Geotechnical Engineering Study

Parking Upgrades and Expansion Project
SAWS Downtown Heating and Cooling Plant
San Antonio, Texas

Arias Job No. 2013-475

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

Prepared For
Weston Solutions, Inc.

October 31, 2013

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

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Via Email: Abdel.Hamed@WestonSolutions.com

Mr. Abdel Hamed, P.E.
Weston Solutions, Inc.
70 NE Loop 410, Suite 600
San Antonio, Texas 78216

RE: Geotechnical Engineering Study
Parking Upgrades and Expansion Project
SAWS Downtown Heating and Cooling Plant
San Antonio, Texas

Dear Mr. Hamed:

The results of a Geotechnical Engineering Study for the proposed upgrades and expansion to the parking lot and access drives at the SAWS Downtown Heating and Cooling Plant are presented in this report. This project was performed in accordance with Subconsultant Agreement 008114 between Weston Solutions, Inc. and Arias & Associates, Inc., dated October 19, 2012 and was authorized through Purchase Order 0083818, dated September 17, 2013.

The purpose of this geotechnical engineering study was to establish pavement engineering properties of the subsurface soil and groundwater conditions present at the site. The scope of the study is to provide geotechnical engineering criteria for use by design engineers in preparing the pavement design. Our findings and recommendations should be incorporated into the design and construction documents for the proposed development.

The long-term success of the project will be affected by the quality of materials used for construction and the adherence of the construction to the project plans and specifications. The quality of construction can be evaluated by implementing Quality Assurance (QA) testing. As the Geotechnical Engineer of Record (GER), we recommend that the earthwork and pavement construction be tested and observed by Arias in accordance with the report recommendations. A summary of our qualifications to provide QA testing is discussed in the "Quality Assurance Testing" section of this report. Furthermore, a message to the Owner with regard to QA testing is provided in the ASFE publication included in Appendix E.

Thank you for the opportunity to be of service to you.

Sincerely,
Arias & Associates, Inc.
TBPE Registration No: F-32

STATE OF TEXAS
RENE P. GONZALES
86259
LICENSED
PROFESSIONAL ENGINEER

Rene P. Gonzales, P.E.
Senior Geotechnical Engineer

Christopher M. Szymczak P.E.
Senior Geotechnical Engineer

REPORT FORMAT INFORMATION

To improve clarity in the intent of our geotechnical recommendations for this project, the report is organized into two separate, but equally important sections.

Section I – *Synopsis* is a summary of our geotechnical recommendations specific to this project.

Section II - The *Main Report* contains more detailed information including foundation and pavement design parameters and site work recommendations.

A study of both of the above referenced sections is recommended for the Project Team Members. Arias cautions that Section I is a consolidated quick reference overview of the more detailed geotechnical recommendations contained in Section II and should not be utilized exclusively from the remainder of the report.

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SECTION I: SYNOPSIS

This synopsis includes a brief description of the project, subsurface findings, pavements, and generalized earthwork requirements and specific items of concern from a geotechnical standpoint for consideration during the design, construction, and maintenance phases of this project.

Table 1: Project Description

Project:	Upgrades and Expansion to parking lot and access drives
Project Location:	SAWS Downtown Heating and Cooling Plant San Antonio, Texas.
Proposed Development:	New Parking Lot addition
Project Constraints:	Below-ground Vault in vicinity of new access drive

Table 2: Existing Conditions at Time of Geotechnical Study

Site Description:	New parking lot located over former SAWS headquarters building that was recently demolished
Predominant Soil Types:	FILL: LEAN CLAY (CL), FAT CLAY (CH), SAND with Gravel (SP-SC), Clayey SAND (SC), Clayey GRAVEL (GC),
Average Plasticity Index (PI) of CLAY (CH-CL):	41 (Range 28 - 53)
Groundwater Depth Measured:	Not Observed
Estimated Potential Vertical Rise (PVR):	2 - 5 inches

Table 3: Recommended Pavement Sections

Layer	Material	Flexible Asphaltic Concrete				Rigid Concrete	
		Light Duty		Medium Duty		Light Duty	Heavy Duty
Surface	HMAC/PCC	2”	2”	2½”	2½”	5½”	7”
Base	Flexible Base	8”	10”	10”	12”	--	--
Subgrade	Tensar Geogrid	yes	--	yes	--	--	--
	Moisture Conditioned	6”	6”	6”	6”	6”	6”

Notes:

1. Pavements founded on top of clayey soils will be subject to PVR soil movements estimated and presented in this report (*i.e.,* about 2 to 5-inches). These potential soil movements are typically activated to some degree during the life of the pavement. Consequently, pavements can be expected to crack and require periodic maintenance. Periodic/preventative maintenance and repair should be planned for to reduce deterioration of the pavement structure while aiding to preserve the investment.
2. Light duty areas include parking and drive lanes that are subjected to passenger vehicle traffic only.
3. Medium duty areas include entrance aprons and drives into the site, single access route drive lanes to parking areas, and areas where passenger vehicular traffic is concentrated with occasional single-unit trucks.
4. Heavy duty areas include areas subjected to 18-wheel tractor trailers, frequent truck traffic, trash collection vehicles, dumpster pads including loading and unloading areas, and areas where truck turning and maneuvering may occur. **At a minimum, seven (7)-inch thick concrete pavement is recommended for heavy duty areas.**
5. During the paving life, maintenance to seal surface cracks within concrete or asphalt paving and to reseal joints within concrete pavement should be undertaken to achieve the desired paving life. Perimeter drainage should be controlled to reduce the influx of surface water from areas surrounding the paving. Water penetration into base or subgrade materials, sometimes due to irrigation or surface water infiltration leads to pre-mature paving degradation. Curbs should be used in conjunction with paving to reduce potential for infiltration of moisture into the base course. Curbs should extend the full depth of the base course and should extend at least 3 inches into the underlying clayey subgrade. The base layer should be tied into the area inlets to drain water that may collect in the base.
6. For flexible asphalt pavements only, Tensar TX-140 geogrid installed over a 6-inch moisture conditioned and compacted subgrade and thickened flexible base can be used to provide a reinforced base layer. Geogrid should be installed as per the manufacturer’s guidelines. Furthermore, the geogrid supplier’s technical representative should be present to instruct the workforce on proper geogrid installation.
7. Material specifications, construction considerations, and pavement section requirements are presented in the “Pavement Subgrade and Section Materials” included in Section II of this report.

Table 4: Project Compaction, Moisture and Testing Requirements

Description	Material	Percent Compaction	Optimum Moisture Content	Testing Requirement
		According to Standard Proctor ASTM D 698		
Pavement Areas	Scarified On-site Soil (Subgrade)	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 tests
	General Fill (Onsite Material)	≥ 95%	0 to +4%	1 per 5,000 SF; min. 3 per lift
	Base Material	≥ 95% **(ASTM D 1557)**	±3%	1 per 5,000 SF; min. 3 per lift
	Hot-mix asphaltic concrete	91% to 95% Theoretical Lab Density (TEX 207 F)	Not applicable	1 per 5,000 SF; min. 3 per lift
Non-Structural Areas	General Fill (On-site Material)	≥ 95%	-2% to +3%	1 per 5,000 SF; min. 3 per lift

SECTION II: MAIN REPORT

PROJECT AND SITE DESCRIPTION

The proposed project will consist of upgrades and expansion to the existing parking lot and access drives at the SAWS Downtown Heating and Cooling Plant. The adjacent Market Street re-alignment project will encroach on a portion of the existing SAWS property. The site access to the east end of the plant building is limited due to a below-ground ice vault that is located beneath the existing parking lot. Heavy equipment and maintenance vehicles are currently not allowed to drive over the vault structure. The proposed property boundaries will further limit site access. A Site Vicinity Map is provided as Figure 1 in Appendix A.

The existing parking lot will be extended to the east to provide additional parking. The new parking area will be constructed over portions of the former SAWS headquarters building that was recently demolished. A new service drive will be provided to allow access from Commerce Street to the existing plant building. The service drive will be aligned to avoid the below-ground vault and will provide entry and egress to service cranes and heavily-loaded maintenance equipment to the Heating and Cooling Plant.

SOIL BORINGS AND LABORATORY TESTS

Three (3) soil borings, designated as Borings B-1 through B-3, were drilled at the approximate locations shown on the Boring Location Plan provided as Figure 2 in Appendix A. Boring B-1 was attempted adjacent to the existing below-grade vault; however, the boring was terminated at about 5 feet due to below-grade obstructions encountered during drilling. Borings B-2 and B-3 were drilled and sampled to a depth of 10 feet in the area of the new parking lot.

The boring depths were measured from below the existing ground surface elevation on October 8, 2013. The borings were sampled in accordance with ASTM D1586 for Split Spoon sampling techniques as described in Appendix C. A truck-mounted drill rig using continuous flight augers together with the sampling tool noted was used to secure the subsurface soil samples.

Soil classifications and borehole logging were conducted during the exploration by our engineering technician working under the supervision of our Geotechnical Engineer. Final soil classifications, as seen on the boring logs included in Appendix B, were determined in the laboratory based on laboratory and field test results and applicable ASTM procedures.

As a supplement to the field exploration, laboratory testing to determine soil water content, Atterberg Limits and percent passing the US Standard No. 200 sieve was conducted. The laboratory results are reported in the attached boring logs included in Appendix B. A key to the terms and symbols used on the logs is also included in Appendix B. The soil laboratory testing for this project was done in accordance applicable ASTM procedures with the specifications and definitions for these tests listed in the Appendix C**.** Remaining soil samples recovered from this exploration will be routinely discarded following submittal of this report.

SUBSURFACE CONDITIONS

Generalized stratigraphy and groundwater conditions encountered are discussed in the following sections. The subsurface and groundwater conditions are based on conditions encountered at the boring locations to the depths explored.

Site Stratigraphy and Engineering Properties

The generalized subsurface stratigraphy encountered at this site varied with location. In general, the soils encountered at this site appeared to be primarily fill soils. The depths and thickness of each soil type varied with location. The predominant soil types observed at this site are summarized in the table below.

Table 5: Generalized Soil Conditions

Stratum	Material Type	PI range	No. 200 range	N range
Pavement (B-3 only)	Asphalt surface and base material	--	--	--
I	LEAN CLAY (CL), FAT CLAY (CH), dark brown, tan, stiff to very stiff, with gravel	28 - 53	51 - 90	7 - 19
II	SAND with Gravel (SP-SC), Clayey SAND (SC), tan, brown, medium dense, very dense	17 - 20	8 - 38	17 – 50
III	CLAYEY GRAVEL (GC), tan, dense, with sand	31	48	26

Where: Depth - Depth from existing ground surface at the time of geotechnical study, feet
PI - Plasticity Index, %
No. 200 - Percent passing #200 sieve, %
N - Standard Penetration Test (SPT) N-value, blows per foot

Borings B-2 and B-3 that were drilled in the area of the new parking lot encountered fill soils. We understand that the fill soils were placed on the site as part of the demolition of the former SAWS headquarters. Without proper documentation of fill construction, there are risks that conditions such as buried rubble/debris and/or loose soils could exist within the fill. The conditions could adversely impact the proposed construction. Reportedly, the fill placement was provided in controlled lifts and did not include rubble/debris as part of the backfill. We recommend that existing test reports and project photos that may have been provided during demolition be reviewed to confirm that the fill was placed in moisture-controlled, compacted lifts.

The recommendations provided in this report with regard to proof rolling and compacting the subgrade will help to reduce the risks of potential areas of loose fill. However, these risks can not be eliminated unless the existing fill is completely removed, cleaned of debris, and placed back in compaction-controlled lifts.

Groundwater

A dry soil sampling method was used to obtain the soil samples at the project site. Groundwater was not observed within the soil borings during soil sampling activities which were performed on October 8, 2013. The open boreholes were backfilled using soil cuttings generated from the drilling process.

Groundwater levels will often change significantly over time and should be verified immediately prior to construction. Water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils. Groundwater levels at this site may differ during construction because fluctuations in groundwater levels can result from seasonal conditions, rainfall, drought, or temperature effects. Pockets or seams of gravels, sands, silts or open fractures and joints can store and transmit “perched” groundwater flow or seepage. After obtaining samples, the drill holes were backfilled with excavated soil.

MOISTURE VARIATIONS AND ESTIMATED MOVEMENT

Structural damage can be caused by volume changes in clay soils. Clays can shrink when they lose water and swell (grow in volume) when they gain water. The potential for expansive clays to shrink and swell is typically related to the Plasticity Index (PI). Clays with a higher PI generally have a greater potential for soil volume changes due to moisture content variations. The soils found at this site are capable of swelling and shrinking in volume dependent on potentially changing soil water content conditions during or after construction. The term swelling soils implies not only the tendency to increase in volume when water is available, but also to decrease in volume or shrink if water is removed.

The measured PIs of the clay soil samples obtained at this site range from 28 to 53, which suggest that the soils have a medium to very high potential for shrinking and swelling due to fluctuations in soil moisture content. Because of the dry soil conditions (existing low soil moisture contents), it has been our experience in the San Antonio area that the standard correlations incorporating the plasticity measurements of the soils may *underestimate* the shrink/swell potential of the soils. Consequently, fluctuations in the soil moisture content generated from climatic conditions (*i.e.*, droughts or floods) or as a result of development (*e.g.*, irrigation of landscaping in the immediate vicinity of the building, poor surface drainage, leaking plumbing or water lines) may result in greater shrink/swell movements than calculated.

Several methods exist to evaluate swell potential of expansive clay soils. We have estimated potential heave for this site utilizing the TXDOT method (Tex 124-E). Using the TXDOT method, we estimate that the PVR is approximately ***2 to 5 inches*** at this site considering the existing dry soil moisture conditions at the time of the sampling activities.

As discussed above, it has been our experience that the PVR method can sometimes underestimate the potential shrink/swell movements in the San Antonio area. This should be accounted for in the overall design and should incorporate positive site drainage to reduce the potential for extreme moisture fluctuations in the subgrade soils.

PAVEMENT RECOMMENDATIONS

Accumulation of water beneath the pavement can cause progressive and rapid deterioration of the pavement section. Similarly, pavement surfaces should be well drained to eliminate ponding with a two-percent minimum slope, as possible. The pavement recommendations were prepared in accordance with the 1993 AASHTO Guide for the Design of Pavement Structures for asphalt and the ACI Design Guide 330R for concrete parking lots. No traffic specific design information was received for this project. Therefore, the following design parameters and assumptions were used in our analysis:

Table 6: Pavement Design Assumptions

Traffic Load for Light Duty Pavement	15,000 equivalent single axle loads (ESALs)
Traffic Load for Heavy Duty Pavement	50,000 equivalent single axle loads (ESALs)
Average Daily Truck Traffic vehicle with at least 6 Wheels	One (1)
Concrete Compressive Strength	3,500 psi
Raw Subgrade California Bearing Ratio (CBR)	2 for moderate to high plasticity compacted clay (CL-CH) subgrade
Raw Subgrade Modulus of Subgrade Reaction, k in pci	75 for moderate to high plasticity compacted clay (CL-CH) subgrade

Options for section thickness for flexible and rigid pavements are provided in SECTION I, Table 3 (Recommended Pavement Sections). Note that the truck lane traffic sections correspond to only one heavy-duty truck per day. If more heavy-duty truck traffic is anticipated, we should be contacted to provide additional recommendations.

A truck traffic section is recommended for use at loading docks, entrances, driveways, dumpsters pads and channeled traffic areas. Areas subjected to truck traffic stopping, starting, loading, unloading or turning should not utilize asphalt pavement. For these areas, at least a 7-inch concrete section should be used.

Rigid Concrete Pavement Joints

Placement of expansion joints in concrete paving on potentially expansive subgrade or on granular subgrade subject to piping often results in horizontal and vertical movement at the joint. Many times, concrete spalls adjacent to the joint and eventually a failed concrete area results. This problem is primarily related to water infiltration through the joint.

One method to mitigate the problem of water infiltration through the joints is to eliminate all expansion joints that are not absolutely necessary. It is our opinion that expansion or isolation joints are needed only adjacent where the pavement abuts intersecting drive lanes and other structures. Elimination of all expansion joints within the main body of the pavement area would significantly reduce access of moisture into the subgrade. Regardless of the type of expansion joint sealant used, eventually openings in the sealant occur resulting in water infiltration into the subgrade.

The use of sawed and sealed joints should be designed in accordance with current Portland Cement Association (PCA) or American Concrete Institute (ACI) guidelines. Research has proven that joint design and layout can have a significant effect on the overall performance of concrete pavement.

Recommendations presented herein are based on the use of reinforced concrete pavement. Local experience has shown that the use of distributed steel (No. 4 rebar @ 18- inch spacing each way, placed D/3 form the top of the slab) placed at a distance of 1/3 slab thickness from the top is of benefit in crack control for concrete pavements. Improved crack control also reduces the potential for water infiltration.

Performance Considerations

Our pavement recommendations have been developed to provide an adequate structural thickness to support the anticipated traffic volumes. Some shrink/swell movements due to moisture variations in the underlying soils, or potential movement from settling utility backfill material, should be anticipated over the life of the pavements. The owner should recognize that over a period of time, pavements may crack and undergo some deterioration and loss of serviceability. We recommend the project budgets include an allowance for maintenance such as patching of cracks or occasional overlays over the life of the pavement.

Pavement Subgrade and Section Materials

Recommendations for subgrade preparation in the planned pavement areas, as well as for the pavement section materials, are provided in Table 7 below.

Table 7: Pavement Subgrade and Section Materials

Subgrade Preparation Prior to Pavement Section Construction	
Minimum undercut depth	6 inches or as needed to remove organics and existing pavement/foundations
Reuse excavated soils	Provided they are free of roots and debris and meet the material requirements for their intended use
Horizontal extent for undercut	2 feet beyond the paving limits
Exposed subgrade	Proof roll with rubber tired vehicle weighting at least 20 tons such as a loaded dump truck with Geotechnical Engineer's representative present during proof rolling
Pumping/rutting areas discovered during proof rolling	Remove to firmer materials and replace with compacted general or select fill under direction of Geotechnical Engineer's representative
Fill Requirements for Grade Increases	
General fill type	Material free of roots, debris and other deleterious material with a maximum rock size of 3 inches; on-site clays having CBR $\geq$ 2 may be used. Imported fill materials used under pavements should have a CBR value of at least 2.
Minimum general fill thickness	As required to achieve grade
Maximum general fill loose lift thickness	8 inches
General fill compaction and moisture criteria	ASTM D 698 $\geq$ 95% compaction at 0 to +4 from optimum
Subgrade Treatment Option - Moisture Conditioning	
Depth of moisture conditioning	9 inches (disk in place and moisture condition)
Compaction and moisture criteria	ASTM D 698 $\geq$ 95% compaction at 0 to +4 from optimum

Pavement Section Materials	
Flexible Base Material Type	TxDOT Item 247, Type A, Grade 1 or 2
Maximum Flexible Base Loose Lift Thickness	8 inches
Hot Mix Asphaltic Concrete (HMAC) Type	TxDOT Standard Specifications Item 340 Type D (PG 76 or higher grade binder)
Portland cement concrete (PCC)	28-day compressive strength of 3,500 psi; 5 inch slump
In-Place Density and Moisture Verification Testing	
Testing frequency (Subgrade)	1 test per 5,000 square feet per lift with minimum of 3 tests per lift

To aid in preventing degradation of the prepared subgrade, paving preferably should be placed within 14 days. If pavement placement is delayed, protection of the subgrade surface with an emulsion-based sealer should be considered. Alternately, the paving section could be slightly overbuilt so blading performed to remove distressed sections does not reduce the treated subgrade thickness.

Design Parameters for Review of Below Grade Walls

Preliminary plans are to provide an access drive adjacent to the below-ground ice vault. The drive will be used to drive heavy-lift cranes and temporary chilling units during emergency maintenance events. We understand that SAWS does not allow heavy traffic to drive over the existing vault structure. Although the drive will not be located directly over the vault structure, the proximity of the drive to the perimeter walls will provide surface surcharge loads to the below-grade walls. We recommend that the effects of the surcharge loading be considered on the below-ground vault structure as part of the design process.

Arias reviewed the results of our soil borings and laboratory test results to develop design parameters for the existing vault walls. Lateral loads will develop on the wall due to: (1) the self weight of the backfill material, and (2) additional surcharge loads imposed by surface loading.

Boring B-1 was drilled to review the backfill soils behind the existing below-ground ice vault structure. The boring encountered below-ground obstructions that resulted in early termination. Based on the limited data obtained, we have conservatively estimated lateral earth pressures to be used by the project structural engineer to review the effects of the new drive on the below-grade walls.

We recommend that the at-rest pressures be used with the assumption that the existing below-ground vault walls are restrained from movement at the top. Based on the limited information obtained in our soil boring, we recommend that an at-rest earth pressure coefficient of 1.0 be used for backfill consisting of clay-type soils. For the clay-type soils encountered in our soil boring, this will result in an equivalent fluid pressure of 125 pcf.

The above values do not include a hydrostatic or ground level surcharge component. As described we recommend that the effect of surcharge loads be incorporated into wall pressure diagrams. This should be done by adding a lateral pressure equal to the lateral earth pressure coefficient times the surcharge pressure for the full height of the wall.

We recommend that a structural engineer review the as-built drawings and provide design calculations to confirm that the new surcharge loading imposed by the access drive will not overstress the existing below grade walls. If it is determined that the thickness of the walls and the reinforcing steel are not adequate to resist the anticipated loading conditions, it may be necessary to provide permanent shoring or other site improvements prior to construction of the access drives.

CONSTRUCTION CRITERIA

Site Preparation

Strip away any existing asphalt, concrete, topsoil, grass, organics, and deleterious debris as needed and dispose outside of the pavement areas. Undercut to the required depth and extent as noted in the main report. Additional excavation may be required to accommodate the required fill thickness, or as required, to remove existing utilities or foundations. Additional excavation may also be necessary due to encountering deleterious materials such as buried debris and/or rubble, or undesirable soft and wet subgrade conditions. The site representative of the geotechnical engineer should observe undercutting operations. Unless passing density reports are provided for a specific area, existing fill soils found during the excavation should be considered as uncertified and removed to suitable natural soils.

After the surface materials are removed, the exposed subgrade surface should be proofrolled with a heavily loaded dump truck weighing at least 20 tons. Any areas which excessively yield or pump under the wheel loading should be undercut to the depth specified by the geotechnical engineer’s representative and replaced with compacted fill to existing grade as specified. The voids in undercut areas can be backfilled and compacted with on-site general fill materials.

Table 8: Site Work (Non Structural/General Fill) Requirements

Stripping Depth	6 inch minimum or as needed to remove any existing asphalt, concrete, and vegetation
Non Structural/General Fill Type	On-site material free of roots, debris and other deleterious material with a maximum particle size of 4 inches
Maximum Non Structural/General Fill Loose Lift Thickness	9 inches

The backfill should be placed and compacted in accordance with the General Fill requirements in Table 4 in Section I.

At least one density test should be conducted per 5,000 square feet of pavement area per lift of prepared fill and subgrade or a minimum of three density tests should be taken per lift within the pavement area.

Drainage

Good positive drainage during and after construction is very important to reduce expansive soil volume changes that can detrimentally affect the performance of the planned development. Proper attention to surface and subsurface drainage details during the design and construction phase of development can aid in preventing many potential soil shrink-swell related problems during and following the completion of the project.

Earthwork Acceptance

Exposure to the environment may weaken the soils at the bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that all excavations be extended to final grade and constructed as soon as possible in order to reduce potential damage to the bearing soils. If bearing soils are exposed to severe drying or wetting, the unsuitable soil must be re-conditioned or removed as appropriate and replaced with compacted fill, prior to paving. The bearing level should be free of loose soil, ponded water or debris and should be observed prior to paving by the geotechnical engineer or his representative.

Concrete should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion during exposure or by desiccation, the unsuitable soils must be removed from the excavation and replaced with compacted fill prior to placement of concrete.

Subgrade preparation and fill placement operations should be monitored by the soils engineer or his representative. As a guideline, at least one in-place density test should be performed for each 5,000 sq. ft. of compacted surface per lift or a minimum of three tests per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

Trench Excavations

Excavations should comply with OSHA Standard 29CFR, Part 1926, Subpart P and all State of Texas and local requirements. Trenches 20 feet deep or greater require that the protective system be designed by a registered professional engineer. A trench is defined as a narrow excavation in relation to its depth. In general, the depth is greater than the width, but the bottom width of the trench is not greater than 15 feet. Trenches greater than 5 feet in depth require a protective system such as trench shields, trench shoring, or sloping back the excavation side slopes.

The Contractor's "Competent Person" shall perform daily inspections of the trench to verify that the trench is properly constructed and that surcharge and vibratory loads are not excessive, that excavation spoils are sufficiently away from the edge of the trench, proper ingress and egress into the trench is provided and all other items are performed as outlined in these OSHA regulations. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation and the presence of any surface slope cracks should also be carefully monitored by the Trench Safety Engineer.

Although the geotechnical report provides an indication of soil types to be anticipated, actual soil and groundwater conditions will vary along the trench route. The "Competent Person" must evaluate the soils and groundwater in the trench excavation at the time of construction to verify that proper sloping or shoring measures are performed.

Appendix B to the regulations has sloping and benching requirements for short-term trench exposure for various soil types up to the maximum allowable 20-foot depth requirement.

GENERAL COMMENTS

The scope of this study is to provide geotechnical engineering criteria for use by design engineers in preparing the foundation and pavement designs. Environmental studies of any kind were not a part of our scope of work or services even though we are capable of providing such services.

This report was prepared as an instrument of service for this project exclusively for the use of Weston Solutions, Inc. and the project design team. If the development plans change relative to project or overall site layout, size, or anticipated traffic loads or if different subsurface conditions are encountered, we should be informed and retained to ascertain the impact of these changes on our recommendations. We cannot be responsible for the potential impact of these changes if we are not informed.

Geotechnical Design Review

Arias should be given the opportunity to review the design and construction documents. The purpose of this review is to check to see if our geotechnical recommendations are properly interpreted into the project plans and specifications. Please note that design review was not included in the authorized scope and additional fees may apply.

Subsurface Variations

Soil and groundwater conditions may vary between the sample boring locations. Transition boundaries or contacts, noted on the boring logs to separate soil types, are approximate. Actual contacts may be gradual and vary at different locations. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions or highly variable subsurface conditions are encountered during construction, we should be contacted to evaluate the significance of the changed conditions relative to our recommendations.

Quality Assurance Testing

The long-term success of the project will be affected by the quality of materials used for construction and the adherence of the construction to the project plans and specifications. As Geotechnical Engineer of Record (GER), we should be engaged by the Owner to provide Quality Assurance (QA) testing. Our services will be to evaluate the degree to which constructors are achieving the specified conditions they're contractually obligated to achieve, and observe that the encountered materials during earthwork for foundation and pavement installation are consistent with those encountered during this study. In the event that Arias is not retained to provide QA testing, we should be immediately contacted if differing subsurface conditions are encountered during construction. Differing materials may require modification to the recommendations that we provided herein. A message to the Owner with regard to the project QA is provided in the ASFE publication included in Appendix E.

Arias has an established in-house laboratory that meets the standards of the American Standard Testing Materials (ASTM) specifications of ASTM E-329 defining requirements for Inspection and Testing Agencies for soil, concrete, steel and bituminous materials as used in construction. We maintain soils, concrete, asphalt, and aggregate testing equipment to provide the testing needs required by the project specifications. All of our equipment is calibrated by an independent testing agency in accordance with the National Bureau of Standards. In addition, Arias is accredited by the American Association of State Highway & Transportation Officials (AASHTO), the United States Army Corps of Engineers (USACE) and the Texas Department of Transportation (TxDOT), and also maintains AASHTO

Materials Reference Laboratory (AMRL) and Cement and Concrete Reference Laboratory (CCRL) proficiency sampling, assessments and inspections.

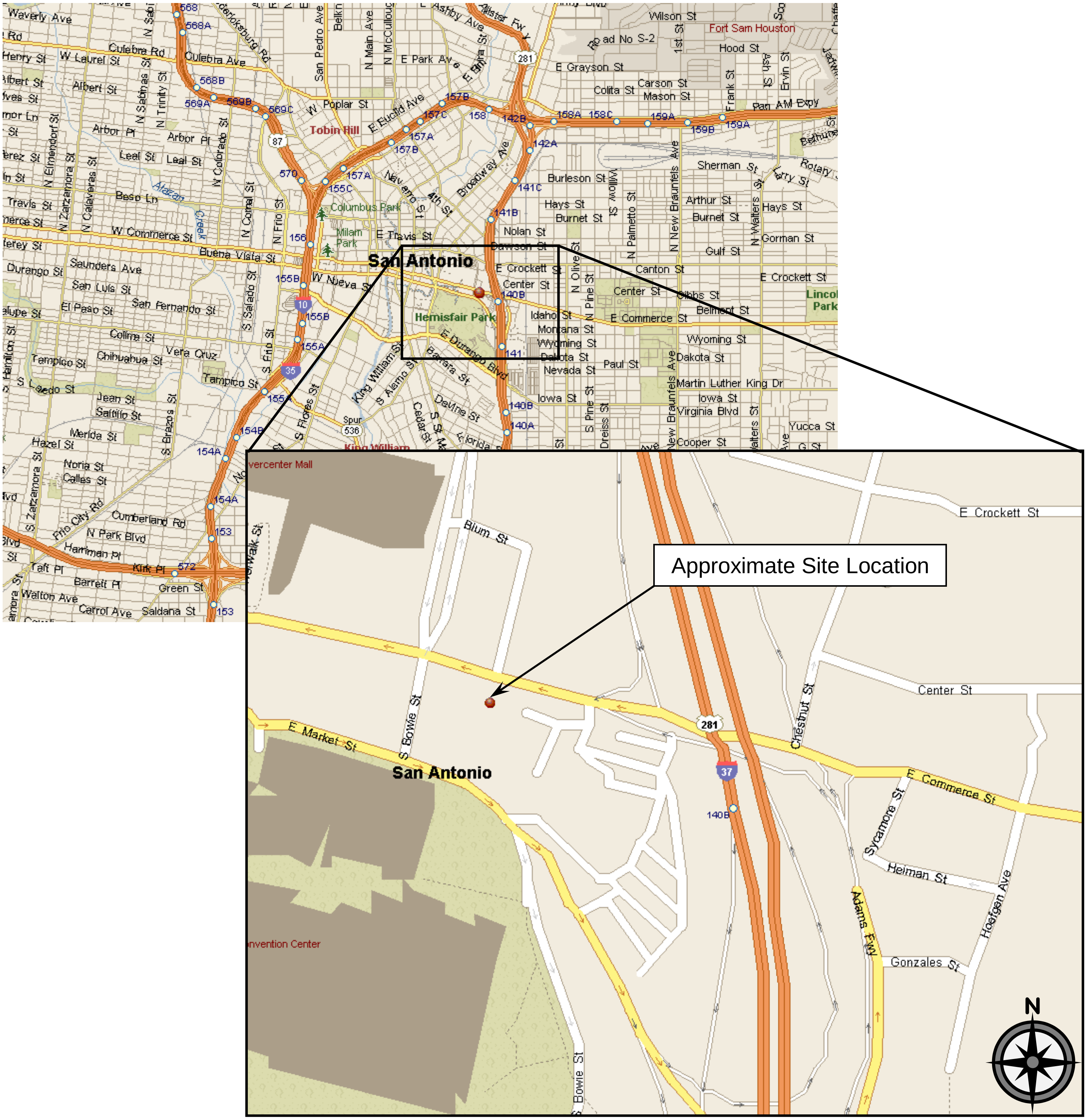
Furthermore, Arias employs a technical staff certified through the following agencies: the National Institute for Certification in Engineering Technologies (NICET), the American Concrete Institute (ACI), the American Welding Society (AWS), the Precast/Prestressed Concrete Institute (PCI), the Mine & Safety Health Administration (MSHA), the Texas Asphalt Pavement Association (TXAPA) and the Texas Board of Professional Engineers (TBPE). Our services are conducted under the guidance and direction of a Professional Engineer (P.E.) licensed to work in the State of Texas, as required by law.

Standard of Care

Subject to the limitations inherent in the agreed scope of services as to the degree of care and amount of time and expenses to be incurred, and subject to any other limitations contained in the agreement for this work, Arias has performed its services consistent with that level of care and skill ordinarily exercised by other professional engineers practicing in the same locale and under similar circumstances at the time the services were performed.

Information about this geotechnical report is provided in the ASFE publication included in Appendix D.

APPENDIX A: FIGURES



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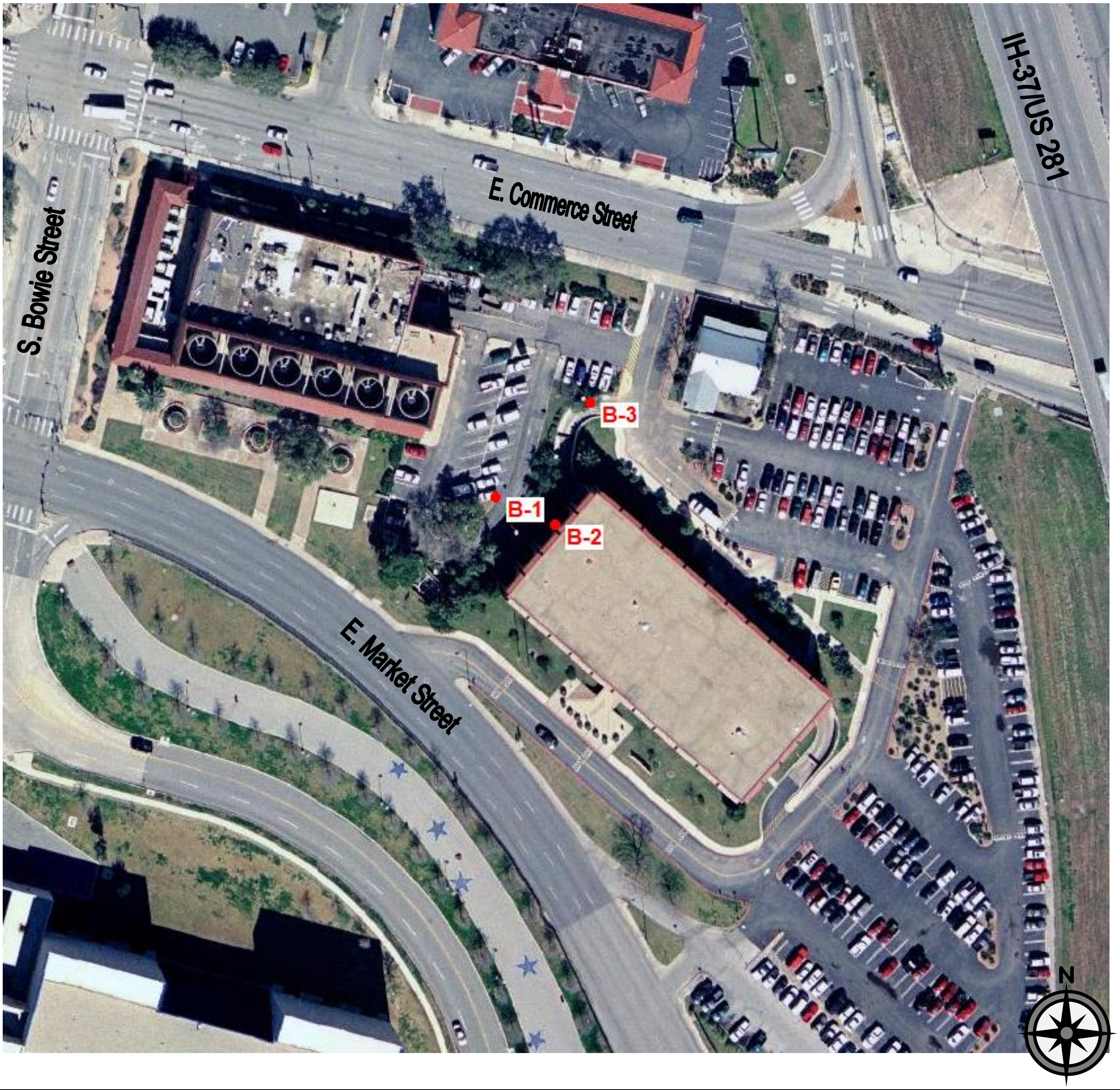
VICINITY MAP

Parking Upgrades and Expansion Project
SAWS Downtown Heating and Cooling Plant
San Antonio, Texas

Date: October 30, 2013	Job No.: 2013-475	**Figure 1**
Drawn By: TAS	Checked By: RPG	
Approved By: SAH	Scale: N.T.S.	**1 of 1**

DISCLAIMER: This drawing is for illustration only and should not be used for design or construction purposes. All locations are approximate.



ARIAS & ASSOCIATES, INC.
Geotechnical • Environmental • Testing
TBPE Registration No. F-32

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BORING LOCATION PLAN

Parking Upgrades and Expansion Project
SAWS Downtown Heating and Cooling Plant
San Antonio, Texas

Date: October 30, 2013	Job No.: 2013-475
Drawn By: TAS	Checked By: RPG
Approved By: SAH	Scale: N.T.S.

NOTE:

- Boring B-1 drilled in 3 different locations, hitting concrete at each location at a depth of 6-ft. Client instructed field personnel to cancel location.

Figure 2

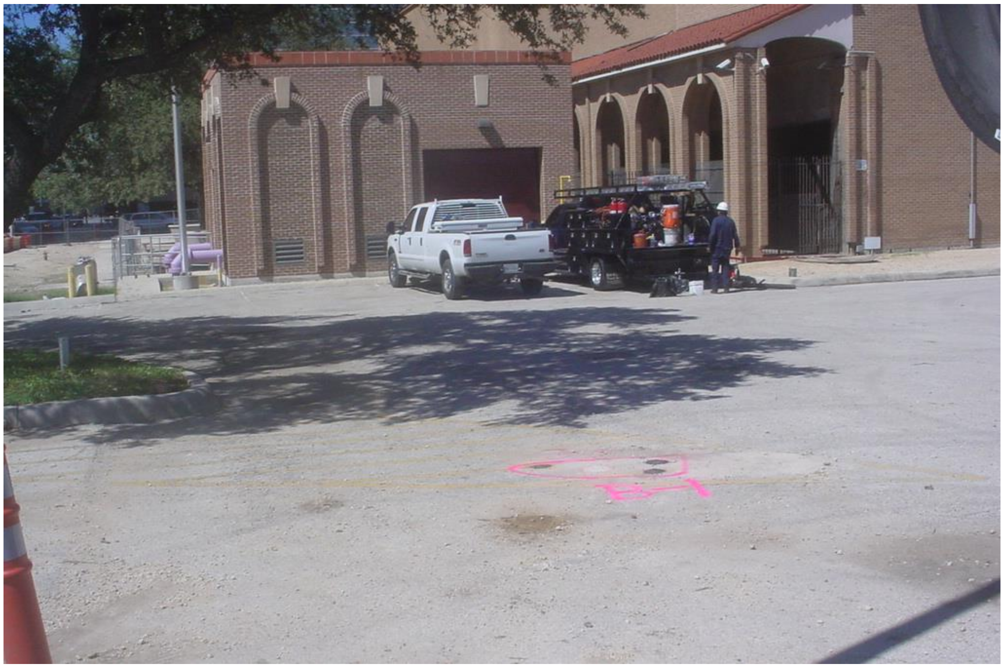

Photo 1 – View looking towards the northwest at the attempted locations of Boring B-1.

Photo 2 – View looking towards the southwest from near Boring B-3, at the drilling operations of Boring B-2.

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SITE PHOTOS

Parking Upgrades and Expansion Project
SAWS Downtown Heating and Cooling Plant
San Antonio, Texas

Date: October 30, 2013	Job No.: 2013-475
Drawn By: TAS	Checked By: RPG
Approved By: SAH	Scale: N.T.S.

Appendix A

APPENDIX B: BORING LOGS AND SYMBOL KEY SHEET

Boring Log No. B-1

Project: **SAWS Downtown Cooling/Heating Plant**
Market Street
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 10/8/13

Coordinates: N29°25'18.8" W98°28'56.3"

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
3.5" Asphalt								
12" BASE		GB	1					
FILL: SANDY FAT CLAY (CH), hard, tan and dark brown, with gravel	2	SS	14				13	
		SS	12	15	58	43	7	55
	4							
-very hard, possibly concrete obstruction, encountered at 5'		SS	13				**50/6"	
Borehole terminated at 5.5 feet								

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: R. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 5.5 ft

Nomenclature Used on Boring Log

Grab Sample (GB) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count

-200 = % Passing #200 Sieve

2013-475.GPJ 10/31/13 (BORING LOG SA13-02,ARIASSA12-01.GDT,LIBRARY2013-01.GLB)

Arias & Associates, Inc.

Job No.: 2013-475

Boring Log No. B-2

Project: **SAWS Downtown Cooling/Heating Plant** **Market Street** **San Antonio, Texas**	Sampling Date: 10/8/13
	Coordinates: N29°25'18.6" W98°28'55.8"
Location: See Boring Location Plan	Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
FILL: LEAN CLAY (CL), very stiff, brown and tan, with gravel		SS	10				19	
	2							
FILL: Poorly-graded SAND with Clay and Gravel (SP-SC), medium dense, tan, with sand		SS	9	15	32	17	27	8
	4							
		SS	6				24	
	6							
very dense at 6'		SS	6				50	
	8							
-dark brown and tan, Clayey SAND (SC), below 8'		SS	12	18	38	20	17	38
	10							

Borehole terminated at 10 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: R. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count

-200 = % Passing #200 Sieve

2013-475.GPJ 10/31/13 (BORING LOG SA13-02,ARIASSA12-01.GDT,LIBRARY2013-01.GLB)

Boring Log No. B-3

Project: **SAWS Downtown Cooling/Heating Plant**
Market Street
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 10/8/13

Coordinates: N29°25'19.5" W98°28'55.5"

Backfill: Cuttings

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
FILL: SANDY LEAN CLAY (CL), stiff, dark brown and brown		SS	16	18	46	28	11	51
	2							
FAT CLAY (CH), stiff, dark brown		SS	32				9	
	4							
		SS	32	26	79	53	14	90
-tan and brown, with gravel beow 6'	6							
		SS	19				20	
CLAYEY GRAVEL (GC), dense, light tan, with sand	8							
		SS	13	24	55	31	48	26
	10							
Borehole terminated at 10 feet								

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Hand-held GPS Unit
Logged By: R. Arizola
Driller: Eagle Drilling, Inc.
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
N = SPT Blow Count

-200 = % Passing #200 Sieve

2013-475.GPJ 10/31/13 (BORING LOG SA13-02,ARIASSA12-01.GDT,LIBRARY2013-01.GLB)

Arias & Associates, Inc.

Job No.: 2013-475

KEY TO CLASSIFICATION SYMBOLS USED ON BORING LOGS

MAJOR DIVISIONS			GROUP SYMBOLS	DESCRIPTIONS
COARSE-GRAINED SOILS More Than Half of Material LARGER Than No. 200 Sieve size	**GRAVELS** More Than Half of Coarse Fraction is LARGER Than No. 4 Sieve Size	Clean Gravels (Little or no Fines)	**GW**	Well-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
		Gravels With Fines (Appreciable Amount of Fines)	**GM**	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More Than Half of Coarse Fraction is SMALLER Than No. 4 Sieve Size	Clean Sands (Little or no Fines)	**SW**	Well-Graded Sands, Gravelly Sands, Little or no Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or no Fines
		Sands With Fines (Appreciable Amount of Fines)	**SM**	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More Than Half of Material is SMALLER Than No. 200 Sieve Size	**SILTS & CLAYS**	Liquid Limit Less Than 50	**ML**	Inorganic Silts & Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
	SILTS & CLAYS	Liquid Limit Greater Than 50	**MH**	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils, Elastic Silts
			CH	Inorganic Clays of High Plasticity, Fat Clays
FORMATIONAL MATERIALS	**SANDSTONE**			Massive Sandstones, Sandstones with Gravel Clasts
	MARLSTONE			Indurated Argillaceous Limestones
	LIMESTONE			Massive or Weakly Bedded Limestones
	CLAYSTONE			Mudstone or Massive Claystones
	CHALK			Massive or Poorly Bedded Chalk Deposits
	MARINE CLAYS			Cretaceous Clay Deposits
	GROUNDWATER		▼	Indicates Final Observed Groundwater Level
			▽	Indicates Initial Observed Groundwater Location

Arias & Associates, Inc.

APPENDIX C: LABORATORY AND FIELD TEST PROCEDURES

FIELD AND LABORATORY EXPLORATION

The field exploration program included drilling at selected locations within the site and intermittently sampling the encountered materials. The boreholes were drilled using either single flight auger (ASTM D 1452) or hollow-stem auger (ASTM D 6151). Samples of encountered materials were obtained using a split-barrel sampler while performing the Standard Penetration Test (ASTM D 1586), using a thin-walled tube sampler (ASTM D 1587), or by taking material from the auger as it was advanced (ASTM D 1452). The sample depth interval and type of sampler used is included on the soil boring log. Arias' field representative visually logged each recovered sample and placed a portion of the recovered sampled into a plastic bag for transport to our laboratory.

SPT N values and blow counts for those intervals where the sampler could not be advanced for the required 18-inch penetration are shown on the soil boring log. If the test was terminated during the 6-inch seating interval or after 10 hammer blows were applied used and no advancement of the sampler was noted, the log denotes this condition as blow count during seating penetration. Penetrometer readings recorded for thin-walled tube samples that remained intact also are shown on the soil boring log.

Arias performed soil mechanics laboratory tests on selected samples to aid in soil classification and to determine engineering properties. Tests commonly used in geotechnical exploration, the method used to perform the test, and the column designation on the boring log where data are reported are summarized as follows:

Test Name	Test Method	Log Designation
Water (moisture) content of soil and rock by mass	ASTM D 2216	WC
Liquid limit, plastic limit, and plasticity index of soils	ASTM D 4318	PL, LL, PI
Amount of material in soils finer than the No. 200 sieve	ASTM D 1140	-200
Particle size analysis of soils (with or without fines fraction)	ASTM D 422	-200

The laboratory results are reported on the soil boring logs.

APPENDIX D: ASFE INFORMATION – GEOTECHNICAL REPORT

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
THE BEST PEOPLE ON EARTH

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
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APPENDIX E: PROJECT QUALITY ASSURANCE

A Message to Owners

Construction materials engineering and testing (CoMET) consultants perform quality-assurance (QA) services to evaluate the degree to which constructors are achieving the specified conditions they're contractually obligated to achieve. Done right, QA can save you time and money; prevent unanticipated-conditions claims, change orders, and disputes; and reduce short-term and long-term risks, especially by detecting molehills before they grow into mountains.

Done right, QA can save you time and money; prevent claims and disputes; and reduce risks. Many owners don't do QA right because they follow bad advice.

Many owners don't do QA right because they follow bad advice; e.g., "CoMET consultants are all the same. They all have accredited facilities and certified personnel. Go with the low bidder." But there's no such thing as a standard QA scope of service, meaning that – to bid low – each interested firms *must* propose the cheapest QA service it can live with, jeopardizing service quality and aggravating risk for the entire project team. Besides, the advice is based on misinformation.

Fact: ***Most CoMET firms are not accredited***, and the quality of those that are varies significantly. Accreditation – which is important – nonetheless means that a facility met an accrediting body's minimum criteria. Some firms practice at a much higher level; others just barely scrape by. And what an accrediting body typically evaluates – management, staff, facilities, and equipment – can change substantially before the next review, two, three, or more years from now.

Most CoMET firms are not accredited. It's dangerous to assume CoMET personnel are certified.

Fact: ***It's dangerous to assume CoMET personnel are certified.*** Many have no credentials at all; some are certified by organizations of questionable merit, while others have a valid certification, but *not* for the services they're assigned.

Some CoMET firms – the "low-cost providers" – *want* you to believe that price is the only difference between QA providers. It's not, of course. Firms that sell low price typically lack the facilities, equipment, personnel, and insurance quality-oriented firms invest in to achieve the reliability concerned owners need to achieve quality in quality assurance.

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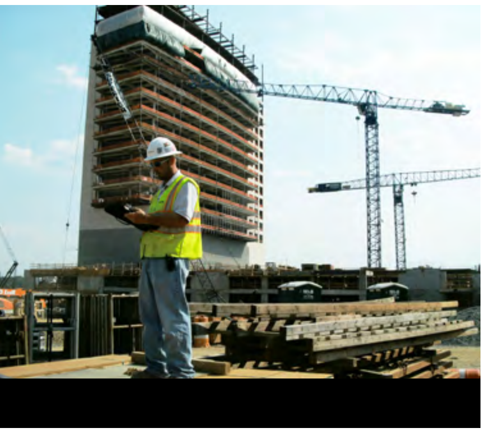
Internet: www.asfe.org

Firms that sell low price typically lack the facilities, equipment, personnel, and insurance quality-oriented firms invest in to achieve the reliability concerned owners need to achieve quality in quality assurance.



To derive maximum value from your investment in QA, require the CoMET firm's project manager to serve actively on the project team from beginning to end, a level of service that's relatively inexpensive and can pay huge dividends. During the project's planning and design stages, experienced CoMET professionals can help the design team develop uniform technical specifications and establish appropriate observation, testing, and instrumentation procedures and protocols. They can also analyze plans and specs much as constructors do, looking for the little errors, omissions, conflicts, and ambiguities that often become the basis for big extras and big claims. They can provide guidance about operations that need closer review than others, because of their criticality or potential for error or abuse. They can also relate their experience with the various constructors that have expressed interest in your project.

To derive maximum value, require the project manager to serve actively on the project team from beginning to end.

CoMET consultants' construction-phase QA services focus on two distinct issues: those that relate to geotechnical engineering and those that relate to the other elements of construction.

The geotechnical issues are critically important because they are essential to the "observational method" geotechnical engineers use to significantly reduce the amount of sampling they'd otherwise require. They apply the observational method by developing a sampling plan for a project, and then assigning field representatives to ensure samples are properly obtained, packaged, and transported. The engineers review the samples and, typically, have them tested in their own laboratories. They use the information they derive to characterize the site's subsurface and develop *preliminary* recommendations for the structure's foundations and for the specifications of various "geo" elements, like excavations, site grading, foundation-bearing grades, and roadway and parking-lot preparation and surfacing.

Geotechnical engineers cannot finalize their recommendations until they or their field representatives are on site to observe what's excavated to verify that the subsurface conditions the engineers predicted are those that actually exist.

When unanticipated conditions are observed, recommendations and/or specifications should be modified.

Responding to client requests, many geotechnical-engineering firms have expanded their field-services mix, so they're able to perform overall construction QA, encompassing – in addition to geotechnical issues – reinforced concrete, structural steel, welds, fireproofing, and so on. Unfortunately, that's caused some confusion. Believing that all CoMET consultants are alike, some owners take bids for the overall CoMET package, including the geotechnical field observation. *Entrusting geotechnical field observation to someone other than the geotechnical engineer of record (GER) creates a significant risk.*

Geotechnical engineers cannot finalize their recommendations until they are on site to verify that the subsurface conditions they predicted are those that actually exist. Entrusting geotechnical field observation to someone other than the geotechnical engineer of record (GER) creates a significant risk.

GERs have developed a variety of protocols to optimize the quality of their field-observation procedures. Quality-focused GERs meet with their field representatives before they leave for a project site, to brief them on what to look for and where, when, and how to look. (***No one can duplicate this briefing***, because no one else knows as much about a project's geotechnical issues.) And once they arrive at a project site, the field representatives know to maintain timely, effective communication with the GER, because that's what the GER has trained them to do. By contrast, it's extremely rare for a different firm's field personnel to contact the GER, even when they're concerned or confused about what they observe, because they regard the GER's firm as "the competition."

Divorcing the GER from geotechnical field operations is almost always penny-wise and pound-foolish. Still, because owners are given bad advice, it's commonly done, helping to explain why ***"geo" issues are the number-one source of construction-industry claims and disputes.***

Divorcing the GER from geotechnical field operations is almost always penny-wise and pound-foolish, helping to explain why "geo" issues are the number-one source of construction-industry claims and disputes.

To derive the biggest bang for the QA buck, identify three or even four quality-focused CoMET consultants. (If you don't know any, use the "Find a Geoprofessional" service available free at www.asfe.org.) Ask about the firms' ongoing and recent projects and the clients and client representatives involved; *insist upon receiving verification of all claimed accreditations, certifications, licenses, and insurance coverages.*

Insist upon receiving verification of all claimed accreditations, certifications, licenses, and insurance coverages.

Once you identify the two or three most qualified firms, meet with their representatives, preferably at their own facility, so you can inspect their laboratory, speak with management and technical staff, and form an opinion about the firm's capabilities and attitude.

Insist that each firm's designated project manager participate in the meeting. You will benefit when that individual is a seasoned QA professional familiar with construction's rough-and-tumble. Ask about others the firm will assign, too. There's no substitute for experienced personnel who are familiar with the codes and standards involved and know how to:

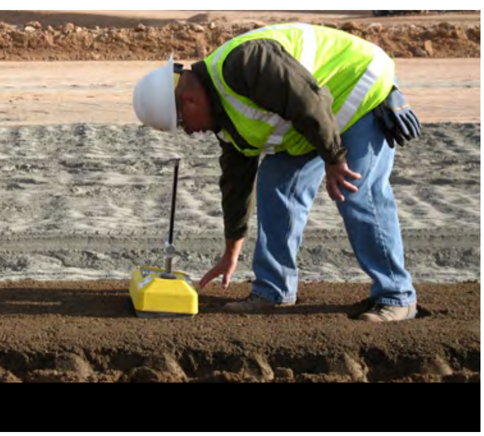
- read and interpret plans and specifications;
- perform the necessary observation, inspection, and testing;
- document their observations and findings;
- interact with constructors' personnel; and
- respond to the unexpected.

Important: Many of the services CoMET QA field representatives perform – like observing operations and outcomes – require the good judgment afforded by extensive training and experience, especially in situations where standard operating procedures do not apply. You need to know who will be exercising that judgment: a 15-year "veteran" or a rookie?

Many of the services CoMET QA field representatives perform require good judgment.

Also consider the tools CoMET personnel use. Some firms are passionate about proper calibration; others, less so. Passion is a good thing! Ask to see the firm's calibration records. If the firm doesn't have any, or if they are not current, be cautious. *You cannot trust test results derived using equipment that may be out of calibration.* Also ask a firm's representatives about their reporting practices, including report distribution, how they handle notifications of nonconformance, and how they resolve complaints.

Scope flexibility is needed to deal promptly with the unanticipated.



For financing purposes, some owners require the constructor to pay for CoMET services. ***Consider an alternative approach*** so you don't convert the constructor into the CoMET consultant's client. If it's essential for you to fund QA via the constructor, have the CoMET fee included as an allowance in the bid documents. This arrangement ensures that you remain the CoMET consultant's client, and it prevents the CoMET fee from becoming part of the constructor's bid-price competition. (Note that the International Building Code (IBC) *requires the owner to pay* for Special Inspection (SI) services commonly performed by the CoMET consultant as a service separate from QA, to help ensure the SI services' integrity. Because failure to comply could result in denial of an occupancy or use permit, having a contractual agreement that conforms to the IBC mandate is essential.)

If it's essential for you to fund QA via the constructor, have the CoMET fee included as an allowance in the bid documents. Note, too, that the International Building Code (IBC) requires the owner to pay for Special Inspection (SI) services.

CoMET consultants can usually quote their fees as unit fees, unit fees with estimated total (invoiced on a unit-fee basis), or lump-sum (invoiced on a percent-completion basis referenced to a schedule of values). No matter which method is used, estimated quantities need to be realistic. Some CoMET firms lower their total-fee estimates by using quantities they know are too low and then request change orders long before QA is complete.

Once you and the CoMET consultant settle on the scope of service and fee, enter into a written contract. Established CoMET firms have their own contracts; most owners sign them. Some owners prefer to use different contracts, but that can be a mistake when the contract was prepared for construction services. *Professional services are different.* Wholly avoidable problems occur when a contract includes provisions that don't apply to the services involved and fail to include those that do.

Some owners create wholly avoidable problems by using a contract prepared for construction services.

This final note: CoMET consultants perform QA for owners, not constructors. While constructors are commonly allowed to review QA reports as a *courtesy*, you need to make it clear that constructors do *not* have a legal right to rely on those reports; i.e., if constructors want to forgo their own observation and testing and rely on results derived from a scope created to meet *only* the needs of the owner, they *must do so at their own risk*. In all too many cases where owners have not made that clear, some constructors have alleged that they did have a legal right to rely on QA reports and, as a result, the CoMET consultant – not they – are responsible for their failure to deliver what they contractually promised to provide. The outcome can be delays and disputes that entangle you and all other principal project participants. Avoid that. Rely on a CoMET firm that possesses the resources and attitude needed to manage this and other risks as an element of a quality-focused service. Involve the firm early. Keep it engaged. And listen to what the CoMET consultant says. A good CoMET consultant can provide great value.

For more information, speak with your ASFE-Member CoMET consultant or contact ASFE directly.

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