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PUBLIC WORKS
Engineering

TO: **E-mail Distribution**

RE: **GEOTECHNICAL REPORT TRANSMITTAL**

The City of Tulsa provides the attached document(s) with the following conditions:

A. The Geotechnical Report is not part of the construction documents. The Geotechnical Report is provided for informational purposes only, to assist the Contractor in understanding the general subsurface conditions at the site. The report presents the data and findings of the geotechnical engineer at the specific boring locations and times of the investigation.

B. The Contractor is solely responsible for all interpretations, conclusions, and deductions drawn from the Geotechnical Report concerning the conditions at the site affecting the execution of the Work, including, but not limited to, the subsurface conditions, the scope of work, means, methods, sequencing, and pricing.

C. The City makes no warranty or representation, express or implied, as to the accuracy, completeness, or interpretations of the data, information, and representations contained in the Geotechnical Report. The information provided is not a substitute for the Contractor's own independent investigation, judgment, and expertise.

D. The Contractor shall visit the site and make their own investigations. This will include any borings, additional borings, and/or testing to determine actual subsurface conditions and the conditions under which the Bid is to be prepared, and the Work is to be performed.

GEOTECHNICAL ENGINEERING REPORT

AIMRIGHT Project No. 12960523
June 30, 2023

Arterial Street Rehabilitation – Pine St (129th to Garnett)

Prepared for:
PEC

AIMRIGHT
TESTING & ENGINEERING

Construction Materials Testing • Special Inspections • Geotechnical Engineering

June 30, 2023

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Re: Geotechnical Engineering Report | Project No. 12960523
City of Tulsa No. 2036A0045Z
Arterial Street Rehabilitation Pine St (129th to Garnett)
Pine St, Tulsa, OK

It has been a pleasure serving you on this project. AIMRIGHT is pleased to submit this Geotechnical Engineering Report for the proposed construction planned at the referenced sites. This report presents the findings of the geotechnical exploration and presents recommendations for design for the project.

We appreciate the opportunity to provide geotechnical consultation services for the subject project. We look forward to serving as your geotechnical engineer and construction materials testing laboratory on the remainder of this and future projects. Please do not hesitate to contact us with any concerns or questions regarding this report.

Respectfully submitted,

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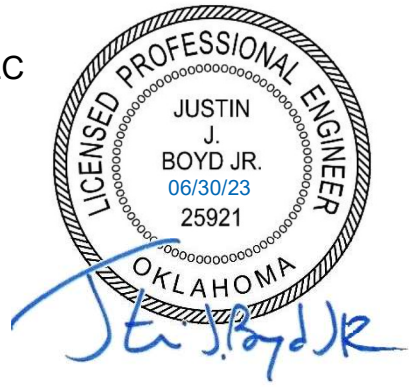

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1.0 PROJECT INFORMATION

1.1 Description

We understand that re-construction and/or re-surfacing is planned for sections of roadway within the City of Tulsa designated areas of Pine Street (129th to Garnett). The existing roadways are currently paved with an asphalt and/or concrete surface.

The roadway areas will be re-constructed with an asphalt or concrete surface and aggregate base course (if applicable); and/or re-surfaced with an asphalt or concrete surface overlay overlying a properly prepared subgrade in general accordance with City of Tulsa Pavement Standards.

1.2 Scope of Services

The primary purpose of this report is to provide geotechnical engineering recommendations for the referenced site development. Our Scope of Services consisted of the following:

- Drilling five (5) soil test borings (borings) to depths of 3 feet.
- Performing laboratory testing of the soil samples obtained.
- Providing engineering analysis and preparation of this report discussing, in general, project description, our scope, exploration, testing, and recommendations.

The Boring Location Plan, Boring Log Summary, and Pavement Core Illustrations are presented in the Appendices to this report. Our Scope of Services did not include a survey of boring locations or elevations, quantity estimates, preparation of plans or specifications, or the identification and evaluation of environmental aspects.

1.3 Field Exploration

AIMRIGHT located the borings in the field by making measurements from known existing site features. No claim is made as to the accuracy of the locations shown on the Boring Location Plan, and they should be considered approximate.

The existing pavement section was cored in general compliance with the American Society of Testing and Materials (ASTM) C42 standard method of Obtaining and Testing Dilled Cores.

The borings were advanced using an ATV-mounted drill rig equipped with an automatic hammer and continuous flight augers. Representative soil samples were obtained using a standard 2-inch outside diameter split-barrel sampler in general compliance with the Standard Penetration Testing (SPT) method of the American Society of Testing and Materials (ASTM) D1586 standard to evaluate the consistency and general engineering properties of the subsurface soils.

The number of blows required to drive the split-barrel sampler three (3) consecutive 6-inch increments is recorded, and the blows of the last two 6-inch increments are added to obtain the SPT N-value in blows per foot (bpf) representing the penetration resistance of the soil. At regular intervals within the borings, split-spoon samples were visually classified based on texture and plasticity.

During the drilling process, all encounters with groundwater, if any, were recorded. Upon completion of drilling, all borings were backfilled per OWRB requirements. The borings were backfilled with soil cuttings and topped-off with asphalt patch compound and/or non-shrink grout.

1.4 Laboratory Testing

The boring and core samples obtained from the geotechnical exploration were transported to the AIMRIGHT laboratory where representative boring samples were selected for testing/measurement.

Testing in general accordance with Atterberg Limits (ASTM D4318), Moisture Content (ASTM D2216), and Sieve Analysis – No. 200 Wash Method (ASTM D1140) was performed on selected samples from each of the borings. Pavement cores samples were measured in general accordance with Thickness or Height of Compacted Asphalt Mixture Specimens (ASTM D3549) and/or Measuring Thickness of Concrete Elements Using Drilled Concrete Cores (ASTM C174). The test results and measurements are presented on the Boring Log Summary.

2.0 EXISTING CONDITIONS

In general, the existing surface is comprised of asphalt with layer depths ranging from approximately 5.5 to 11.3 inches and underlain with approximately 3 inches of aggregate base (7.5 inches concrete in B-3). The surface depth measurements and soil subgrade descriptions are presented on the Boring Log Summary. Photographs of the cores are presented in the Pavement Core Illustrations.

The subsurface conditions shown on the Boring Log Summary represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between soil strata are usually less distinct than shown on the Boring Log Summary.

Groundwater during or at the completion of drilling was not encountered in any of the borings. Water traveling through soil and rock is often unpredictable and may be present at shallow depths. Due to the seasonal changes in groundwater and the unpredictable nature of groundwater paths, groundwater levels will fluctuate.

As such, groundwater levels at other times of the year may be different than those described in this report. It is necessary during construction to be observant for groundwater seepage in excavations to assess the situation and make necessary changes. Where applicable, the contractor should determine the actual groundwater levels at the time of construction.

3.0 NEW CONSTRUCTION

3.1 Site Preparation and Earthwork

Before proceeding with new or re-construction activities, AIMRIGHT recommends conducting a pre-construction meeting to discuss recommendations as outlined in this report. Where applicable, any existing topsoil, pavement section, soft or very loose soils and any other deleterious non-soil materials should be removed to a minimum distance of 2 feet beyond the roadway area footprints, where applicable.

Upon completion of the required removal/excavations, proof-rolling of the subgrade with a 20 to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight should be performed. Proof-rolling should be performed during a time of good weather and not while the site is wet, frozen, or severely desiccated. The proof-rolling observation is an opportunity for the geotechnical engineer to locate inconsistencies intermediate of our boring locations in the existing subgrade. Any unsuitable materials observed during the evaluation and proof-rolling operations should be over-excavated and replaced with properly compacted engineered fill or stabilized in place. The possible need for, and extent of over-excavating and/or in-place stabilization required can best be determined by the geotechnical engineer at the time of construction.

Soils with a PI greater than 10 will be exposed upon completion of grading activities within some of the roadway areas; where encountered, the upper 8 inches of the final soil subgrade shall then be replaced with engineered fill or scarified-treated with lime (or other appropriate additive), then moisture-conditioned, and re-compacted to at least ninety-five percent (95%) of the maximum dry density and within ±2 percentage points of the optimum moisture content as determined by a Standard Proctor (ASTM D698).

The actual amounts of lime or other additive should be determined in the field and shall be performed and monitored in general accordance with 2009 ODOT Standard Specifications for Highway Construction Section 307 Subgrade Treatment. The moisture content and compaction shall be maintained prior to beginning any fill placement and/or construction.

At the time of the investigation, the site soils were generally moist. If dry weather conditions exist prior to and during construction, the near surface soils may need moisture-conditioning to sufficiently enable adequate scarifying and compaction. However, if wet conditions exist at the time of construction, then care shall be taken to assure proper surface water drainage. If these soils do get wet, they must be dried or treated prior to further compaction efforts.

An important aspect to consider during development of this site is surface water control. During the initiation of grading operations, we recommend that the grading contractor take those steps necessary to enhance surface flow and promote rapid clearing of rainfall and runoff water following rain events. It should be incumbent on the contractor to maintain favorable site drainage during construction to minimize deterioration of otherwise stable subgrades.

3.2 Fill Material

A sample of each material type should be submitted to the geotechnical engineer for evaluation. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

All fill material in structural areas (including utility backfill) should be placed in continuous, horizontal lifts having a maximum pre-compacted thickness of 9 inches (aggregate base ≤ 6 inches; and fill compacted with hand-held or smaller-sized equipment ≤ 4 to 6 inches).

Each lift should be compacted to at least ninety-five percent (95%) of the maximum dry density and within ±2 percentage points of the optimum moisture content as determined by a Standard Proctor (ASTM D698), unless noted otherwise and shall be maintained throughout construction activities.

A minimum of two (2) field tests to determine in-place density and moisture content should be performed per lift for each 2,500-sf footprint or as otherwise required by project specifications.

Engineered fill should consist of approved materials that are free of organic matter and debris, exhibit a maximum plasticity index (PI) of 10, maximum liquid limit (LL) of 40, and a maximum rock size of 1.5 inches or as otherwise required by project specifications.

Native soils could be used as fill for final subgrade; whereby, upon re-use, the soils meet the requirements for engineered fill as stated in this report or as otherwise required by project specifications. AIMRIGHT recommends conducting additional soil sampling and laboratory testing of any excavated or cut native soils to determine characteristics and stabilization requirements prior to beginning any fill placement.

AIMRIGHT estimates that approximately 4 to 5 percent (based on the soil's compacted dry weight) hydrated lime would be required to reduce the PI of the native soils to 10 or less. The actual amounts of lime or other appropriate additive should be determined in the field and shall be performed and monitored in general accordance with current ODOT Standard Specifications for Highway Construction Section 307 Subgrade Treatment.

Aggregate base shall meet the requirements for ODOT Type A, may be utilized as engineered fill, and compacted to at least ninety-five percent (95%) of the maximum dry density and within ±2 percentage points of the optimum moisture content as determined by a Modified Proctor (ASTM D1557) or as otherwise required by project specifications.

3.3 Pavement Design

These recommendations are based on our discussions with you, interpretation of the field and laboratory data, assumed traffic loading conditions, review of the provided documents, our experience with similar projects and utilization of the 1993 AASHTO Pavement Design Guidelines. AIMRIGHT recommends that governing authorities (i.e., city, county, or other recognized officials) be contacted to discuss appropriate pavement section requirements with respect to this project. The project engineer of record should design the final pavement sections.

Design Period in Years	25	**Overall Standard Deviation**	**Asphalt**	0.45
Equivalent 18-kip Single-Axle Loads, ESALs	varies		**Concrete**	0.35
Subgrade Resilient Modulus (M_r), psi	3,000	**Serviceability**	**Initial (Asphalt)**	4.2
Modulus of Subgrade Reaction (k), psi/in	100		**Initial (Concrete)**	4.5
Concrete Modulus of Rupture (R), psi	650		**Terminal**	2.0
Load Transfer Coefficient	3.2	**Layer Coefficients**	**Asphalt Wearing**	0.44
Drainage Coefficient	1.0		**Asphalt Base**	0.40
Reliability, %	90		**Aggregate Base**	0.14

It is our opinion the following minimum sections may be utilized for construction:

Pavement Type	Section	Thickness (inches)		
		7,000,000 ESALs SN = 5.85	5,000,000 ESALs SN = 5.60	3,000,000 ESALs SN = 5.24
Concrete[1]	Concrete (≥ 4,000 psi, air-entrained)	9.25	8.75	8.25
	ODOT Type A Aggregate Base	4.0		
	Properly Prepared Subgrade[2]	As Required		
Asphalt[1,3]	ODOT Type B (S4) or C (S5)	3.0	3.0	3.0
	ODOT Type A (S3)	9.0	8.0	7.0
	ODOT Type A Aggregate Base	8.0		
	Properly Prepared Subgrade[2]	As Required		

1. Constructed in accordance with Oklahoma Department of Transportation (ODOT) and city or county governing specifications and applicable American Concrete Institute (ACI) guidelines.

2. Per Section 3.1, 3.2, 3.4.

3. Asphalt pavement design section thickness may be revised by project engineer of record.

3.4 Pavement Construction

The roadway areas generally consist of near surface conditions that are suitable for support of the anticipated loads. However, soft, wet surface, or other unsuitable exposed subgrade conditions may be encountered in some locations. Remediation of these soils shall be required during site preparation and earthwork while following the recommendations outlined in this report.

In general, long-term pavement performance requires good drainage, performance of periodic maintenance activities, and attention to subgrade preparation. We emphasize that good base course drainage is essential for successful pavement performance and should always be maintained in a drained condition. Consideration for proper drainage design should be carefully evaluated where unequal minimum pavement sections meet (i.e., light to heavy duty). Depending on drainage flow design, it may be necessary to deepen the aggregate base course for the thinner section requirement.

Water build-up in the base course could result in premature pavement failures. Sub-drains are typically utilized beneath a pavement where water may enter the pavement from below or above. Based on the results of the borings, we do not anticipate that sub-drains are required for this site. However, site drainage problems may be revealed during construction that requires sub-drains.

Proper drainage may be aided by grading the site such that surface water is directed away from pavements and by construction of swales adjacent to the pavements. All pavements should be graded such that surface water is directed towards the outer limits of the paved areas or to catch basins located such that surface water does not remain on the pavement.

The longitudinal joint between any existing pavement and new pavement sections should be well sealed throughout its life service. Typically, due to the positioning of this joint, it is the primary source of water infiltration below the surface, deterioration of the subgrade as well as the cause of premature pavement surface cracking and deformation.

4.0 RE-SURFACE OVERLAY CONSTRUCTION

4.1 Pavement Design

These recommendations are based on our discussions with you, interpretation of the field and laboratory data, assumed traffic loading conditions, review of the provided documents, our experience with similar projects, and utilization of the 1993 AASHTO Pavement Design Guidelines. AIMRIGHT recommends that governing authorities (i.e., city, county, or other recognized officials) be contacted to discuss appropriate pavement section requirements with respect to this project. The project engineer of record should design the final pavement section.

The re-surfacing overlay recommendations should be based on preliminary qualifying criteria:

(1) at minimum, the remaining pavement section thickness after milling should be approximately 4 to 6 inches (or as required by project engineer of record); and the pavement condition for the remaining section should be satisfactory and capable of supporting the construction process; and

(2) the calculation of the Theoretical New Design Structural Number should meet or exceed the required Minimum New Design Structural Number specified. It is our opinion that the following calculation be utilized for determination of the Theoretical New Design Structural Number (TNDSN) for the final mill and re-surfaced overlay sections:

TNDSN = *0.40 x Asphalt (Existing) + 0.50 x Concrete (Existing) + 0.11 x Aggregate Base (Existing) + 0.44 x Re-surface Overlay Depth*

Most of the existing roadway areas do appear to be capable of meeting the criteria and may be considered for re-surface overlay except at boring B-2. Careful review of support capability of the remaining section and soil subgrade should be performed when considering re-surface design in these areas.

Prior to beginning construction activities, AIMRIGHT recommends conducting additional exploration to verify the existing pavement section conditions where the existing pavement thickness is less than 4 inches or as directed by project team. Additional exploration will aid in determining the extent of areas where unsatisfactory support of the pavement process may be encountered.

Within some sections, the existing pavement section may need to be completely re-constructed or the existing site elevations would need to be increased to meet the Minimum New Design Structural Number due to poor pavement/subgrade conditions and/or thinner existing pavement sections.

4.2 Pavement Construction

Upon completion of milling process, all sections of the exposed pavement surface shall be evaluated utilizing the site preparation and earthwork recommendations outlined in this report. Any exposed pavement areas deemed unsuitable should be over-excavated and removed to expose the underlying subgrade.

It should be noted that where appropriate, a lighter construction traffic may be implemented during the construction progress to reduce the stresses in areas where unsatisfactory support of the pavement process may be encountered. This could be accomplished by reducing the weight of incoming asphalt/concrete loads, using lighter equipment, controlling traffic patterns, etc.

Within satisfactory areas, a crack sealing and patch repair protocol shall then be prepared and executed prior to beginning re-surfacing. In some cases, it may be determined that a paving geotextile be installed prior to re-surfacing to reduce water infiltration and retard reflective cracking propagating to the new surface.

Upon exposing the underlying subgrade during within unsatisfactory areas requiring removal of remaining pavement section, the site preparation and earthwork recommendations outlined in this report should be followed. Any unsuitable materials observed should be over-excavated and replaced with properly compacted engineered fill, additional aggregate base, or stabilized in place. The possible need for, and extent of over-excavating and/or in-place stabilization required can best be determined by the geotechnical engineer at the time of construction.

The roadway areas generally consist of near surface conditions that are suitable for support of the anticipated loads. However, soft, wet surface, or other unsuitable exposed subgrade conditions may be encountered in some locations. Remediation of these soils shall be required during site preparation and earthwork while following the recommendations outlined in this report.

Similarly, due to the absence of any existing effective drainage for most of the roadway areas, AIMRIGHT does not recommend utilizing aggregate base as the final subgrade for any replacement for areas not constructed with an aggregate base layer.

Proper drainage may be aided by grading the site such that surface water is directed away from pavements and by construction of swales adjacent to the pavements. All pavements should be graded such that surface water is directed towards the outer limits of the paved areas or to catch basins located such that surface water does not remain on the pavement.

Flexible asphalt pavements and bases should be constructed in accordance with the recommendations outlined in this report and the guidelines of the latest applicable Oklahoma Department of Transportation (ODOT) and city or county governing specifications. Materials, weather limitations, placement and compaction are specified under appropriate sections of this publication. Concrete pavement construction should also be in accordance with applicable American Concrete Institute (ACI) guidelines.

5.0 CONSTRUCTION MONITORING

We recommend that all earthwork construction be monitored by an experienced engineering technician of AIMRIGHT. Monitoring should be included during site preparation, subgrade earthwork, engineered fill earthwork, and structural slab construction.

Monitoring will allow AIMRIGHT to confirm the soil conditions on site and evaluate the recommendations presented within this report. If at the time of construction, our recommendations are inappropriate for the project, monitoring will allow us to remediate the recommendations at that time to better serve the project.

Monitoring during construction will also allow for the testing of all construction materials for the project. This includes but is not limited to:

- subgrade inspection and density testing,
- structural area fill placement density testing,
- structural and reinforcing steel inspection,
- concrete testing, and
- asphaltic concrete testing, as applicable.

We recommend that AIMRIGHT be retained to provide these services based upon our current familiarity with the project subsurface conditions, and the provided intent of the geotechnical recommendations pertaining to the proposed development.

6.0 LIMITATIONS

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site discussed in this report. If our statements or assumptions concerning the location and design of this project contain incorrect information, or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations if they are inappropriate for the proposed project.

Regardless of the thoroughness of the geotechnical exploration, there is always a possibility that subsurface conditions will be different from those at a specific boring location and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created. The conclusions and recommendations presented in this report were derived in accordance with standard geotechnical engineering practices and no other warranty is expressed or implied.

APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 12960523

PROJECT: Arterial Street Rehabilitation Pine St

AIMRIGHT TESTING & ENGINEERING

Location	Existing Asphalt Depth (in)	Existing Concrete Depth (in)	Existing Aggregate Base Depth (in)	Soil Test Boring Data		General Soil Strength Consistency	General Soil Color	General Soil Description	Unified Soil Classification System Group Symbol	In-place Moisture Content (%)	Finer than No. 200 Sieve (%)	Atterberg Limits		
				Depth (ft)	SPT N-Value							Liquid Limit (%)	Plastic Limit (%)	Plasticity Index
B-1	7.40	N/A	3.00	0 to 1.5	17	Very Stiff	Dark and Light Grayish Brown	Sandy Lean Clay	CL	12.9	50.6	26	15	11
				1.5 to 3	2	Soft	Dark Grayish Brown	Lean Clay w/ Sand						
B-2	5.53	N/A	3.50	0 to 1.5	6	Medium Stiff	Dark Grayish Brown	Lean Clay w/ trace Sand	CL	23.3	86.3	33	21	12
				1.5 to 3	4	Medium Stiff	Dark Grayish Brown	Lean Clay w/ trace Sand						
B-3	6.08	7.54	3.00	0 to 1.5	4	Medium Stiff	Dark Grayish Brown	Fat Clay	CH	21.3	95.5	66	20	46
				1.5 to 3	6	Medium Stiff	Dark and Medium Grayish Brown	Lean to Fat Clay						
B-4	11.30	N/A	3.00	0 to 1.5	3	Soft	Medium and Light Grayish Brown	Sandy Lean Clay	CL	21.9	56.2	44	19	25
				1.5 to 3	6	Medium Stiff	Medium and Light Grayish Brown	Sandy Lean Clay						
B-5	6.70	N/A	3.00	0 to 1.5	5	Medium Stiff	Medium Grayish Brown	Sandy Lean Clay	CL	23.7	50.1	44	23	21
				1.5 to 3	6	Medium Stiff	Medium Grayish Brown	Sandy Lean Clay						

BORING LOG SUMMARY

PROJECT NO.: 12960523

PROJECT: Arterial Street Rehabilitation Pine St

AIMRIGHT TESTING & ENGINEERING

B-1

B-2

B-3

B-4

PAVEMENT CORE ILLUSTRATIONS

PROJECT NO.: 12960523

PROJECT: Arterial Street Rehabilitation Pine St

AIMRIGHT TESTING & ENGINEERING

B-5

PAVEMENT CORE ILLUSTRATIONS

PROJECT NO.: 12960523

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