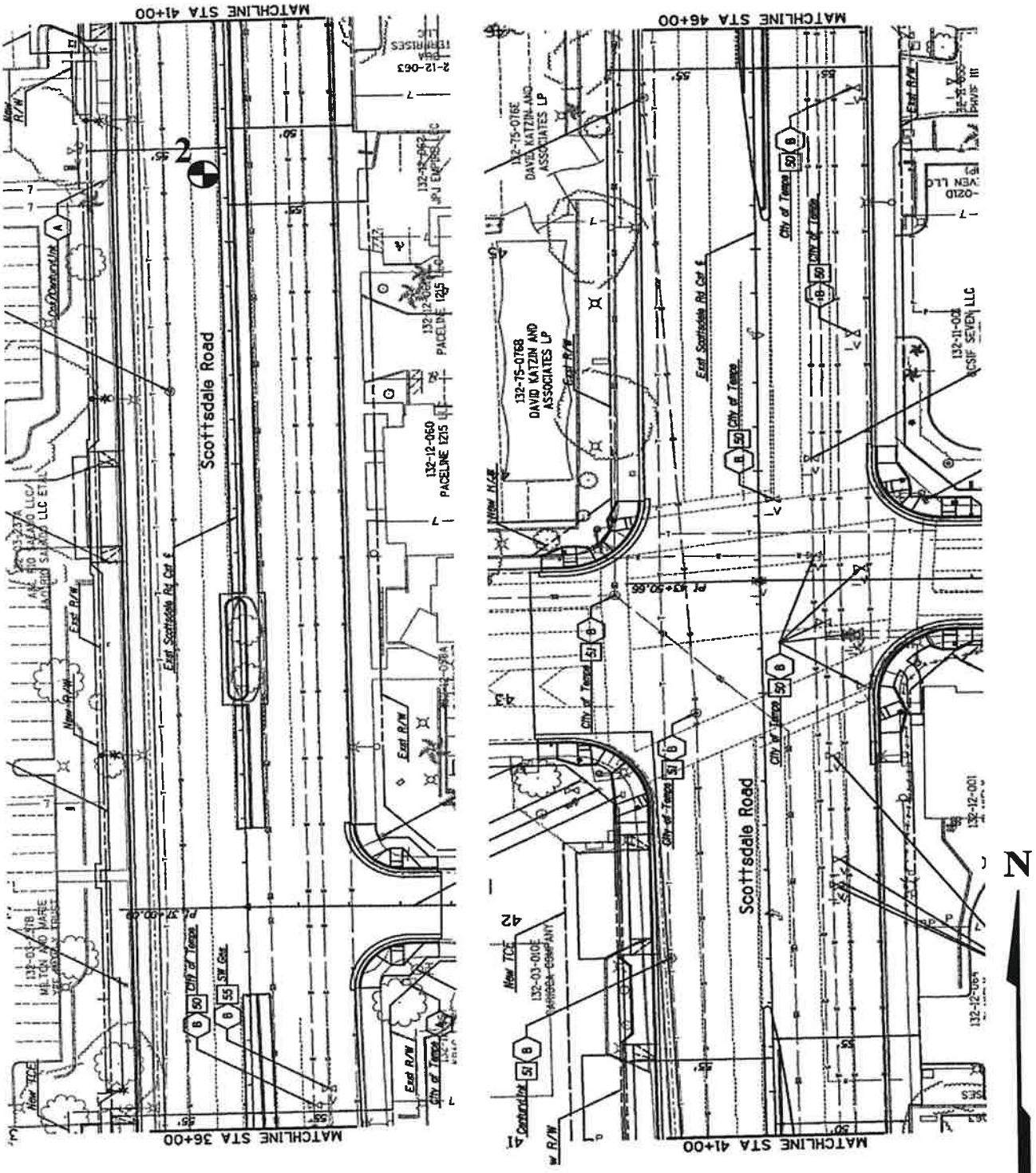
Test Boring Location

Not To Scale

SITE PLAN

RAMM Project No. G27138

A1-1

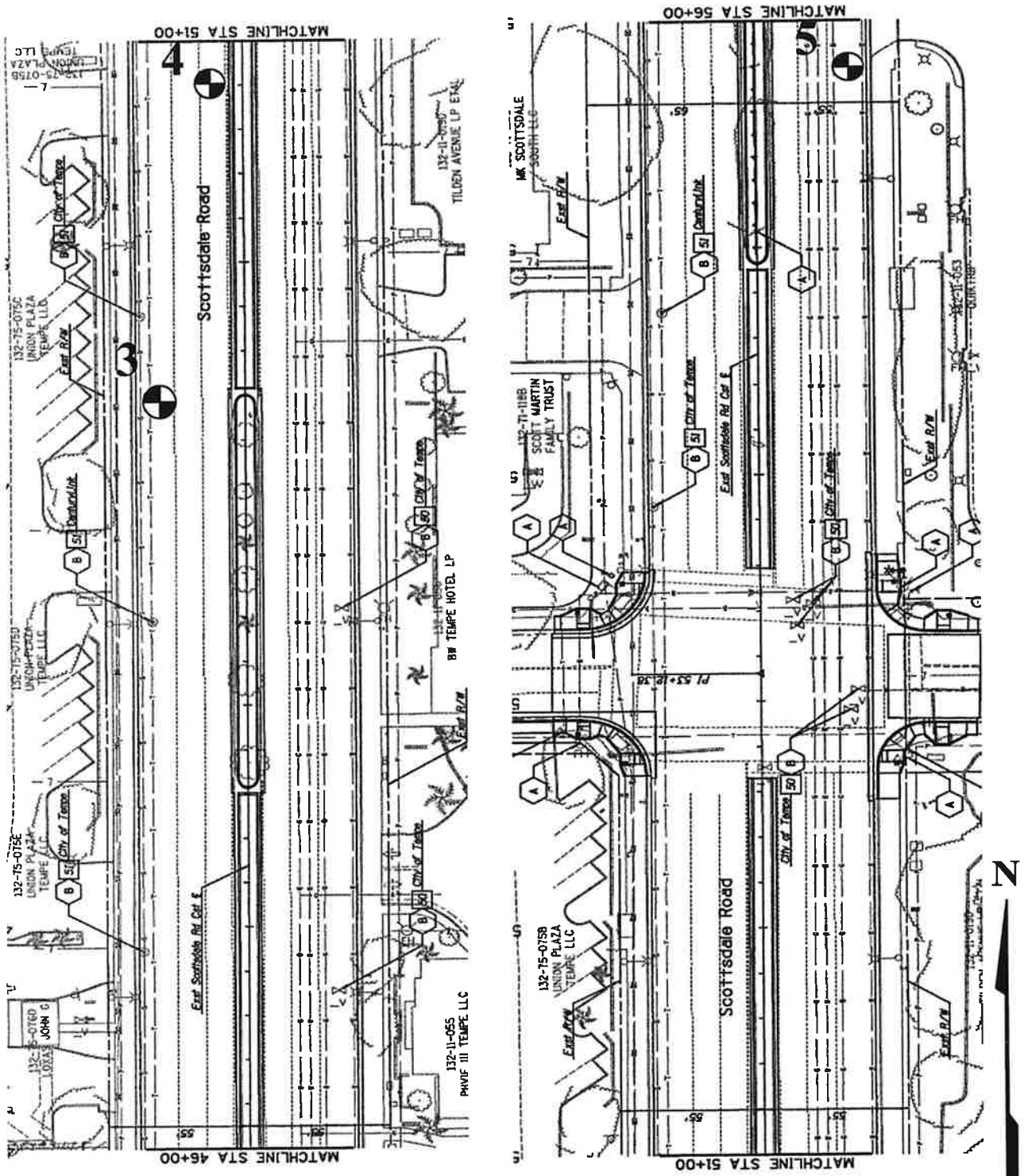


Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

Test Boring Location

Not To Scale

SITE PLAN

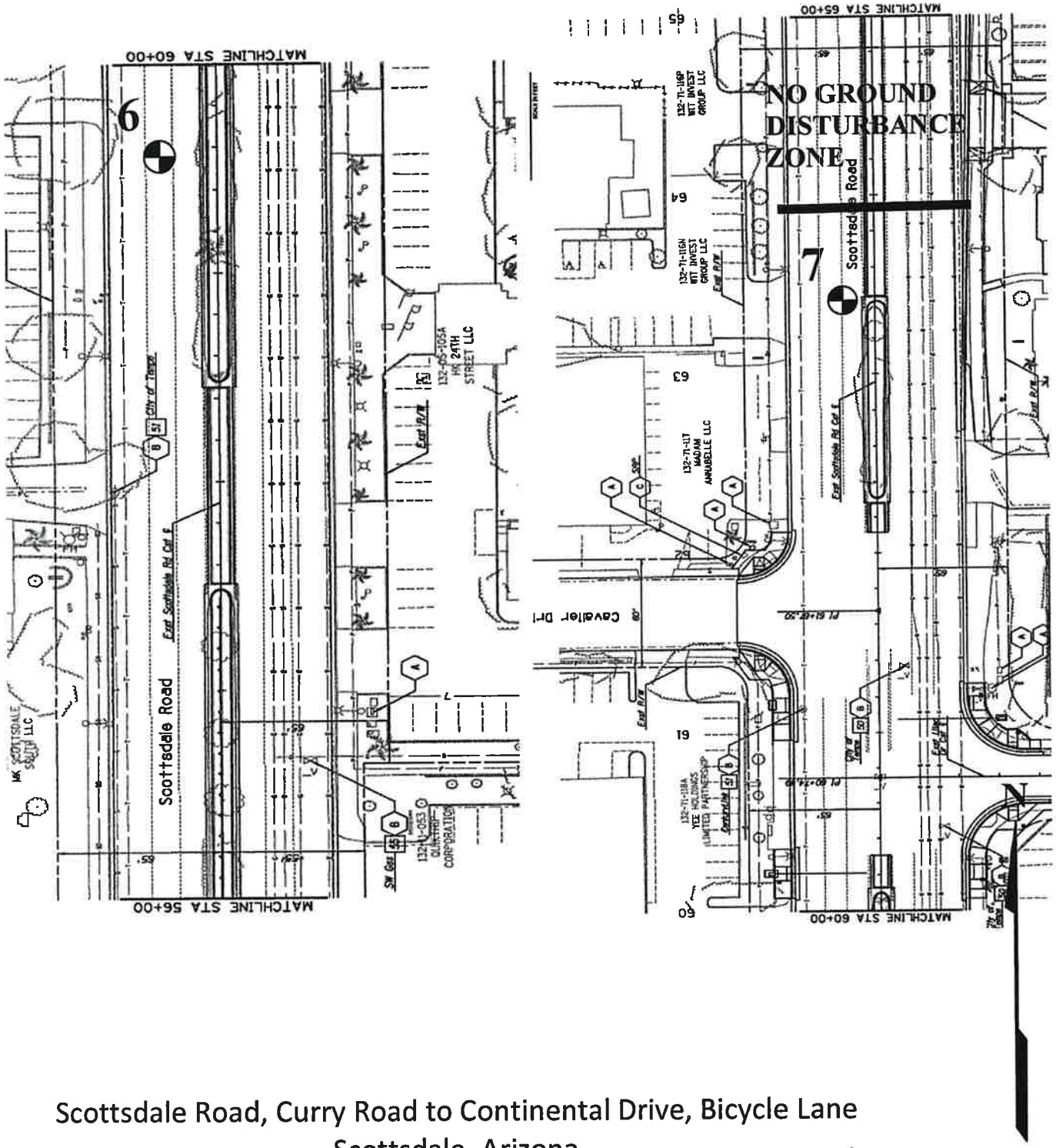


Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

Test Boring Location

Not To Scale

SITE PLAN

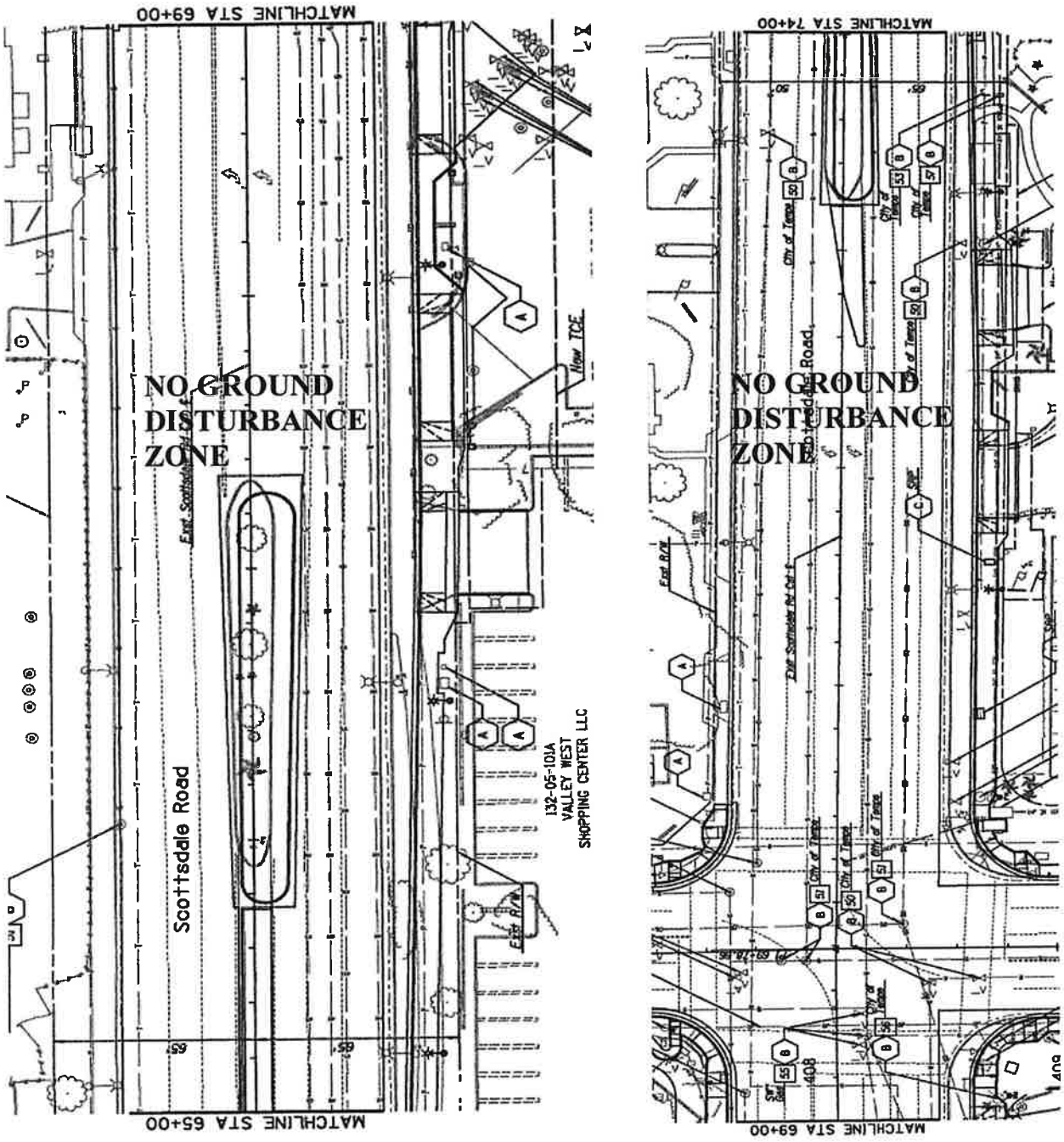


Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

Test Boring Location

Not To Scale

SITE PLAN

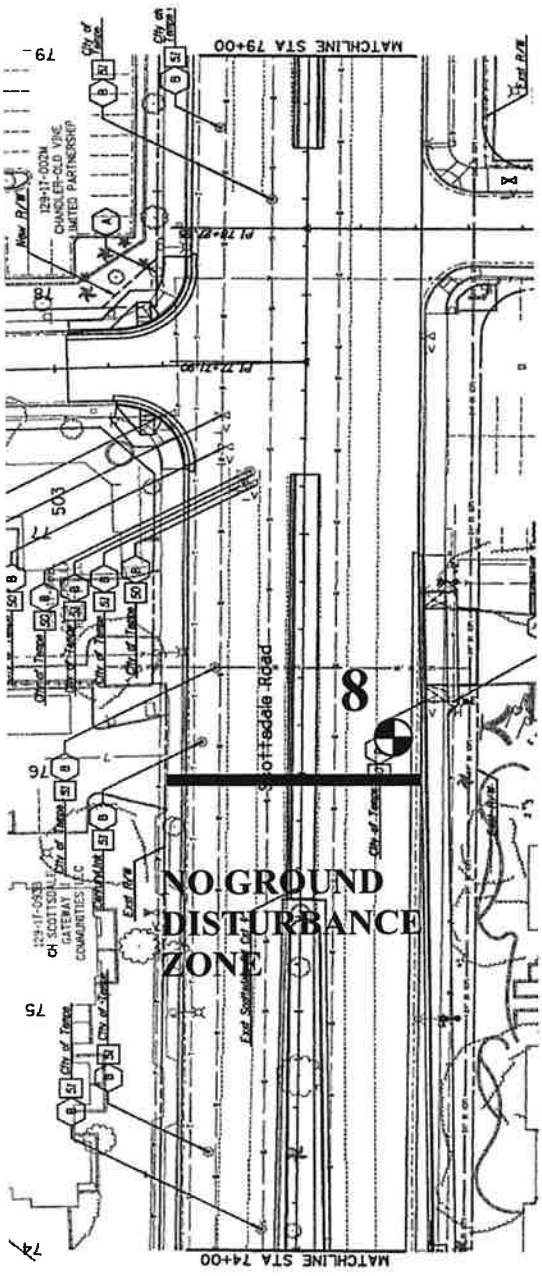


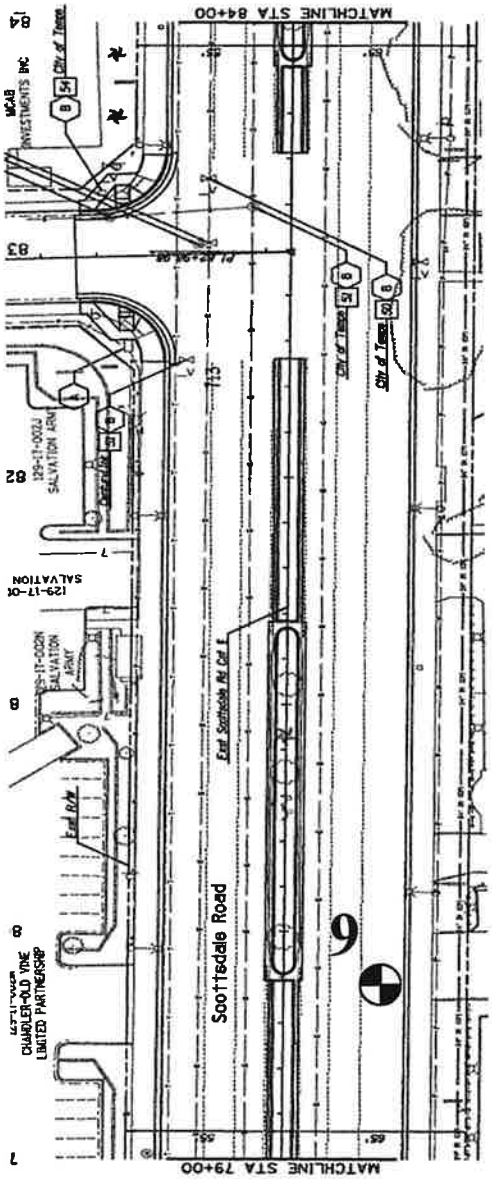
Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

Test Boring Location

Not To Scale

SITE PLAN





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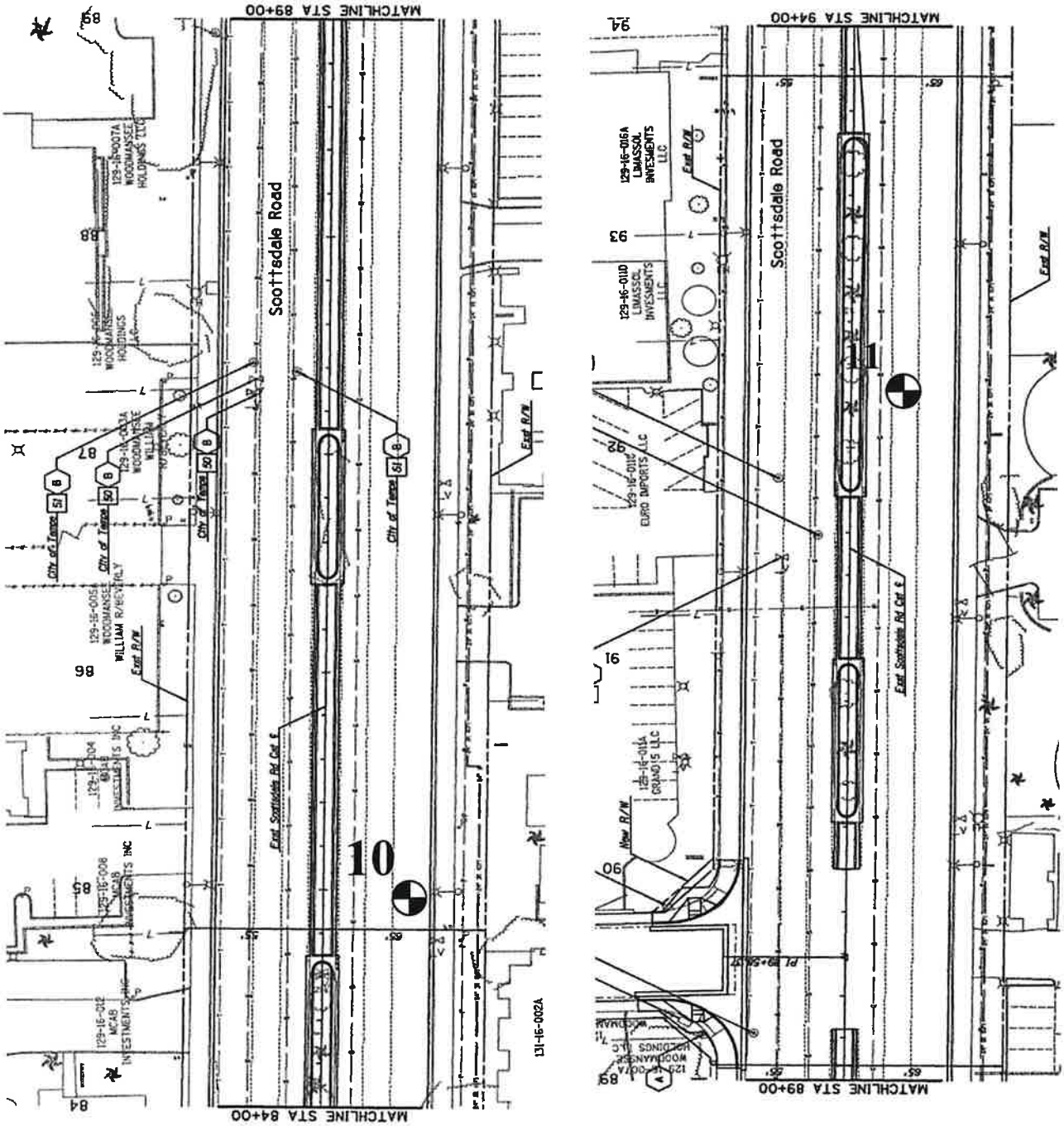
Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

Test Boring Location

Not To Scale

SITE PLAN



Scottsdale Road, Curry Road to Continental Drive, Bicycle Lane
Scottsdale, Arizona

Test Boring Location

Not To Scale

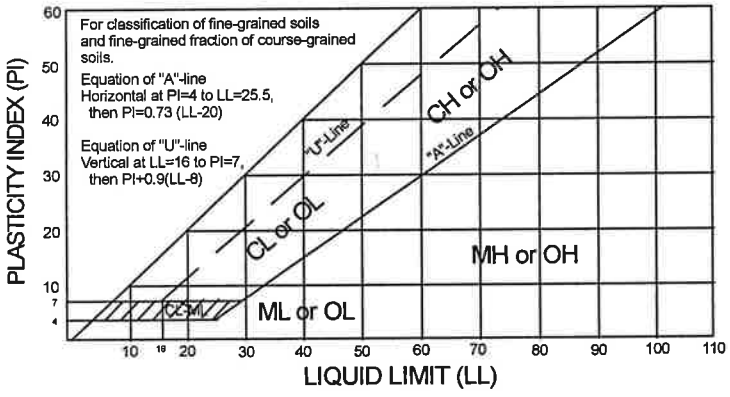
SITE PLAN

LEGEND

CLASSIFICATION OF SOILS

ASTM Designation: D2487-11
(Based on Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests					Soil Classification: Group Symbol	Soil Classification: Name
COARSE-GRAINED SOILS More than 50% retained on No. 200 Sieve	Gravels More than 50% coarse fraction retained on No. 4 Sieve	Clean Gravels Less than 5% fines	Cu > 4 and 1 <Cc <3		GW	Well graded gravel
			Cu<4 and/or 1>Cc>3		GP	Poorly graded gravel
		Gravels with Fines More than 12% fines	Fines classify as ML or MH		GM	Silty gravel
			Fines classify as CL or CH		GC	Clayey gravel
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	Cu > 6 and 1 <Cc <3		SW	Well-graded sand
			Cu<6 and/or 1>Cc>3		SP	Poorly graded sand
		Sands with Fines More than 12% fines	Fines classify as ML or MH		SM	Silty sand
			Fines classify as CL or CH		SC	Clayey sand
FINE-GRAINED SOILS 50% or more passes the No. 200 Sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI>7 and plots on or above "A" line		CL	Lean clay
			PI<4 or plots below "A" line		ML	Silt
		Organic	Liquid Limit - oven dried / Liquid limit - not dried	<0.75	OL	Organic clay / Organic silt
	Silts and Clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line		CH	Fat clay
			PI plots below "A" line		MH	Elastic silt
		Organic	Liquid limit - oven dried / Liquid limit - not dried	<0.75	OH	Organic clay / Organic silt
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor				PT	Peat



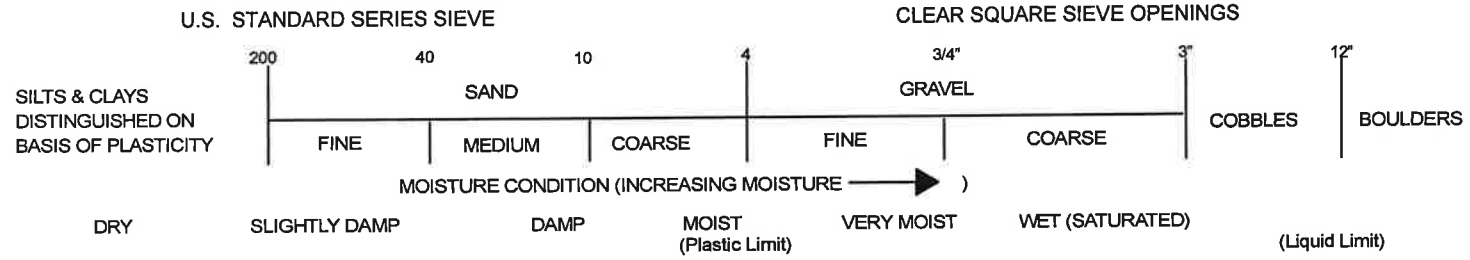
TEST BORING LOG DEFINITIONS

Blows per foot using 140 pound hammer with 30 inch free-fall.

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density pcf	Water Content %	Unified Classification	Description

C = Continuous Penetration Resistance (2 inch diameter rod)
N = Standard Penetration Resistance (ASTM D1586)
R = Penetration Resistance (3 inch diameter ring line sampler)

GRAIN SIZES



CONSISTENCY CORRELATION		RELATIVE DENSITY CORRELATION	
CLAYS & SILTS	BLOWS/FOOT*	SANDS & GRAVELS	BLOWS/FOOT*
VERY SOFT	0-2	VERY LOOSE	0-4
SOFT	2-4	LOOSE	4-10
FIRM	4-8	MEDIUM DENSE	10-30
STIFF	8-16	DENSE	30-50
VERY STIFF	16-32	VERY DENSE	OVER 50
HARD	OVER 32		

*Number of blows of 140 lb hammer falling 30" to drive a 2" O.D. (1-3/8" I.D.) split-spoon sampler (ASTM D1586).

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 1

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 9.0" Base Course.
		15	R	103	18	ML	Sandy Silt, Trace Gravel; brown, very damp, firm to stiff, non-plastic.
5		15	R	102	17		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 2

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							4.5" Asphalt Concrete on 9.0" Base Course.
		6	R	97	13	SM	Silty Sand, Some Gravel; brown, very damp, loose, non-plastic fines.
5		7	R	100	12		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 3

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							4.0" Asphalt Concrete on 12.0" Base Course.
		12	R	111	9	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5		7	R	108	9		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 4

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							4.0" Asphalt Concrete on 11.0" Base Course.
		10	R	115	7	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5		8	R	104	5		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 5

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.5" Asphalt Concrete on 8.0" Base Course.
		13	R	106	19	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5		10	R	108	11	CL	Sandy Clay, Trace to Some Gravel; brown, damp to very damp, firm to stiff, medium plasticity.
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 6

Elevation: Not Determined Datum: --- Date: 1/26/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 10.0" Base Course.
		7	R	94	18	CL	Sandy Clay, Trace to Some Gravel; brown, damp to very damp, firm to stiff, medium plasticity.
5		12	R	98	9		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 7

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 10.0" Base Course.
		14	R	106	14	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5							Medium dense to dense below 4.0 feet.
		38	R	105	9		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 8

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 12.0" Base Course.
		19	R	123	13	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5							Medium dense to dense below 4.0 feet.
		45	R	121	9		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 9

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 8.0" Base Course.
		26	R	114	7	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5							Medium dense to dense below 3.5 feet.
		46	R	122	11		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 10

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 10.0" Base Course.
		42	R	118	11	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, medium dense to dense, medium plasticity fines.
5		46	R	117	6		
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

TEST BORING LOG

Project: Scottsdale Road Improvements, Tempe, Arizona Test Boring: 11

Elevation: Not Determined Datum: --- Date: 1/25/23

Depth, feet	Blows/Foot C	Blows/Foot N/R	Sample Type	Dry Density, pcf	Water Content, %	Unified Classification	Description
							5.0" Asphalt Concrete on 10.0" Base Course.
		8	R	109	14	SC	Clayey Sand, Trace to Some Gravel; brown, damp to very damp, loose to medium dense, medium plasticity fines.
5		45	R	110	10		Medium dense to dense below 3.5 feet.
							Stopped drilling at 6.0 feet. No groundwater observed.
10							
15							
20							
25							

This boring log represents the conditions encountered on the date of drilling at this particular location. No other warranty is expressed or implied to the actual conditions which may exist within the vicinity of this boring location.

APPENDIX B
LABORATORY ANALYSIS

R·A·M·M

LABORATORY TEST RESULTS

Date: 15-Mar-23

SAMPLE SOURCE: As noted below

TESTING PERFORMED: Percent Passing No. 200 Sieve, Atterberg Limits, Percent Expansion (ASTM D1140, D4318, D4546)

SAMPLED BY: RAMM/Olson

RESULTS:

Sample Source	Percent Retained No. 4 Sieve	Percent Passing No. 200 Sieve	Liquid Limit	Plasticity Index	Percent Expansion*	Remolded Dry Density (pcf)	Remolded Moisture Content (%)
1 @ 0'-3'	6	67	N/A	Non-Plastic			
2 @ 0'-3'	17	45	N/A	Non-Plastic			
3 @ 0'-3'	18	37	29	14			
4 @ 0'-3'	21	29	26	7			
5 @ 0'-3'	19	36	44	11			
6 @ 0'-3'	7	66	28	10			
7 @ 0'-3'	10	47	28	13			
8 @ 0'-3'	25	34	27	10	0.5	119	8
9 @ 0'-3'	15	33	31	13			
10 @ 0'-3'	6	48	38	8	0.5	117	9
11 @ 0'-3'	15	31	27	11	0.7	125	10

* Based upon sample remolded to 95% of the maximum dry density at 2% below the optimum moisture content, with a surcharge pressure of 100 psf.

LABORATORY TEST RESULTS

Date: 16-Feb-23

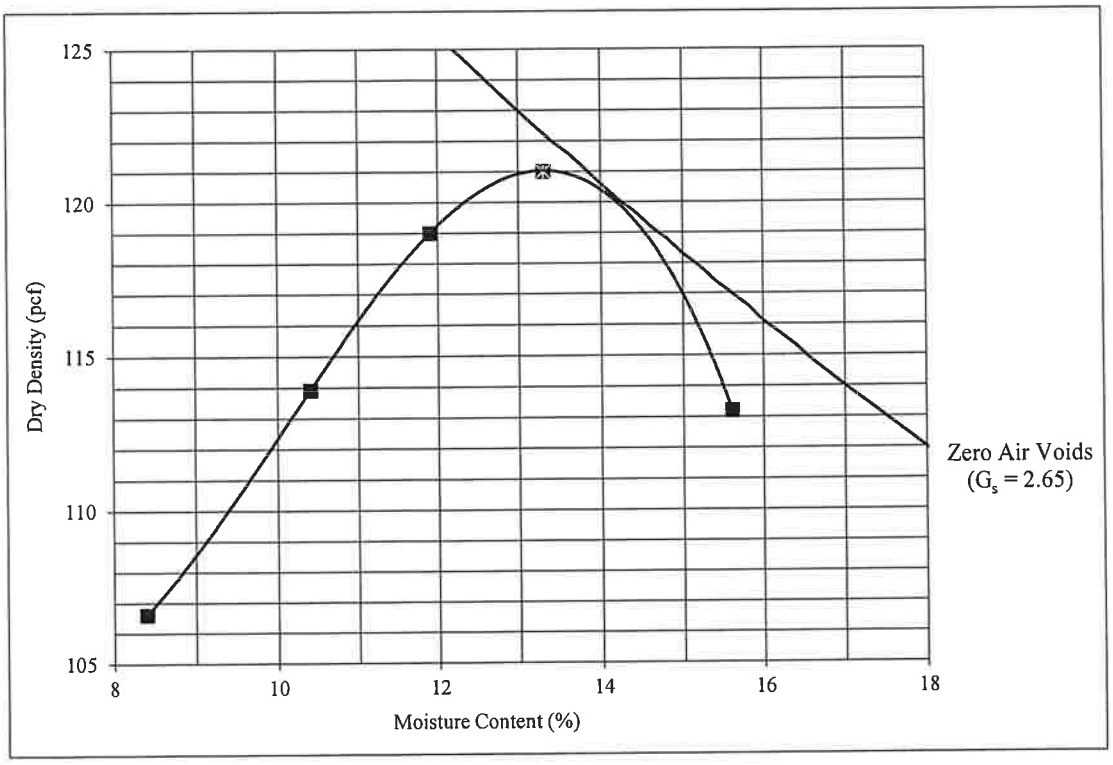
SAMPLE SOURCE: 1 @ 0'-3'

TESTING PERFORMED Maximum Density-Optimum Moisture Determination (ASTM D698 Method A)

SAMPLED BY: RAMM/Olson

RESULTS:

Maximum Density (pcf) = 121.0 Optimum Moisture (%) = 13.3



LABORATORY TEST RESULTS

Date: 16-Feb-23

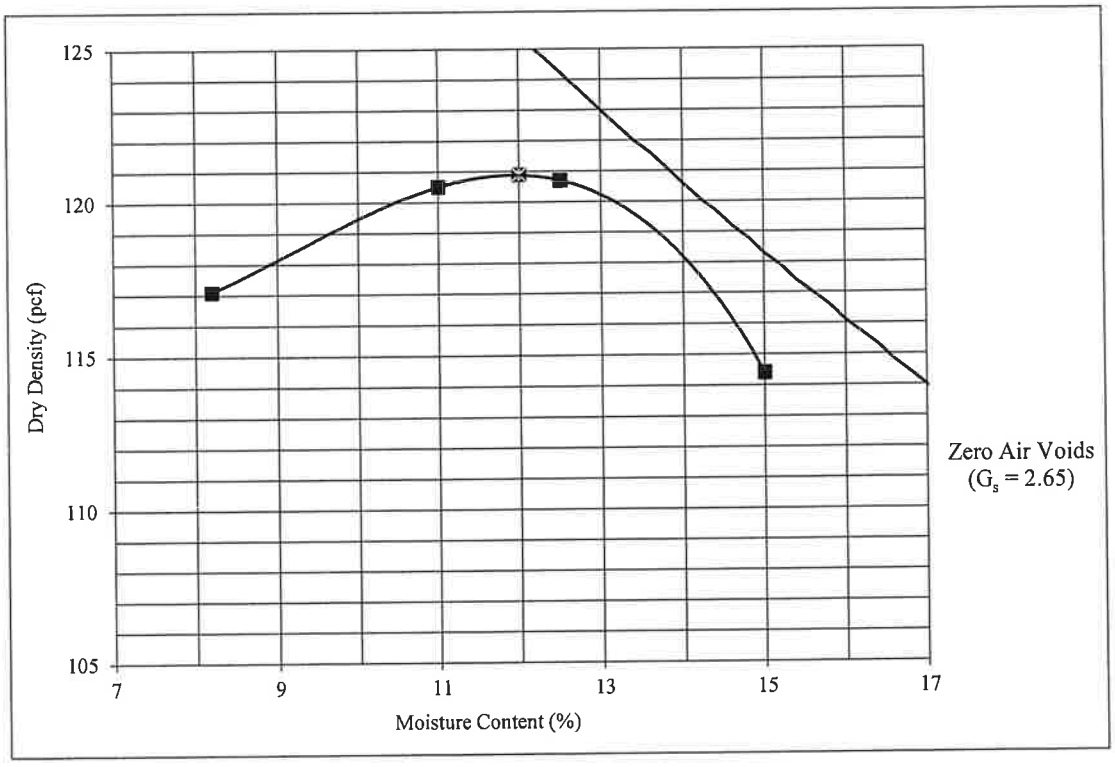
SAMPLE SOURCE: 3 @ 0'-3'

TESTING PERFORMED Maximum Density-Optimum Moisture Determination (ASTM D698 Method A)

SAMPLED BY: RAMM/Olson

RESULTS:

Maximum Density (pcf) = 120.9 Optimum Moisture (%) = 12.0



LABORATORY TEST RESULTS

Date: 16-Feb-23

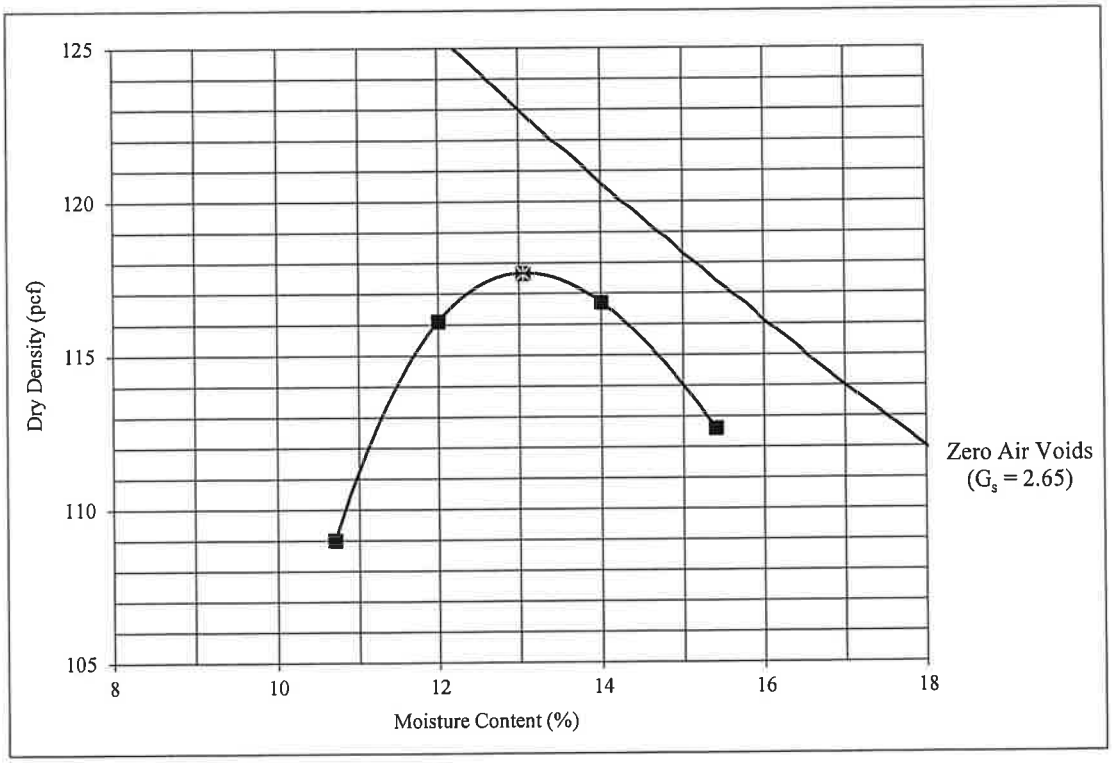
SAMPLE SOURCE: 5 @ 0'-3'

TESTING PERFORMED Maximum Density-Optimum Moisture Determination (ASTM D698 Method A)

SAMPLED BY: RAMM/Olson

RESULTS:

Maximum Density (pcf) = 117.7 Optimum Moisture (%) = 13.1



LABORATORY TEST RESULTS

Date: 16-Feb-23

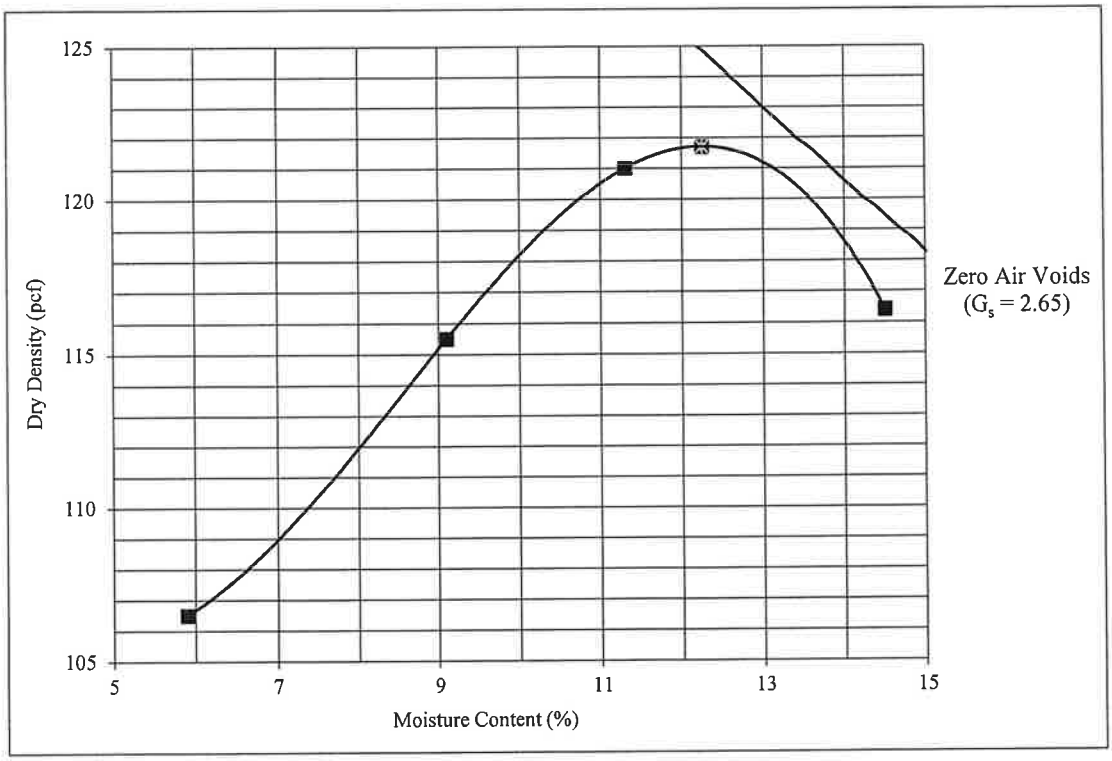
SAMPLE SOURCE: 7 @ 0'-3'

TESTING PERFORMED Maximum Density-Optimum Moisture Determination (ASTM D698 Method A)

SAMPLED BY: RAMM/Olson

RESULTS:

Maximum Density (pcf) = 121.7 Optimum Moisture (%) = 12.3



LABORATORY TEST RESULTS

Date: 16-Feb-23

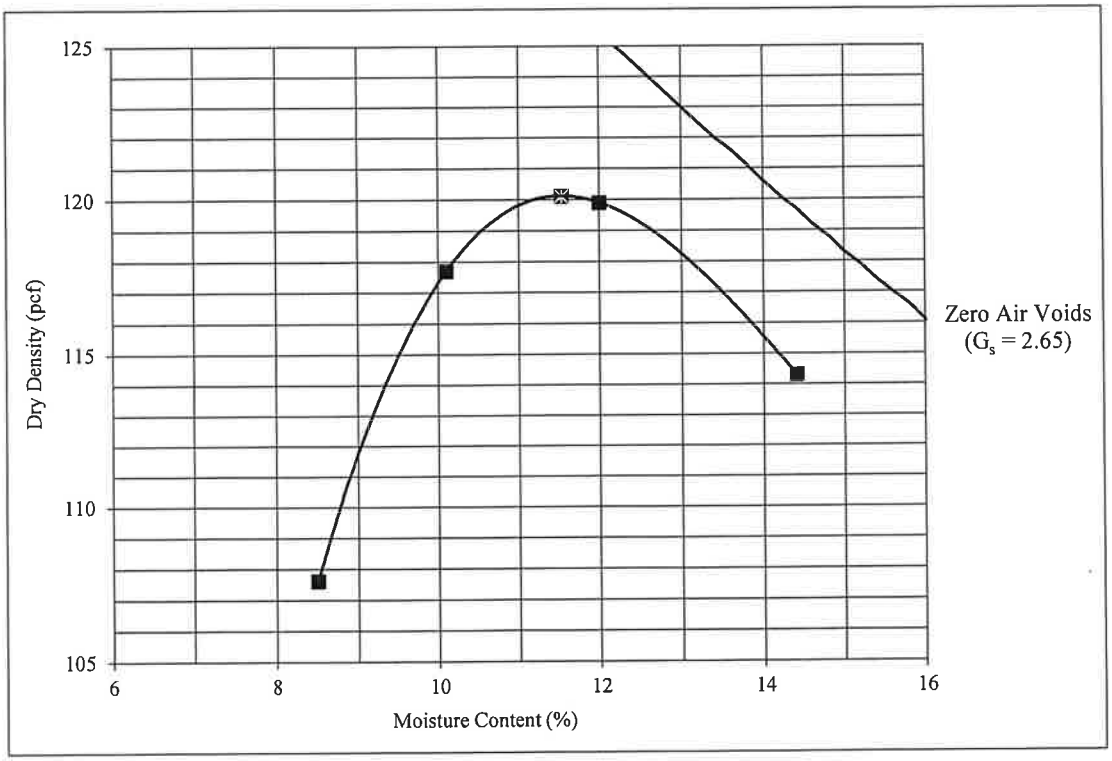
SAMPLE SOURCE: 9 @ 0'-3'

TESTING PERFORMED Maximum Density-Optimum Moisture Determination (ASTM D698 Method A)

SAMPLED BY: RAMM/Olson

RESULTS:

Maximum Density (pcf) = 120.1 Optimum Moisture (%) = 11.5



LABORATORY TEST RESULTS

Date: 16-Feb-23

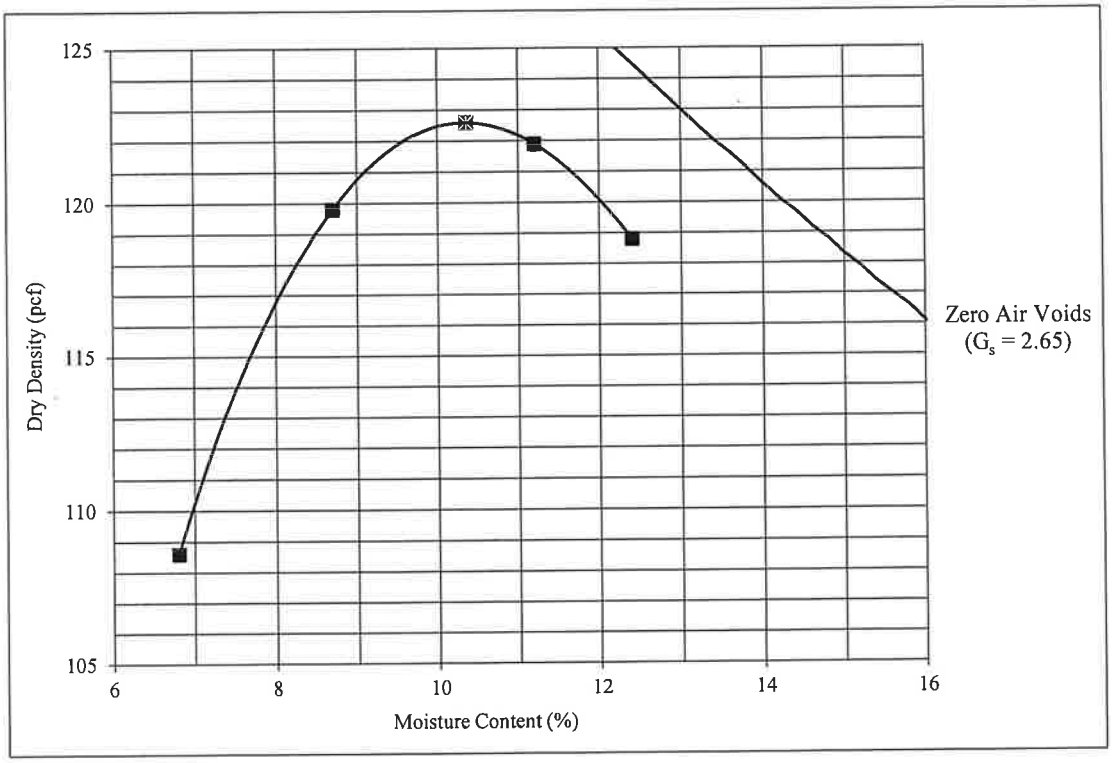
SAMPLE SOURCE: 11 @ 0'-3'

TESTING PERFORMED Maximum Density-Optimum Moisture Determination (ASTM D698 Method A)

SAMPLED BY: RAMM/Olson

RESULTS:

Maximum Density (pcf) = 122.6 Optimum Moisture (%) = 10.4



LABORATORY TEST RESULTS

Date: 16-Feb-23

SAMPLE SOURCE: As noted below

TESTING PERFORMED: pH, Minimum Resistivity (ADOT 236a)

SAMPLED BY: RAMM/Olson

RESULTS:

Sample Source	pH	Minimum Resistivity (ohm-cm)
2 @ 3'-5'	8.4	3293
6 @ 3'-5'	8.4	2495
10 @ 3'-5'	8.4	3082

LABORATORY SERVICES REPORT

Report Number: 65201090.0029
Service Date: 02/20/23
Report Date: 02/20/23
Task:

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

Client

Ricker Atkinson McBee Morman & Associates Inc.
Attn: Shawn Morman
2105 South Hardy Drive, Suite 13
Tempe, AZ 85282-1924

Project

R.A.M.M. On-Call Testing
In House - Terracon Tempe Lab
Tempe, AZ 85282

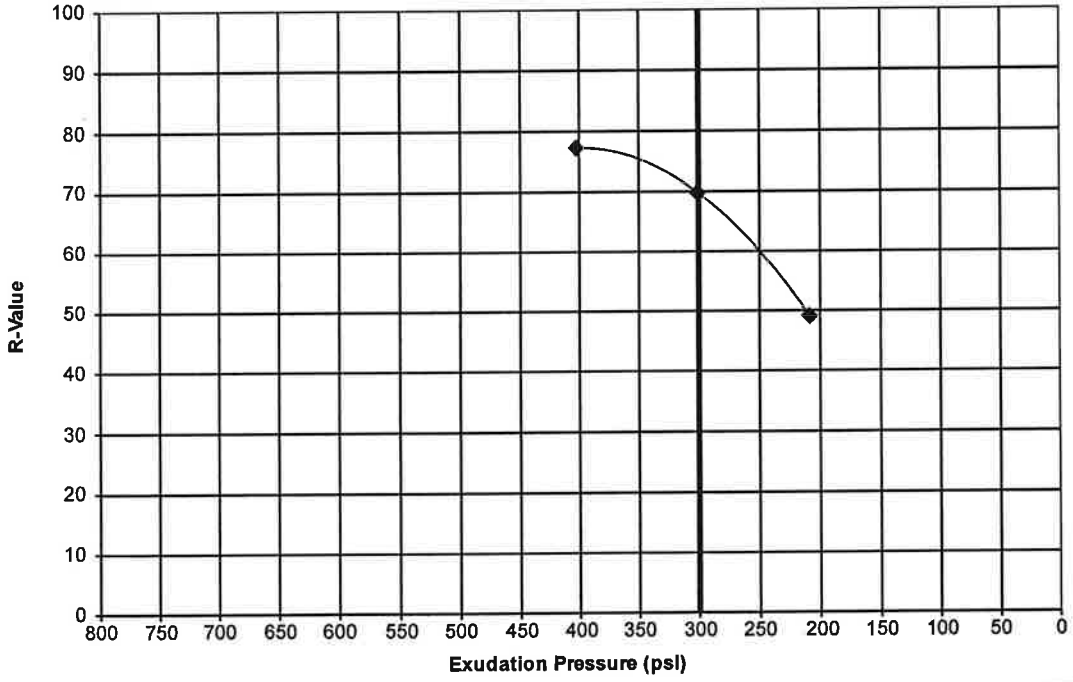
Project No. 65201090

Material Description: Sandy Silt with Clay and Gravel
Sample Location: 1@0-3'
Lab Number: 5759
Sample Source: RAMM Project# G27138

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

SPECIMEN I. D.	A	B	C
Moisture Content	11.3%	10.9%	10.4%
Compaction Pressure (psi)	225	350	350
Specimen Height (inches)	2.58	2.46	2.57
Dry Density (pcf)	125.9	131.5	126.8
Horiz. Pres. @ 1000lbs (psi)	29.0	18.0	14.0
Horiz. Pres. @ 2000lbs (psi)	58.0	33.0	26.0
Displacement	4.94	4.17	4.07
Expansion Pressure (psi)	0.0	0.1	0.1
Exudation Pressure (psi)	209	301	403
R Value	49.1	69.8	77.3

R-Value: 70



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution
(1) Ricker Atkinson McBee Morman &

Reviewed By: Michael Peters
Laboratory Supervisor

LABORATORY SERVICES REPORT

Report Number: 65201090.0029
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4685 S Ash Ave, Ste H-4
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480-897-8200

Client

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Attn: Shawn Morman
2105 South Hardy Drive, Suite 13
Tempe, AZ 85282-1924

Project

R.A.M.M. On-Call Testing
In House - Terracon Tempe Lab
Tempe, AZ 85282

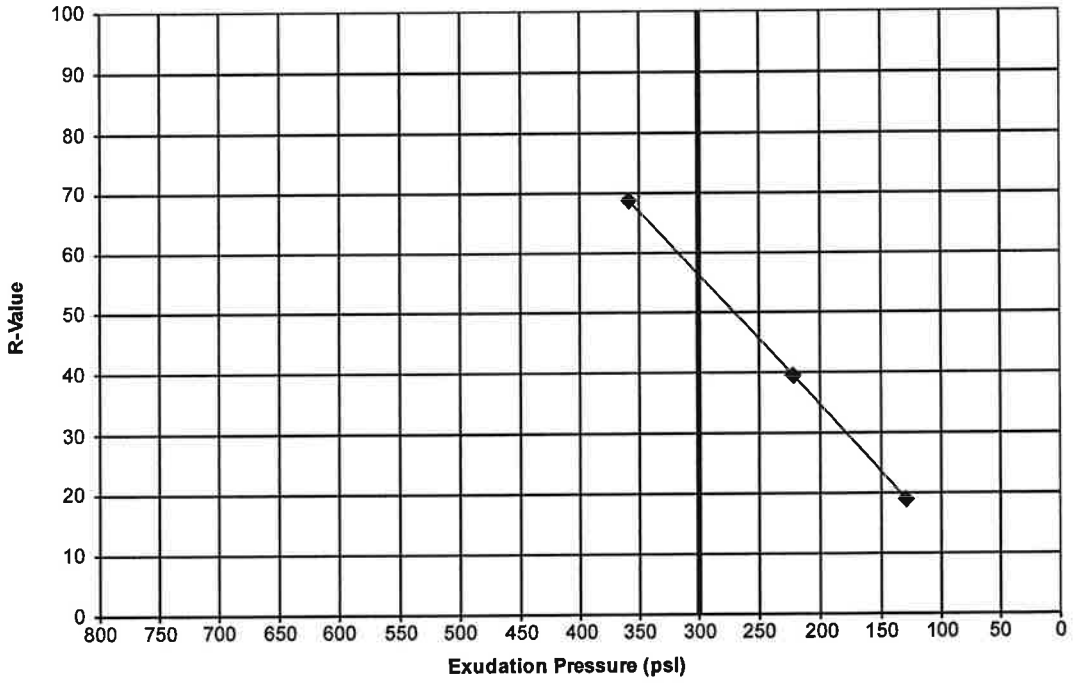
Project No. 65201090

Material Description: Sandy Clay with Gravel
Sample Location: 3@0-3'
Lab Number: 5759
Sample Source: RAMM Project# G27138

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

SPECIMEN I. D.	A	B	C
Moisture Content	9.8%	9.0%	8.1%
Compaction Pressure (psi)	75	175	350
Specimen Height (inches)	2.46	2.49	2.48
Dry Density (pcf)	131.3	133.5	134.6
Horiz. Pres. @ 1000lbs (psi)	48.0	35.0	19.0
Horiz. Pres. @ 2000lbs (psi)	118.0	81.0	39.0
Displacement	3.80	3.74	3.53
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	130	222	359
R Value	19.0	39.5	68.7

R-Value: 56



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

(1) Ricker Atkinson McBee Morman &

Reviewed By: Michael Peters
Michael Peters
Laboratory Supervisor

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480-897-8200

Client

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Tempe, AZ 85282-1924

Project

R.A.M.M. On-Call Testing
In House - Terracon Tempe Lab
Tempe, AZ 85282

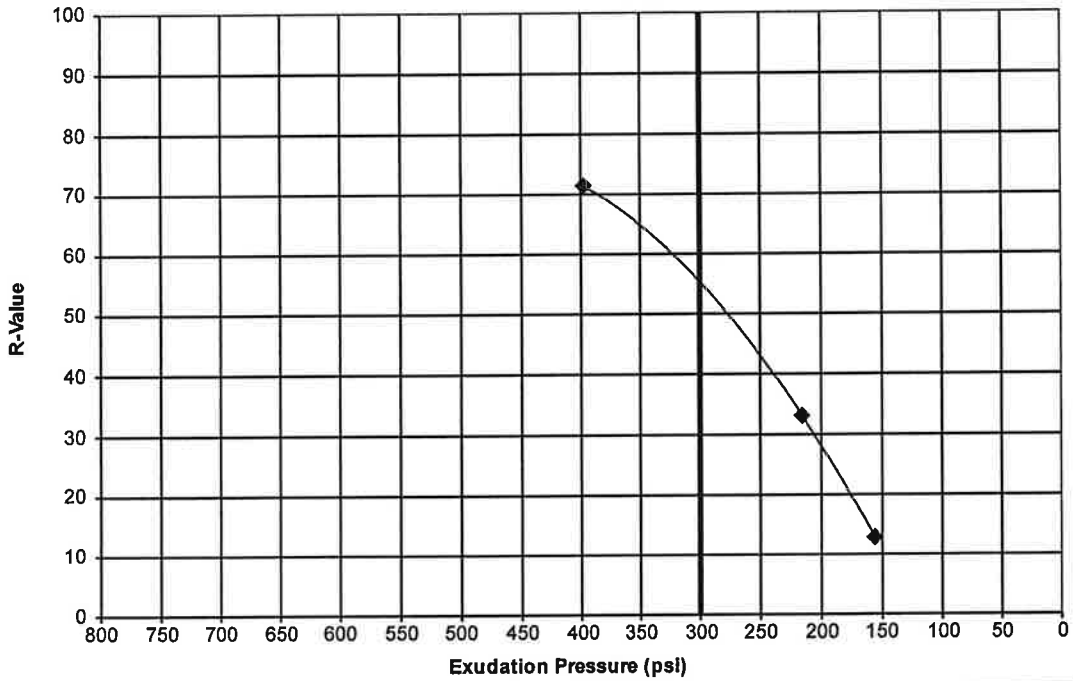
Project No. 65201090

Material Description: Sandy Clayey Silt
Sample Location: 5@0-3'
Lab Number: 5759 Sample Source: RAMM Project# G27138

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

SPECIMEN I. D.	A	B	C
Moisture Content	13.0%	11.3%	9.6%
Compaction Pressure (psi)	75	150	350
Specimen Height (inches)	2.61	2.56	2.51
Dry Density (pcf)	121.9	125.6	129.5
Horiz. Pres. @ 1000lbs (psi)	58.0	40.0	19.0
Horiz. Pres. @ 2000lbs (psi)	129.0	86.0	32.0
Displacement	4.52	4.61	4.00
Expansion Pressure (psi)	0.0	0.0	0.2
Exudation Pressure (psi)	157	216	398
R Value	12.9	33.1	71.4

R-Value: 55



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

(1) Ricker Atkinson McBee Morman &

Reviewed By: Michael Peters
Laboratory Supervisor

LABORATORY SERVICES REPORT

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Report Date: 02/20/23
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4685 S Ash Ave, Ste H-4
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480-897-8200

Client

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Tempe, AZ 85282-1924

Project

R.A.M.M. On-Call Testing
In House - Terracon Tempe Lab
Tempe, AZ 85282

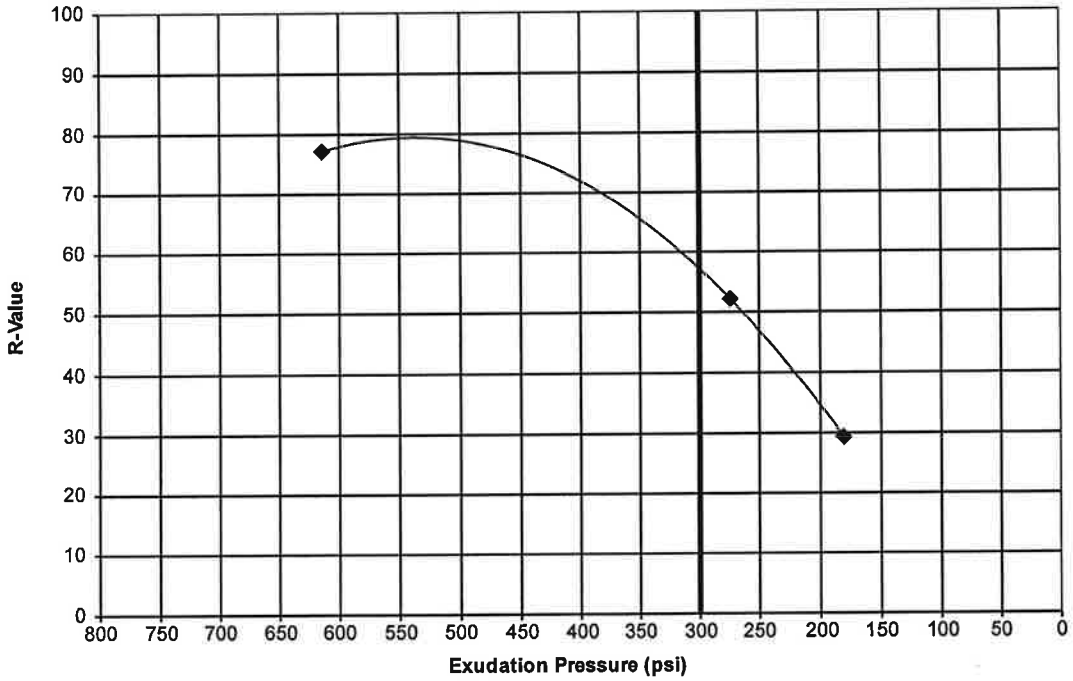
Project No. 65201090

Material Description: Clayey Silty Sand with Gravel
Sample Location: 8@0-3'
Lab Number: 5759 Sample Source: RAMM Project# G27138

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

SPECIMEN I. D.	A	B	C
Moisture Content	9.1%	8.3%	7.4%
Compaction Pressure (psi)	100	200	350
Specimen Height (inches)	2.49	2.51	2.54
Dry Density (pcf)	132.3	133.0	133.9
Horiz. Pres. @ 1000lbs (psi)	40.0	32.0	14.0
Horiz. Pres. @ 2000lbs (psi)	90.0	56.0	24.0
Displacement	4.68	4.26	4.20
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	181	274	614
R Value	29.4	52.2	77.1

R-Value: 57



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

(1) Ricker Atkinson McBee Morman &

Reviewed By: Michael Peters
Laboratory Supervisor

LABORATORY SERVICES REPORT

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Report Date: 02/20/23
Task:

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

Client

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Attn: Shawn Morman
2105 South Hardy Drive, Suite 13
Tempe, AZ 85282-1924

Project

R.A.M.M. On-Call Testing
In House - Terracon Tempe Lab
Tempe, AZ 85282

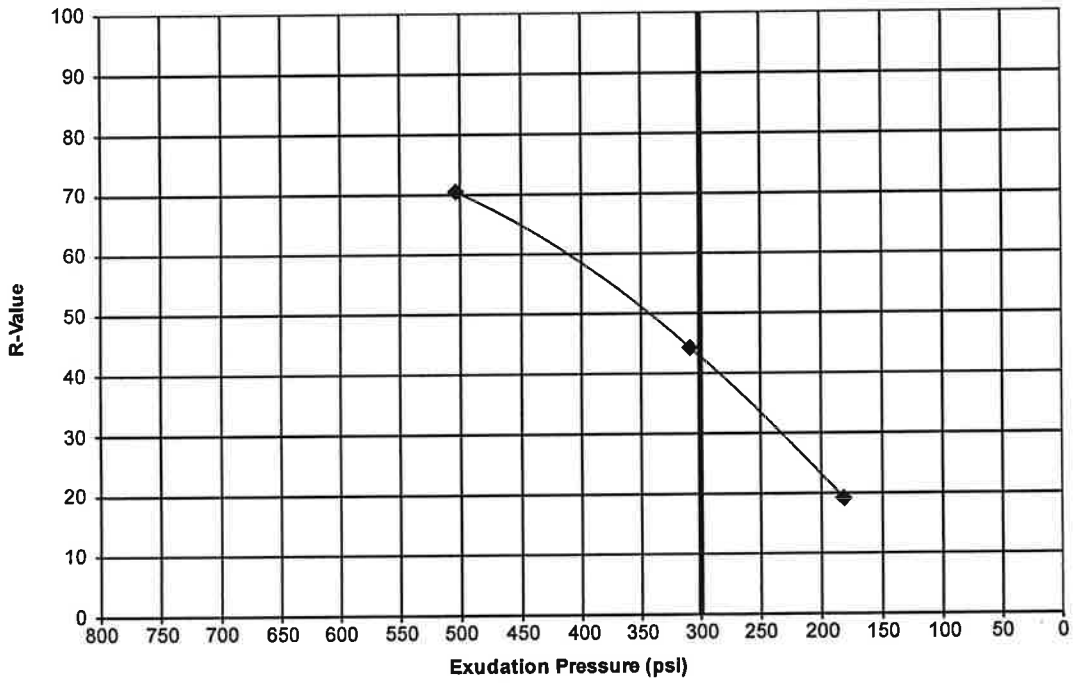
Project No. 65201090

Material Description: Silty Clayey Sand
Sample Location: 10@0-3'
Lab Number: 5759
Sample Source: RAMM Project# G27138

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

SPECIMEN I. D.	A	B	C
Moisture Content	10.3%	9.4%	8.6%
Compaction Pressure (psi)	*	175	350
Specimen Height (inches)	2.51	2.46	2.50
Dry Density (pcf)	130.1	132.3	133.5
Horiz. Pres. @ 1000lbs (psi)	49.0	31.0	19.0
Horiz. Pres. @ 2000lbs (psi)	116.0	72.0	41.0
Displacement	4.00	3.84	3.04
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	182	309	504
R Value	19.2	44.3	70.5

R-Value: 43



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution
(1) Ricker Atkinson McBee Morman &

Reviewed By: Michael Peters
Michael Peters
Laboratory Supervisor

LABORATORY SERVICES REPORT

Report Number: 65201090.0029
Service Date: 02/20/23
Report Date: 02/20/23
Task:

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

Client

Ricker Atkinson McBee Morman & Associates Inc.
Attn: Shawn Morman
2105 South Hardy Drive, Suite 13
Tempe, AZ 85282-1924

Project

R.A.M.M. On-Call Testing
In House - Terracon Tempe Lab
Tempe, AZ 85282

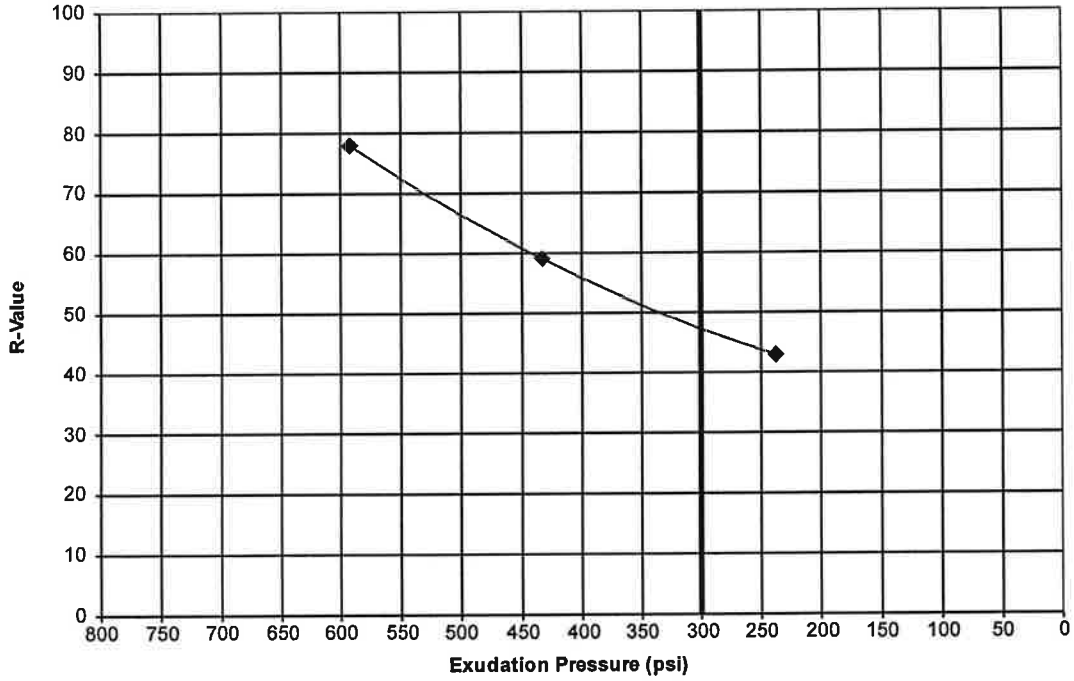
Project No. 65201090

Material Description: Sandy Clayey Silt
Sample Location: 11@0-3'
Lab Number: 5759
Sample Source: RAMM Project# G27138

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

SPECIMEN I. D.	A	B	C
Moisture Content	9.6%	9.2%	8.8%
Compaction Pressure (psi)	125	275	350
Specimen Height (inches)	2.50	2.48	2.50
Dry Density (pcf)	131.4	132.8	132.4
Horiz. Pres. @ 1000lbs (psi)	33.0	23.0	12.0
Horiz. Pres. @ 2000lbs (psi)	70.0	47.0	24.0
Displacement	4.28	4.17	4.02
Expansion Pressure (psi)	0.0	0.0	0.1
Exudation Pressure (psi)	238	433	592
R Value	42.9	59.0	77.9

R-Value: 47



Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

(1) Ricker Atkinson McBee Morman &

Reviewed By: Michael Peters
Michael Peters
Laboratory Supervisor

APPENDIX C
FLEXIBLE PAVEMENT DESIGN
AND
CITY OF TEMPE
SUPPLEMENT OF M.A.G.

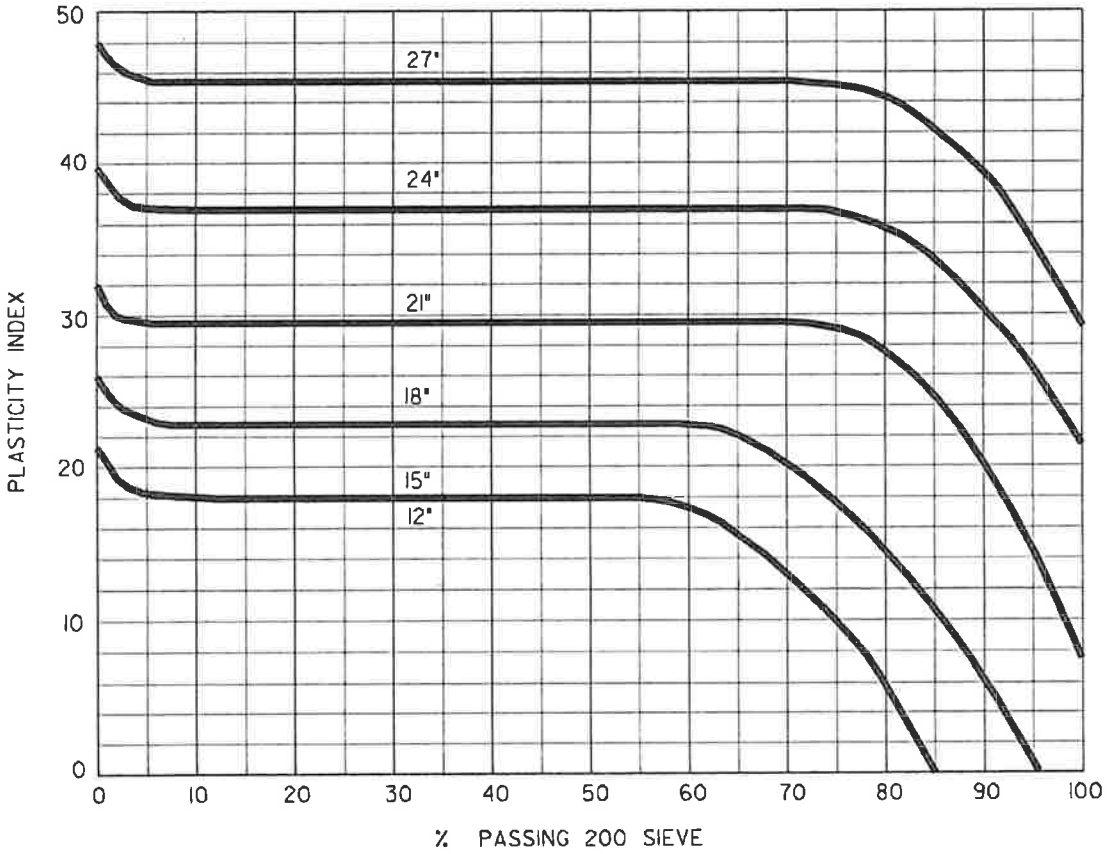
R·A·M·M

TEMPE SUPPLEMENT TO THE M.A.G. UNIFORM STANDARD DETAILS AND SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION

PUBLIC WORKS DEPARTMENT

2014
ARIZONA

The details and specifications are also accessible through our web site at www.tempe.gov/engineering

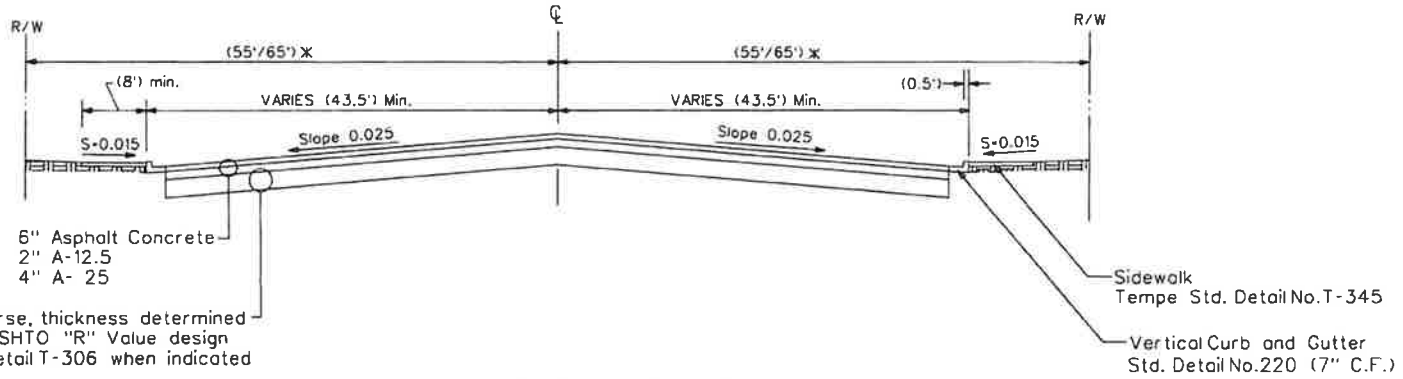


NOTES:

1. TOP 4" OF BASE SHALL BE A.B.C. BALANCE SHALL BE A.B.C. OR SELECT MATERIAL.
2. MINIMUM-DEPTH OF FLEXIBLE BASE COURSE REQUIRED UNDER 4" (MIN.) BITUMINOUS SURFACE.
3. CHART TO BE USED ONLY WHEN 'R' VALUES ARE NOT AVAILABLE.

APPROVED: Howard A. Kaiser 12/8/98
CITY ENGINEER DATE

CITY OF TEMPE PUBLIC WORKS DEPARTMENT	DEPTH OF BASE COURSE (A-1,A-2 AND HEAVY INDUSTRIAL STREETS)	DETAIL T-306 REVISED 1998



A-1 ARTERIAL STREET

* At Arterial/Arterial Intersection (+/_300' Before Curb Return.)

NOTES:

- MINIMUM LENGTH OF FULL HEIGHT CURB BETWEEN ADJACENT DRIVEWAYS IS (3').
- RESTORATION OF ANY DAMAGE PAVEMENT TO BE PLACED BY LAYDOWN MACHINE. LOCATIONS WHERE EXISTING ASPHALT-RUBBER, THE SURFACE COURSE OF THE PAVEMENT REPLACEMENT TO MATCH THE EXISTING TYPE: ASPHALT RUBBER HOT MIX, ARAC, ULTRATHIN BONDED WEARING COURSE, OR AS DIRECTED BY THE CITY ENGINEER.
- ALL JOINTS INCLUDING THE JOINT BETWEEN ANY CONCRETE NEED TO BE CRACK SEALED WITH A HOT APPLIED RUBBERIZED ASPHALT SEALANT SUCH AS POLYFLEX 3 BY CRAFCO OR APPROVED EQUAL.
- USE OF STEEL PLATES WILL NOT EXCEED SEVENTY-TWO (72) HOURS. PRIOR TO FINAL PATCH. PER MAG DETAIL NO. 211.

APPROVED: Andrea 6/11/10
DEPUTY PUBLIC WORKS MANAGER / CITY ENGINEER — DATE

CITY OF TEMPE PUBLIC WORKS DEPARTMENT	ARTERIAL STREET CROSS-SECTION. (A-1)	DETAIL T-313 REVISED 4,2010

Flexible Pavement Design

DESIGN FOR:	*Scottsdale Road, Continental Drive to Curry Road*	
PROJECT NO.: G27138		17-Mar-23
1. Traffic & Highway Data-		
18-kip Equivalent Single Axle Load Applications:	15,104,576	Design
THA Highway Class (1,2,3,4,5):	3	Comments
2. Project Design Criteria-		
Initial Design Serviceability - Po:	4.1	
Design Serviceability - Pt:	2.6	
Pavement Material Coefficients:		
a. Asphalt Concrete (0.44 max.):	0.44	
b. CTB or BTB (0.28 max.):	0	
c. Cement/Lime treated subgrade (0.23 max):	0	
d. Aggregate Base (0.14 max.):	0.14	
e. Aggregate Subbase (0.11 max.):	0	
3. Drainage Characteristics:		
Excellent(1); Good (2); Fair (3); Poor (4); Very Poor (5)		
a. Base Course:	3	
b. Subbase Course - Layer 1:	0	
c. Subbase Course - Layer 2:	0	
4. Location:	Tempe	
5. Calculation Section:		
SVF =	1	
Zr =	-1.282	
Index Ret. Strength =	40	
So =	0.45	
Quality of Drainage		
Base Course (m2)	1	
Subbase Course-1 (m3)	Not Used	
Subbase Course-2 (m3)	Not Used	
R-mean =	48	
Resilient Modulus =	26000	Max. Allow.
Structural Number		
SN	3.46	
RHS =	7.179	
LHS =	7.179	
Minimum SN =	4.32	
Minimum Pavement Thickness =	6	
Actual SN =	4.320	Use minimum