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REPORT FOR
GEOTECHNICAL ENGINEERING SERVICES
83RD AVENUE ROADWAY IMPROVEMENTS
NORTHERN AVENUE TO OLIVE AVENUE
MARICOPA COUNTY & PEORIA, ARIZONA

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO.
25235
TIM W.
ANDERSON
Date Signed 01/26/00
ARIZONA, U.S.A.

MAXIM
TECHNOLOGIES INC

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REPORT FOR
GEOTECHNICAL ENGINEERING SERVICES
83RD AVENUE ROADWAY IMPROVEMENTS
NORTHERN AVENUE TO OLIVE AVENUE
MARICOPA COUNTY & PEORIA, ARIZONA

Submitted To:

Mr. Mark E. Wavering, P.E.
INCA Engineers, Inc.
3800 North Central Avenue, Suite 200
Phoenix, Arizona 85012-1910

Project No. 99-11376

January 26, 2000

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MAXIM
TECHNOLOGIES INC®

Mr. Mark E. Wavering, P.E.
INCA Engineers, Inc.
3800 North Central Avenue, Suite 200
Phoenix, Arizona 85012-1910

January 26, 2000

RE: Report for Geotechnical Engineering Services
83rd Avenue Roadway Improvements
Northern Avenue to Olive Avenue
Maricopa County and Peoria, Arizona

Project No. 99-11376

Dear Mr. Wavering:

This report presents the results of the geotechnical engineering services authorized for the proposed roadway improvements along 83rd Avenue, from Northern Avenue north to Olive Avenue, in Maricopa County and the City of Peoria, Arizona.

The purpose of these services is to determine the soil conditions at the locations indicated which thereby provide a basis for the design discussions and recommendations presented herein. This firm should be notified for evaluation if conditions other than described herein are encountered during construction.

The services performed provide an evaluation at selected locations of the soils throughout the zone of significant pavement and storm drain influence. Our field services have not included exploration for underlying geologic conditions or evaluation of potential geologic hazards such as seismic activity, faulting, and ground subsidence / earth cracking potential due to groundwater withdrawal, or the presence of soil or groundwater contamination.

The recommendations presented in this report are based upon the project information received and described in "Scope" Part I. This firm should be contacted for review if the design conditions are changed substantially.

Respectfully submitted,
MAXIM TECHNOLOGIES, INC.

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
25285
TIM W.
ANDERSON
Date Signed 01/26/00
ARIZONA, U.S.A.

By:_____
Tim W. Anderson, P.E.

Copies to: Addressee (5)

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REGISTERED PROFESSIONAL ENGINEER (CIVIL)
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PART I

REPORT

MAXIM
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SCOPE

The proposed 83rd Avenue Roadway Improvements project will consist of upgrading the current 2-lane Urban Minor Arterial Roadway to a City of Peoria 5-lane section between Northern Avenue and Olive Avenue. This new roadway section will include a 4.0 meter (13-foot) edge lane with curb and gutter in both directions, a 3.7 meter (12-foot) through lane in each direction and a 4.2 meter (14-foot) two-way left turn lane that becomes a directional left turn lane at the intersections. The majority of the project will consist of complete removal and replacement of the existing pavement structure with a new pavement section. However, there is a portion of the project that will likely consist of milling the existing asphalt surfacing and installing an asphaltic concrete overlay on the milled section. With the exception of some new sidewalk ramps and sidewalks around the curb radii at all intersections, there will be no new sidewalks constructed in association with this project.

This project will also include the design and installation of storm drainage improvements. These improvements will include the construction of storm drains and enlarging drainage ditches behind the curb and gutter to accept larger flows. The proposed final outfall of the surface runoffs from 83rd Avenue will be conveyed to the existing SRP irrigation discharge ditch. It is our understanding that the size of the new storm drain pipe will range from 450 mm (18-inch) to 1650 mm (66-inch) in diameter. In addition, we are assuming that the storm drains will be constructed of concrete pipe and that the depth of cover will be greater than 1.5 meters (5 feet) for the large diameter trunk line.

SITE DESCRIPTION

The proposed 83rd Avenue Roadway Improvements project is located between Northern Avenue and Olive Avenue, in Maricopa County and Peoria, Arizona. The existing roadway currently includes one traffic lane in each direction and a left turn only lane in the center of the roadway. It is our understanding that the existing roadway is classified as a 2-lane Urban Minor Arterial Roadway.

INVESTIGATION

On January 11, 2000, representatives of Maxim Technologies, Inc. (Maxim) advanced a total of five (5) exploratory test borings within the proposed roadway improvement areas of 83rd Avenue. These test borings were advanced at approximately 400-meter (1/4 mile) intervals to depths ranging from approximately 4.3 to 6.2 meters (roughly 14 to 20.5 feet), for examination of the surface and subsurface profile along the project alignment. The locations of the test borings are shown on the Site Plan included in Appendix A of this report, entitled "Field Results".

The test borings were drilled with a CME-55 drill rig using 0.18 m (7-inch) diameter hollow-stem auger. Relatively undisturbed soil samples were obtained from the test borings by driving a 64 mm (2.42-inch) inside diameter, ring-lined soil sampler, and representative samples were obtained using a 50 mm (2.0-inch) outside diameter, standard split spoon sampler (SPT), at selected intervals. During the test drilling, the soils encountered were visually classified by this firm's field engineer, and representative soil samples were also obtained at selected depths from the auger cuttings. The complete results of the test drilling efforts are presented in Appendix A of this report.

Representative samples obtained during the test drilling were subjected to the following laboratory analyses:

Test	Sample(s)	Purpose
Sieve Analysis & Plasticity Index	Representative surface and subsurface soils (7)	Pavement design criteria and soil classification
R-Value (ASTM D2844)	Representative subgrade soil (1)	Pavement design
pH, Soluble Salts, Sulfate & Chloride	Representative subsurface soil (3)	Corrosivity of site soils to buried concrete
Dry Density and/or Moisture Content	Undisturbed (9)	In-situ density and/or moisture determination

Other than the results of the dry density and moisture content determinations, which are presented on the boring logs in Appendix A, the complete results of the laboratory testing efforts performed for this investigation are presented in Appendix B of this report, entitled "Laboratory Results".

SUBSURFACE CONDITIONS

Soil profiles at the test boring locations varied somewhat along the alignment of the proposed roadway improvements, and detailed descriptions are presented on the individual boring logs in Appendix A. Below the existing shoulder fills and pavement structure, the naturally occurring surface and near-surface soils underlying the site were found to consist of sandy clay (CL), clayey sand (SC), and clayey silty sand (SM-SC) deposits of variable low to medium plasticity. These native surface and near-surface deposits extended to depths ranging from roughly 1.5 to 2.74 meters (5 to 9 feet) and were found to have consistencies in the stiff to very stiff range (clays) and were in a medium dense to dense state (sands).

At the locations of Test Borings 1 and 4, the sandy clay surface soils were noted to be underlain by granular deposits of gravelly sand, some silt (SP-SM) and silty sand, with gravel (SM). These granular site soils were observed to be non-plastic, and were found to be in a medium dense to dense state, generally increasing with depth. In addition, this layer was noted to become dense to very dense below depths of approximately 4 to 4.3 meters (13 to 14 feet) at both test boring locations. Test Boring 4 was terminated in these granular soils at a depth of 4.34 meters (14.25 feet). At the location of Test Boring 1, these granular deposits were found to be underlain by sandy clay soils of low to medium plasticity. These deeper, finer grained soils were found to be very stiff to hard in consistency, contained variable weak calcium carbonate cementation (caliche), and extended to the total depth of exploration at this location (6.07 meters/19.9 feet).

At the locations of Test Borings 2, 3 and 5, the native surface and near-surface soils were found to be underlain by sandy silty clay (CL) deposits of variable low to medium

plasticity. These clayey soils were found to have consistencies in the very stiff to hard range, and were observed to contain variable weak to moderate cementation with nodules. Test Boring 3 was terminated in these sandy silty clay soils at a depth of roughly 4.42 meters (14.5 feet). However, at the locations of Test Borings 2 and 4, these sandy silty clay soils were found to be underlain by coarser grained deposits of clayey sand and silty sand soils at depths of 2.74 meters (9 feet) and 5.18 meters (17 feet), respectively. These deeper, sandy soils were noted to have plasticities in the nil (silty sand) to low (clayey sand) range, and were generally found to be in a dense state. Both of these test borings were terminated in these deeper, sandy soils at depths of 4.72 meters (15.5 feet) and 6.25 meters (20.5 feet), respectively.

Soil moisture conditions were found to be only somewhat variable throughout the locations and depths explored, ranging from damp to slightly damp, generally decreasing with depth. No groundwater was encountered in any of the test borings at the time of drilling.

DISCUSSION AND RECOMMENDATIONS

General: Geotechnical engineering recommendations for support of new pavements and storm drains are presented in the following sections. The recommendations presented in the following sections are based upon the results of the field and laboratory testing that are presented in Appendices A and B of this report, and our present understanding of the project details. Alternative recommendations may be possible and will be considered upon request.

As stated previously herein, the majority of the project will include the total reconstruction of the roadway with a new pavement structure, which will require the removal of the existing pavement structure that consists of asphaltic concrete, aggregate base course, and in some areas, old portland cement concrete pavement. At the present time, it is our understanding that total reconstruction is proposed between Sta. 10+070 & Sta. 10+510 and between Sta. 11+250 & Sta. 11+600. In addition, total reconstruction is also proposed for a portion of the roadway that is

located between Sta. 10+510 & Sta. 11+250. In this area, the portion of the roadway to be reconstructed will begin at roughly 1.4 meters (4.5 feet) west of the construction centerline and extend to the east edge of the pavement. The remaining (western) portion of the roadway that is located between these stations will likely include milling the existing asphalt surfacing and placing a new asphaltic concrete overlay on top of the milled section.

Flexible Pavements: Specific traffic data for use in the design of new pavement sections along 83rd Avenue from Northern Avenue to Olive Avenue were provided by the Maricopa County Department of Transportation (MCDOT). As stated previously, the new roadway section will be classified as a City of Peoria 5-lane roadway (major arterial). In 1996, MCDOT determined an Average Daily Traffic (ADT) value of 17,501 for this section of 83rd Avenue. According to the projections of the Maricopa Association of Governments (MAG), the ADT value in the year 2020 for this same section of roadway has been estimated to be 22,000. Additional design information that was provided by MCDOT (verified by INCA using HNTB's "Traffic Impact Study") include a directional distribution (D) of 39.6 percent, an assumed truck factor (T) of 5 percent, and structural coefficients of 0.44, 0.14 and 0.11 for new asphaltic concrete (AC), aggregate base course (ABC), and aggregate sub base course (Select or similar), respectively.

Utilizing the above information for the 83rd Avenue roadway, we have determined the initial, final and average ADT for use in the design of the new pavement sections at the site and they are summarized in the following tabulation:

Roadway Section	Initial ADT[1]	Final ADT[2]	Average ADT[3]
Northern Avenue to Olive Avenue	10,330	11,960	11,145

[1]Initial (year 2000) ADT for the roadway section was based on an estimated two way ADT of 19,000 and the directional distribution provided.

[2]Final (year 2020) ADT for the roadway section was based on the MAG 2020 projection and the directional distribution provided by INCA.

[3]Average ADT based on the Initial and Final ADTs for the roadway section.

Based on the average design ADT presented in the previous table, and assuming that 5 percent of the traffic that will use the new roadway will consist of medium to heavy trucks, the Equivalent 18-kip Single Axle Load (ESAL) for the roadway section was calculated and is presented in the following table:

Roadway Section	Design ESAL[1]
Northern Avenue to Olive Avenue	4,942,810

[1]Based on 5 percent medium to heavy trucks with an average Vehicle Equivalence of 1.2. Remainder of traffic assumed to be passenger cars.

Composite bulk samples of the subgrade soils underlying the existing and proposed pavement areas were retrieved from auger cuttings at each of the roadway test boring locations. Based on the results of our field and laboratory testing efforts, the subgrade soils at the site were found to consist of sandy clay, clayey sand, and clayey silty sand soils of variable low to medium plasticity. The percent passing the 75 μm (#200) sieve values ranged from a low of 47 percent to a high of 66 percent, with an average value of 53.6 percent. The plasticity indices (PIs) ranged from a low of 6 to a high of 20, with an average of 14.

The laboratory R-value of the fine grained sandy clay soils (as was encountered at the locations of Test Borings 3 and 4) was found to be 36. Based on the Arizona Department of Transportation's (ADOT's) correlation equation and chart, the correlated R-values for all of the site subgrade soils were found to range from a low

of 20 to a high of 41, with an average value of slightly less than 29 (a construction control R-value of 24 is recommended). As such, an R-value of 29 was used in the design of the new pavement sections on 83rd Avenue between Northern Avenue and Olive Avenue.

The design of the new asphaltic concrete pavement sections for 83rd Avenue was performed in accordance with the structural coefficient method presented in ADOT's Preliminary Engineering and Design Manual. The following design criteria were used to determine new pavement section thicknesses:

Design Method . . . . . AASHTO/ADOT, 1989
Design Life . . . . . 20 years
Design ESAL 4,942,810
Design R Value . . . . . 29 (ADOT Correlation)
Design Resilient Modulus . . . . . 17,264 (ADOT Correlation)
Regional Factor 1.0
Structural Coefficients;
- Asphaltic Concrete 0.44
- Aggregate Base Course 0.14
- Aggregate Sub Base Course 0.11

Design Structural Number (SN): 3.36
(minimum SN of 3.16, based on MCDOT's requirements)
Terminal Serviceability Index 2.6

Site grading within the proposed pavement areas should be accomplished as recommended in Parts II and III of this report to provide subgrade support for new flexible pavements. A compacted subgrade of on-site clayey soils, or imported soils with comparable supporting properties is assumed. The following tabulation presents four (4) alternative recommended pavement sections that are minimums based upon the previously tabulated design criteria:

Alternative Number	Asphaltic Concrete Surfacing	Granular Base Course
1	100 mm (4.0")	300 mm (12.0")

Alternative Number	Asphaltic Concrete Surfacing	Granular Base Course
2	125 mm (5.0")	225 mm (9.0")
3	150 mm (6.0")	150 mm (6.0")
4	200 mm (8.0")	none

The previously tabulated pavement sections are considered minimal for the site subgrade but are expected to function with some periodic maintenance or overlays where proper drainage is provided and maintained. If the subgrade soils experience a significant increase in moisture content, accelerated pavement deterioration and increased maintenance should be anticipated. Base course or pavement materials should not be placed when the subgrade is wet. Good surface drainage should be provided away from the edges of paved areas to minimize lateral moisture transmission into the subgrade. Curbs or down-turned sections should be used where pavement abuts landscaping areas or drainage swales. The bituminous surfacing should be sealed after weathering is apparent to minimize water infiltration directly through the pavement section and retard oxidation.

As stated previously herein, a small portion of the project will not be reconstructed with a new pavement section. This portion of the project will consist of milling the existing asphaltic concrete surfacing and installing an asphaltic concrete overlay. Based on the results of our field investigation, laboratory testing, and the pavement design information contained herein, we are recommending the following for the mill out and overlay portion of the project:

1. As a minimum, mill out the upper 40 mm (1.5 inches) of the existing asphaltic concrete surfacing in the designated areas.

2. After milling and the placement of an approved emulsified asphalt tack coat, a minimum of 50 mm (2.0 inches) of new asphaltic concrete should be placed and compacted in the areas that have been milled.

3. In order to match the existing curb line along the west edge of the roadway, it may be necessary to remove the entire pavement structure (AC, ABC, and possibly PCCP) within the area immediately adjacent to the existing curb and extending at least and replace it with one of the pavement sections previously recommended herein.

The above mill out and overlay recommendations are based predominantly on the assumption that the existing pavement sections in this area of 83rd Avenue are similar in nature to those encountered at the locations of Test Borings 3 and 4. At these locations, we encountered an AC surface layer of 75 to 100 mm (3 to 4 inches) in thickness, an ABC layer of 100 mm (4 inches) in thickness, and an old layer of concrete pavement with thicknesses ranging from 150 to 175 mm (6 to 7 inches).

It is also our understanding that new driveways may have to be constructed along portions of 83rd Avenue for the current residential and commercial developments. For new driveways along 83rd Avenue, it is our opinion that 75 mm (3 inches) of AC constructed over 150 mm (6 inches) of ABC will be suitable for the type and volume of traffic expected.

Surface Drainage: The usual source of increasing moisture in soils is from infiltrating surface water. Therefore, landscaped or open areas next to the new pavement should be constructed with positive slopes (minimum 2 percent in all directions) to prevent surface water ponding within 1.5 meters (5 feet) of the pavement edges. Special attention should be given to the collection and drainage away of pavement runoff and to the location and design of drainage paths and water retention areas.

Site Soil Workability: In bituminous paved areas, the moisture content of the subgrade and fill should be maintained at 2 percent below optimum or lower during site grading to reduce the potential for pumping. If moisture contents are higher than this during construction, pumping may occur and cause early pavement failure. Special precautions should be taken to prevent disturbance, equipment mobility problems, and loss of shear strength in the subgrade. These precautions may include spreading and drying of wet soils, removal and replacement of wet soils, construction of temporary gravel roads at channelized traffic areas, and/or use of lighter compaction equipment.

Earthwork Factors: Compaction of the ground surface due to construction activities are expected to be generally low and will occur rapidly during the new construction activities. Based on the results of our recent field and laboratory testing efforts, we estimate that the earthwork shrinkage should be on the order of 15 to 20 percent, while the ground compaction should be less than 50 mm (2 inches).

Backfills: Along the proposed storm drain alignment, on-site soils will likely be used for trench backfills in new pavement areas. The majority of these soils have a fines content and plasticity index significantly higher than allowed for water settling by the Maricopa Association of Governments (MAG) Specifications. Subsequently, we do not recommend water settling of these materials in areas near structures, below paved streets, or in heavy equipment access corridors. Rather, we recommend mechanical compaction. Uniform moisture distribution, near optimum, and relatively thin to moderate lift thickness will be required to facilitate compaction of these soils in confined trenches.

Pipe Bedding Materials: The surface and near-surface soils underlying the site were found to consist of sandy clay, clayey sand, and clayey silty sand soils. These clayey soils are not suitable for use as bedding material. However, some of the deeper, more granular soils that were encountered at some of the test borings may be suitable for

bedding with selective screening. Regardless, all on-site or imported materials to be used as pipe bedding should conform to the appropriate MAG Standard Specifications.

Corrosion: Corrosion is most likely to occur in fills and natural soils with high moisture contents. The native subsoils across the site were noted to be variable and were generally found to be in a damp to slightly damp condition, decreasing somewhat with depth. Based on the results of the laboratory pH, soluble salts, sulfate and chloride testing that was performed as part of this investigation, the corrosion potential to buried concrete structures appears to be slight. Therefore, concrete in contact with soil should use either Portland Type II cement, or Portland Type I low alkali cement.

PART II

MATERIALS

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FILL MATERIALS

All fill materials should be inorganic soils free of vegetation, debris, organic contaminants, and fragments larger than *6 inches in size. The existing subgrade soils that were encountered within the test borings within the 83rd Avenue right-of-way are suitable for use for fills below the new pavement sections. All new fills should be equivalent to (or better than) the on-site soils, and we recommend that a construction control R-value of 24 be used when considering borrow sources for this roadway project.

BASE COURSE

Base course materials for use beneath the new pavement should be well graded sand and gravel materials meeting the Maricopa Association of Governments' Specifications for Aggregate Base Materials (MAG Section 702).

ASPHALT PAVEMENT

It is likely that the new asphaltic concrete at the site will be a *Superpave* (Arizona Modified *SHRP*) mix. The asphaltic concrete mix design method shall be as described for a Level 1 mix design in The Superpave Mix Design Manual for New Construction and Overlays (SHRP-A-407). The asphaltic concrete pavement for the new roadway section on 83rd Avenue should consist of a base course layer of *SHRP* 19 mm (3/4-inch) AC and a surface course layer of *SHRP* 12.5 mm (1/2-inch) AC, bonded together with a tack coat layer of emulsified asphalt. The asphalt binder used in the new AC should consist of PG 70-10 based on the PG-Grading System as specified in the American Association of State Highway & Transportation Officials (AASHTO) Provisional Standard Specifications for Performance Graded Asphalt Binder, and the binder selection guide contained in the SHRP A-407 Manual.

BEDDING

Bedding Materials for use beneath the storm drain pipe should be well graded granular materials meeting the MAG Specifications for Bedding (MAG Section 601).

PART III

EXECUTION

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SITE GRADING

Preparation of the new pavement and storm drain areas for construction will include removal of vegetation or existing structures (pavements, etc.) and excavating to proposed subsurface structure grade. The following recommendations are presented for site grading in the proposed excavation areas. In addition, criteria for placement of backfill and fill materials are presented. All phases of earthwork should be performed under observation and testing directed by a qualified geotechnical engineer.

1. Remove vegetation and organic contaminants, all existing shoulder fills (up to 0.61 meters/2 feet was encountered at the test boring locations), surface and subsurface remnants of any former facilities (existing asphalt pavement, concrete pavement, aggregate base course, etc.) scheduled for removal, any backfills, and any unstable soils (loose, disturbed, wet, etc.) from new pavement and storm drain areas. Observe the cleared surfaces before and during subsequent scarification for evidences of debris-laden soils, disturbance, or loose zones requiring additional removal.

2. Widen any resulting depressions as necessary to accommodate compaction equipment and provide a level base for placing fill.

3. Subsequent to the surface clearing and grubbing and the removal efforts, scarify, moisture condition (or dry back) and compact the exposed native surface soils to a minimum depth of 0.20 meters (8 inches) in areas beneath new pavements, sidewalks, and curbs & gutters.

4. Place backfill or fill materials required to elevate site areas to specified subbase grade. Fill materials should be placed and compacted in horizontal lifts of thicknesses compatible with the compaction equipment used.

5. Compaction of cleaned exposed soil, and each lift of backfill, subbase fill, and base course materials should be accomplished to the following density criteria:

Material	Percent Compaction (ASTM D698)
Cleaned Exposed Soil, Backfill, and Subbase Fill:	
Below asphalt paving (includes storm drain trench backfill)	95 min.
Below curbs & gutters	95 min.
Below concrete sidewalks	90 min.
*Miscellaneous Backfill	90 min.
Base Course:	
Below asphalt paving	100 min.

* Utility trench and exterior fill or backfill not intended for utility line, pavement or utility line support.

Compaction of subgrade soil and fill material below asphaltic pavement (including trench backfill within 1 meter/3 feet of finish subgrade) should be accomplished at a moisture content 2 percent below optimum, or lower. Compaction of clayey soils below new sidewalk areas should be accomplished at uniform moisture contents in the range from optimum to optimum plus 3 percent. Compaction of imported or on-site granular soils below new sidewalk areas (and trench backfill more than 1 meter/3 feet below finish pavement subgrade) should be accomplished at moisture contents in the range of optimum minus 2 percent to optimum plus 2 percent.

Natural undisturbed soils or compacted soils subsequently disturbed or removed by construction operations should be replaced with materials compacted as specified above or as directed in the field by the geotechnical engineer.

ASPHALT PAVING

Placement requirements for asphalt paving should be in accordance with the Maricopa Association of Governments' Specifications for Asphalt Concrete Pavement (MAG Section 321). Observation and testing should be performed as necessary to verify conformance with these recommended specifications, especially compaction requirements for asphalt concrete surfacing.

APPENDIX A

FIELD RESULTS

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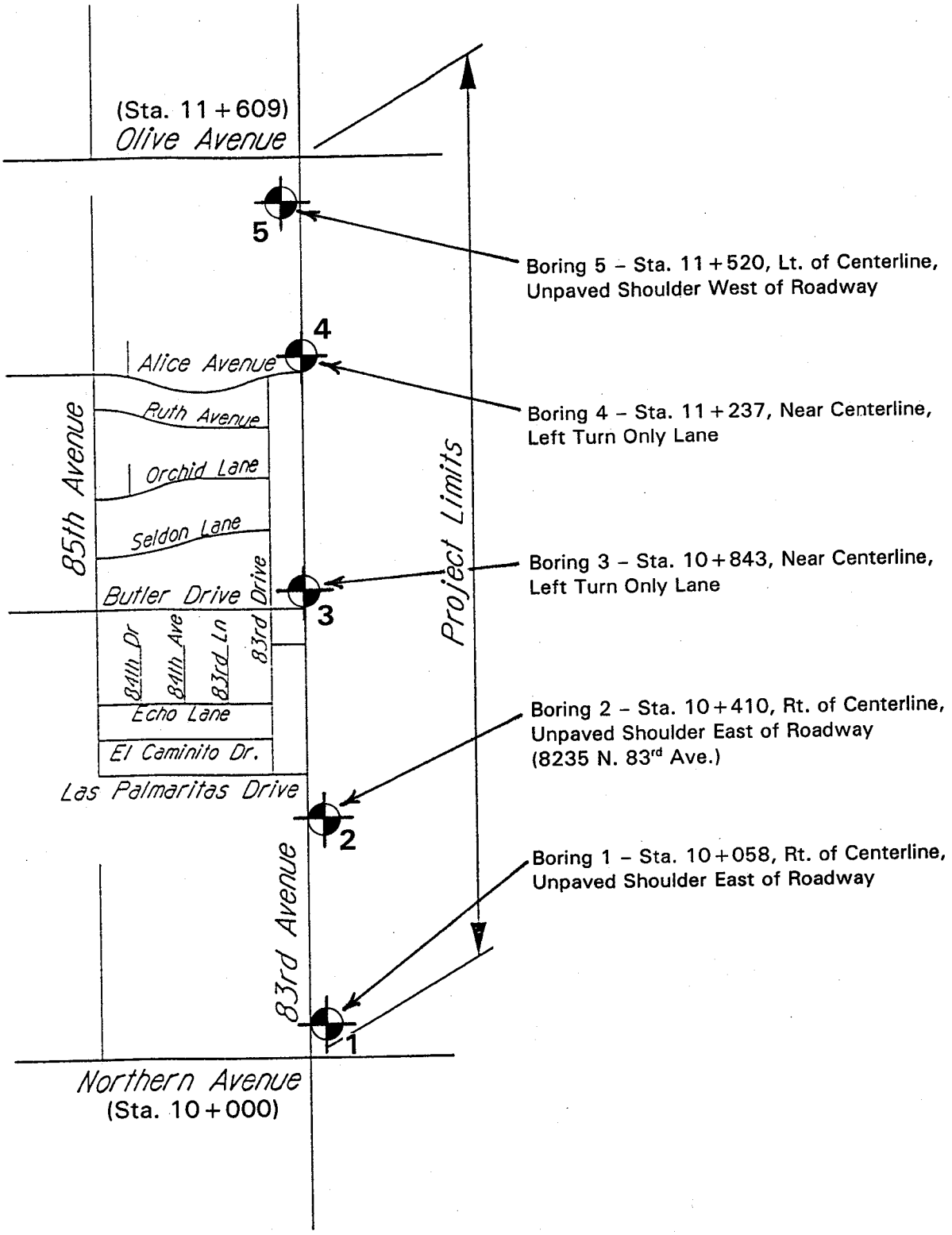

N

NO SCALE

EXPLANATION

TEST BORING

SITE PLAN

83rd Avenue Roadway Improvements
Northern Avenue to Olive Avenue
Project No. 99-11376

MAXIM TECHNOLOGIES, INC.

LEGEND

Soil Classification

COARSE-GRAINED SOIL

More than 50% larger than 200 sieve size

SYMBOL	LETTER	DESCRIPTION	MAJOR DIVISIONS
	GW	Well-graded gravels or gravel sand mixtures. Less than 5% -#200 fines	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size
	GP	Poorly-graded gravels or gravel sand mixtures. Less than 5% -#200 fines	
	GM	Silty gravels or gravel-sand-silt mixtures. More than 12% -#200 fines	
	GC	Clayey gravels or gravel-sand-clay mixtures. More than 12% -#200 fines	
	SW	Well-graded sands or gravelly sands. Less than 5% -#200 fines	SANDS More than half of coarse fraction is smaller than No. 4 sieve size
	SP	Poorly-graded sands or gravelly sands. Less than 5% -#200 fines	
	SM	Silty sands or sand-silt mixtures. More than 12% -#200 fines	
	SC	Clayey sands or sand-clay mixtures. More than 12% -#200 fines	

FINE-GRAINED SOIL

More than 50% smaller than 200 sieve size

SYMBOL	LETTER	DESCRIPTION	MAJOR DIVISIONS
	ML	Inorganic silts, rock flour, and fine sandy or clayey silts of low to medium plasticity	SILTS AND CLAYS Liquid limit less than 50
	CL	Inorganic clays, gravelly clays, sandy clays, and lean clays of low to medium plasticity	
	MH	Inorganic silts, micaceous or diatomaceous, and fine sandy or clayey silts of high plasticity	SILTS AND CLAYS Liquid limit greater than 50
	CH	Inorganic clays, fat clays, and silty or sandy clays of high plasticity	

GRAIN SIZES

U.S. Standard Series Sieves — U.S. Standard Sieve Openings

200 (0.075 mm) | 40 (0.425 mm) | 10 (2.0 mm) | 4 (4.75 mm) | 19 mm (3/4 in.) | 75 mm (3 in.) | 300 mm (12 in.)

Silts and clays distinquished on basis of plasticity	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

MOISTURE CONDITION

Dry — Slightly Damp — Damp — Moist — Very Moist — Wet (Saturated)

(Plastic Limit) — (Liquid Limit)

CONSISTENCY CORRELATION		RELATIVE DENSITY CORRELATION	
Clays & Silts	Blows/0.30 Meters*	Sands & Gravels	Blows/0.30 Meters*
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 63.5 kg hammer falling 0.76 m to drive a 50 mm O.D. (35 mm I.D.) split-spoon sampler (ASTM D1586)

Sampler blow counts and 50 mm O.D. bullnose penetration resistance shown on logs are blows per 0.30 meters using 63.5 kg hammer with 0.76 meter free-fall unless otherwise noted.

LIMITATIONS

The data presented on the test boring logs represent subsurface conditions only at the specific locations and at the times designated. These data may not represent conditions at other locations and/or times. Contacts between soil strata may be gradual rather than abrupt. These data were compiled primarly for design purposes and should not be construed as part of the plans governing construction or defining construction techniques. Bidders are fully responsible for interpretations or conclusions they draw from the test boring logs.

TEST BORING LOG

Job Number:	99-11376	Boring No.:	1
Project:	83rd Avenue Roadway Improvements	Drill Type:	CME-55, 0.18m HSA
Date Started:	1/11/00	Ground Elev.:	
Date Completed:	1/11/00	Station:	10+058, Rt of CL

Legend of Symbols: 64 mm Ring Sample; Standard Split Spoon Sample; Thin Wall Tube; Water Table Encountered; Stabilized Water Table

Elevation (m)	Depth (m)	Graphic Log	Sampler Blow Count	Sample Type	Dry Density (kg/m3)	Water Content (%)	SOIL DESCRIPTION
							0.46m (18") GRANULAR FILL; appearance of dirty ABC.
			23/NR				**SANDY CLAY (CL)**; trace gravel; brown; damp; medium plasticity; stiff to very stiff; interbedded with lenses of clayey sand (SC).
	1		44		1855	8	
	2						**GRAVELLY SAND, SOME SILT (SP-SM)**; brown to grey brown; damp; non-plastic; medium dense to dense, increasing with depth; stratified with lenses of silty sand (SM) and clayey silty sand (SM-SC) throughout layer.
	3		17				
	4		50/ 0.13m				layer becoming dense to very dense below about 4.3m (14 feet).
	5						**SANDY CLAY (CL)**; brown to light brown; damp; low to medium plasticity; very stiff to hard; variable weak cementation.
	6		36 50/ 0.13m				

Stopped drilling at 5.79 meters (19 feet).
Sampler refused at about 6.07 meters (19.9 feet).
No groundwater encountered in test boring.

TEST BORING LOG

Job Number: 99-11376
Project: 83rd Avenue Roadway Improvements
Date Started: 1/11/00
Date Completed: 1/11/00

Boring No.: 2
Drill Type: CME-55, 0.18m HSA
Ground Elev.:
Station: 10+410, Rt of CL

Legend of Symbols: 64 mm Ring Sample; Standard Split Spoon Sample; Thin Wall Tube; Water Table Encountered; Stabilized Water Table

Elevation (m)	Depth (m)	Graphic Log	Sampler Blow Count	Sample Type	Dry Density (kg/m3)	Water Content (%)	SOIL DESCRIPTION
							0.61m (24") GRANULAR FILL; appearance of dirty ABC.
	1		50		1592	15	**CLAYEY SAND (SC)**; some gravel; brown to light brown; damp; low to medium plasticity; medium dense to dense; interbedded with lenses and/or layers of sandy silty clay (CL); intermittent slight to weak cementation.
			35		1725	14	
	2						**SANDY SILTY CLAY (CL)**; light brown to tan; slightly damp to damp; low to medium plasticity; very stiff; variable weak to moderate cementation with some nodules.
	3		39 50/ 0.10m				**CLAYEY SAND (SC)**; silty; trace to some gravel; light brown; low plasticity; dense with some very dense zones; intermittent and somewhat variable weak to moderate cementation with nodules.
	4		35				
							Stopped drilling at 4.27 meters (14 feet). Stopped sampling at 4.72 meters (15.5 feet). No groundwater encountered in test boring.

TEST BORING LOG

Job Number:	99-11376	Boring No.:	3
Project:	83rd Avenue Roadway Improvements	Drill Type:	CME-55, 0.18m HSA
Date Started:	1/11/00	Ground Elev.:	
Date Completed:	1/11/00	Station:	10+843, Near CL

Legend of Symbols: 64 mm Ring Sample; Standard Split Spoon Sample; Thin Wall Tube; Water Table Encountered; Stabilized Water Table

Elevation (m)	Depth (m)	Graphic Log	Sampler Blow Count	Sample Type	Dry Density (kg/m3)	Water Content (%)	SOIL DESCRIPTION
							75mm (3") ASPHALTIC CONCRETE (AC)
							100mm (4") AGGREGATE BASE COURSE (ABC)
							150mm (6") CONCRETE PAVEMENT (PCCP)
			42		1791	12	SANDY CLAY (CL); damp; brown to light brown; medium plasticity; very stiff to hard; variable slight to weak cementation.
	1						
			50		1671	15	light brown to tan, hard, and variable moderate cementation with nodules below about 1.37m (4.5 feet).
	2						
	3		72				SANDY SILTY CLAY (CL); light brown; damp; low to medium plasticity; very stiff to hard; variable weak to moderate cementation with some nodules.
	4						
			50/ 0.15m				some gravel and increasing nodules below about 4.1m (13.5 feet).

Stopped drilling at 4.27 meters (14 feet).
Sampler refusal at about 4.42 meters (14.5 feet).
No groundwater encountered in test boring.

TEST BORING LOG

Job Number: 99-11376
Project: 83rd Avenue Roadway Improvements
Date Started: 1/11/00
Date Completed: 1/11/00

Boring No.: 4
Drill Type: CME-55, 0.18m HSA
Ground Elev.:
Station: 11+237, Near CL

Legend of Symbols: 64 mm Ring Sample; Standard Split Spoon Sample; Thin Wall Tube; Water Table Encountered; Stabilized Water Table

Elevation (m)	Depth (m)	Graphic Log	Sampler Blow Count	Sample Type	Dry Density (kg/m3)	Water Content (%)	SOIL DESCRIPTION
							100mm (4") ASPHALTIC CONCRETE (AC)
							100mm (4") AGGREGATE BASE COURSE (ABC)
							175mm (7") CONCRETE PAVEMENT (PCCP)
	1		35		1717	13	SANDY CLAY (CL); slight trace gravel; brown to light brown; damp; medium plasticity; stiff to very stiff; variable slight to weak cementation.
	2		25		1573	15	SILTY SAND, WITH GRAVEL (SM); brown; damp; non-plastic; medium dense.
	3		17				
	4						increasing gravel and dense to very dense below about 4m (13 feet).
			50/ 0.08m				Stopped drilling at 4.27 meters (14 feet). Sampler refused at about 4.34 meters (14.25 feet). No groundwater encountered in test boring.

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TEST BORING LOG

Job Number:	99-11376	Boring No.:	5
Project:	83rd Avenue Roadway Improvements	Drill Type:	CME-55, 0.18m HSA
Date Started:	1/11/00	Ground Elev.:	
Date Completed:	1/11/00	Station:	11+520, Lt of CL

Legend of Symbols: 64 mm Ring Sample; Standard Split Spoon Sample; Thin Wall Tube; Water Table Encountered; Stabilized Water Table

Elevation (m)	Depth (m)	Graphic Log	Sampler Blow Count	Sample Type	Dry Density (kg/m3)	Water Content (%)	SOIL DESCRIPTION
							200mm (8") GRANULAR FILL; appearance of dirty ABC.
			50/ 0.25m		1639	7	**CLAYEY SILTY SAND (SM-SC)**; trace to some gravel; brown; damp; low plasticity; dense to medium dense; variable slight to weak cementation.
	1						
			25		1709	12	light brown to tan and increasing weak to moderate cementation below about 1.2m (4 feet).
	2						
	3		44				**SANDY SILTY CLAY (CL)**; brown to light brown; damp; low plasticity; very stiff; variable weak cementation; interbedded with lenses of sandy silt (ML).
	4						
			42				
	5						
							SILTY SAND (SM); some gravel; brown to grey brown; damp; non-plastic; dense.
	6		38				
							Stopped drilling at 5.79 meters (19 feet). Stopped sampling at 6.25 meters (20.5 feet). No groundwater encountered in test boring.

APPENDIX B

LABORATORY RESULTS

MAXIM
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REPORT ON R-VALUE TESTS

Project: 83rd Avenue Roadway Improvements
Northern Avenue to Olive Avenue

Project No: 99-11376

Source: TB-3 @ 0.5-1.2m & TB-4 @ 0.6-1.5m

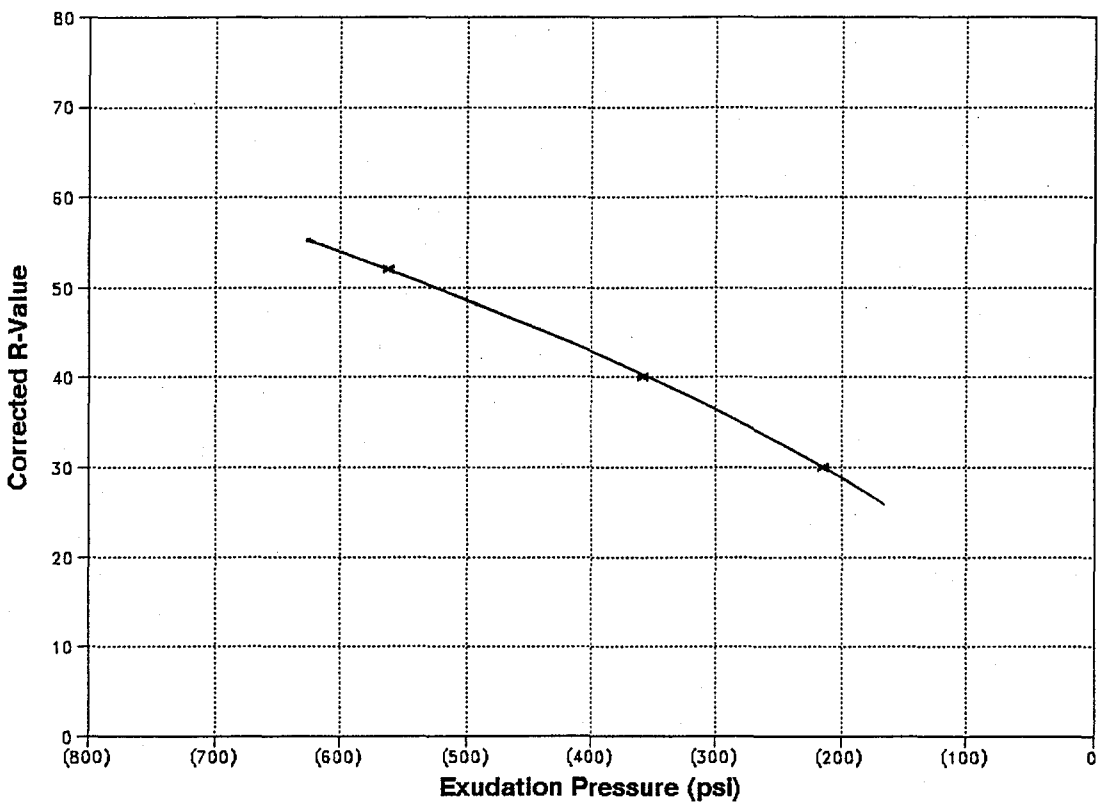
Report Date: January 21, 2000

Material: Sandy Clay (CL)

Sampled By: Maxim / P. Brun

TEST METHOD: ASTM D2844 SAMPLE GRADING: Minus 3/4"

Moisture Content (%)	Dry Density (pcf)	Expansion Pressure (psi)	Exudation Pressure (psi)	Corrected R-Value
18.1	110.1	0.54	214	30
17.4	112.7	0.66	359	40
16.6	114.3	1.23	562	52



Corrected R-Value at 300 PSI = 36

REPORT ON SIEVE ANALYSIS AND PLASTICITY INDEX

83rd Avenue Roadway Improvements
Northern Avenue to Olive Avenue
Maricopa County & Peoria, Arizona

SAMPLE: **DATE:** January 21, 2000

Source: As Noted Below
Type: Bulk Grab Samples from Auger Cuttings
Material: On-Site Surface and Subsurface Soils
Sampled By: Maxim / P. Brun

TESTED: Sieve Analysis and Plasticity Index

Test Results

Location (depth)	Atterberg Limits		Sieve Size - Accumulative % Passing								*
	LL	PI	75μm (#200)	150μm (#100)	300μm (#50)	1.18mm (#16)	4.75mm (#4)	12.5mm (1/2")	25mm (1")	50mm (2")	CLASS
TB-1 (0.5-1.5m)	35	16	51	--	--	85	96	100			CL
TB-1 (1.5-4.5m)	--	NP	11	12	17	43	75	90	100		SP-SM
TB-2 (0.6-1.5m)	29	10	47	--	--	78	91	--	100		SC
TB-3 (0.5-1.2m)	44	20	57	--	--	93	99	100			CL
TB-4 (0.6-1.5m)	40	18	66	--	--	93	98	100			CL
TB-4 (1.8-4.3m)	--	NP	13	17	23	53	83	92	100		SM
TB-5 (0.3-0.9m)	27	6	47	--	--	86	94	--	100		SM-SC

* - Unified Soil Classification System (USCS)

NP - Non-Plastic

Note: With the exception of the deeper samples from Test Borings 1 and 4, the majority of the above samples were subjected to Minus 75μm (#200) Sieve and Plasticity Index (PI) testing only.

REPORT ON SOLUBLE SALTS, SULFATE, CHLORIDE & pH TESTS

83rd Avenue Roadway Improvements
Northern Avenue to Olive Avenue
Maricopa County & Peoria, Arizona

SAMPLE: **DATE:** January 21, 2000

Source: As Noted Below
Type: Bulk Grab Samples from Auger Cuttings
Material: On-Site Surface and Subsurface Soils
Sampled By: Maxim / P. Brun

TESTED: Laboratory Soluble Salts (ADOT237b), Sulfate (CA417), Chloride (CA422M), and pH (ADOT237) Tests (performed by Laboratory Consultants, Ltd.)

Test Results

Location and Depth	Soluble Salts	Sulfate	Chloride	pH
TB-1 (1.5-4.5m)	0.054%	0.0040%	0.0054%	7.8
TB-3 (1.2-4.2m)	0.072%	0.0070%	0.015%	8.2
TB-5 (0.9-2.7m)	0.038%	0.0040%	0.0035%	8.0