Preliminary Geotechnical Evaluation Report

Hempstead County Economic Development Potential Site
State Highway 32
Hope, Arkansas

Prepared for

Hempstead County Economic Development Corporation

No. 10237
DAVID A. WRIGHT

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September 10, 2019

Project B1907122

Braun Intertec Corporation
Certificate of Authorization No. 2930, Expires 12/31/2020

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September 10, 2019

Project B1907122

Mr. Steve Harris
Hempstead County Economic Development Corporation
108 West 3rd street
Hope, Arkansas 71801

Re: Preliminary Geotechnical Evaluation
Hempstead County Economic Development Potential Site
State Highway 32
Hope, Arkansas

Dear Mr. Harris:

We are pleased to present this Preliminary Geotechnical Evaluation Report for the proposed industrial park for the Hempstead County Economic Development Corporation located at the above referenced site. The recommendations provided within this report are preliminary and should be confirmed or revised based on a final geotechnical evaluation.

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please contact us at 903-581-8080, or email CWardien@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION
Arkansas COA #2930, exp. 12/31/2020

Cody Wardien
Associate Principal

David A. Wright, P.E.
Principal Engineer

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A. Introduction

A.1. Project Description and Use of This Report

This Preliminary Geotechnical Evaluation Report addresses the design and construction feasibility of a new warehouse building in Hope, Arkansas. The primary property consists of a 164-acre tract south of State Highway 32 and east of a Union Pacific railroad track. There is an additional 72-acre tract located north of State Highway 32 and east of US Highway 278. Based on our understanding, the building will be located on approximately 35 acres of the property located south of State Highway 32. The exact location of the building was not known at the time this report was prepared. Also, specific building layout and structural information was not available at the time of this report. Table 1 below provides project assumptions made based on our conversations with the Hempstead County Economic Development Corporation (Hempstead County EDC).

Table 1. Building Descriptions

Aspect	Description
Below grade levels	None
Above grade levels	Single-story structure (Assumed)
Column loads (kips)	Less than 75 (Assumed)
Wall loads (kips per linear foot)	Less than 5 (Assumed)
Nature of construction	Pre-engineered metal building (Assumed)
Cuts or fills for buildings	Grade changes up to 5 feet depending on the final location of the structure (Assumed)
Tolerable building movement	Less than 1 inch (assumed)

This investigation report can be used for providing information to industrial prospects, including available ranges of soil bearing pressures, variations in stratigraphy, groundwater occurrence, and related technical site characteristics. Once a specific site and building layout is selected, a final geotechnical investigation must be made for design and construction of the structure, based on known loading, planned grading and other details. We will be pleased to provide a supplemental or final investigation at the appropriate time, to the appropriate party.

A.2. Site Conditions and History

Currently, the areas planned for the proposed new warehouse building are either grass covered or plowed agricultural fields. The surrounding areas have been developed with the existing Union Pacific railroad track to the west, and commercial buildings/warehouses and streets and utilities to the north. The following Figure provides an aerial image of the site in Google Earth™ with the proposed property outlined in red.

Figure 1. Aerial Photograph of the Site

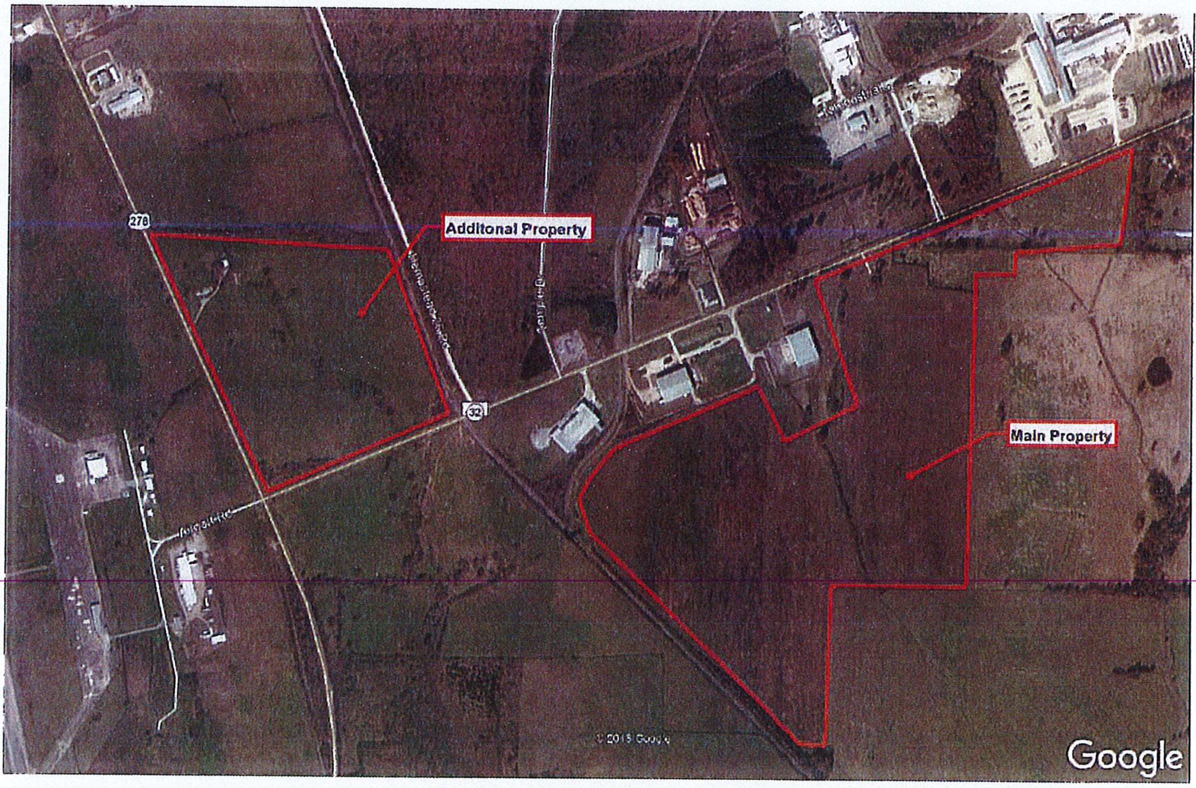


Figure obtained from Google Earth™, imagery date of March 16, 2019.

Based on elevations obtained from Google Earth™ and the topographic map provided to us, the main property gradually slopes downward from the northeast corner to the southwest corner with grade changes on the order of 32 feet, corresponding to elevations ranging from 376 to 344 feet. Grades across the additional site slope downward from the northwest corner to the southeast corner with grade changes on the order of 43 feet, corresponding to elevations ranging from 371 to 328 feet.

Both of the sites have low-lying areas or drainage swales that run through the centers of each of the properties.

A.3. Purpose

The purpose of our preliminary geotechnical evaluation is to characterize the subsurface geologic conditions at selected exploration locations and evaluate the impact on the feasibility of design and construction of the proposed warehouse building.

A.4. Background Information and Reference Documents

We reviewed the following information:

- Site overview by Hempstead County EDC entitled "Heather HWL property contours", received on April 23, 2019.
- Communications with Mr. Steve Harris with Hempstead County EDC, regarding project details.
- Aerial images of the site viewed in Google Earth™, imagery dates of January 1994 to March 2019.
- Arkansas Geology Web Explorer (https://mrdata.usgs.gov/geology/state/).

In addition to the provided sources, we have used several publicly available sources of information.

We have described our understanding of the proposed construction and site to the extent others reported it to us. Depending on the extent of available information, we have made assumptions based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, the project team should notify us. New or changed information could require additional evaluation, analyses and/or recommendations.

A.5. Scope of Services

We performed our scope of services for the project in accordance with our revised proposal to Mr. Steve Harris dated June 28, 2019 and authorized July 2, 2019. Due to the site access/conditions a change order was submitted and accepted by Mr. Harris authorizing the use of an all-terrain drill rig. The following list describes the geotechnical tasks completed in accordance with our authorized scope of services.

- Reviewing the background information and reference documents previously cited.
- Clearing the exploration location to avoid potential interference with existing underground utilities. We staked the borings using a hand-held GPS device by placing the borings approximately ½ mile apart (as requested by Mr. Harris) in Google Earth™ and obtaining coordinates at those locations. Ground surface elevations were also interpolated from Google Earth™. The Soil Boring Location Sketch included in the Appendix shows the approximate locations of the borings.
- Drilling four (4) borings, denoted as ST-1 to ST-4, to nominal depths of 50 feet below grade across the site. Due to the high penetration resistance values recorded at all four locations, the borings were terminated at the depth of approximately 40 feet below grade.
- Performing laboratory testing on selected samples to aid in soil classification and engineering analysis.
- Preparing this report containing a boring location sketch, logs of soil borings, a summary of the soils encountered, results of laboratory tests, and preliminary findings for structure subgrade preparation and the design of foundations, floor slabs, exterior slabs, and utilities.

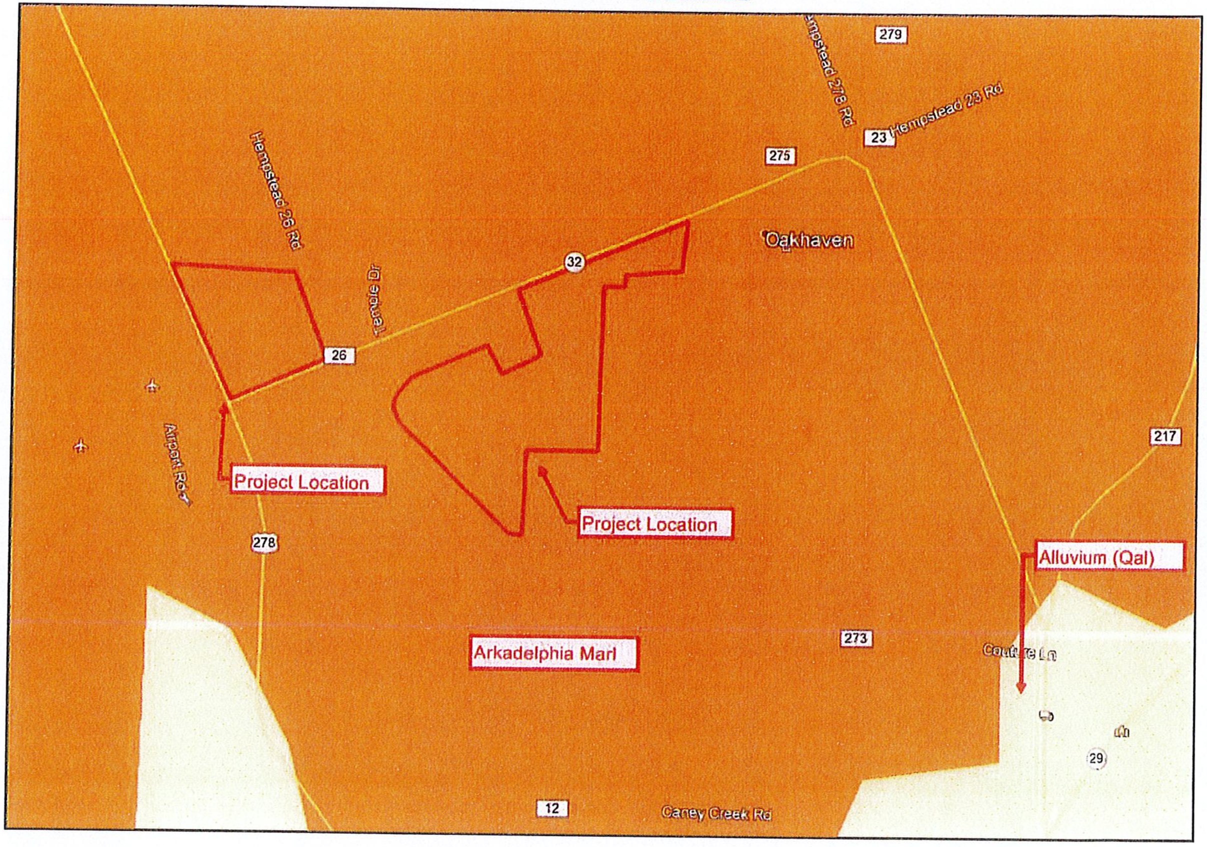
Our scope of services did not include environmental services or testing, and we did not train the personnel performing this evaluation to provide environmental services or testing. We can provide these services or testing at your request.

B. Results

B.1. Geologic Overview

Based upon our review of available geologic resources, the site is located within the Arkadelphia Marl Formation which consists of fossiliferous marl, marly clay, and sandy limestone. The surface materials at this site are primarily comprised of very stiff to hard fat clay, underlain by deeper deposits of fat clay and marl. Below is a geologic map for the area with the site location shown in red.

Figure 2. Geologic Map (https://mrdata.usgs.gov/geology/state/)



We based the geologic origins used in this report on the soil types, laboratory testing, and available common knowledge of the geological history of the site. Because of the complex depositional history, geologic origins can be difficult to ascertain. We did not perform a detailed investigation of the geologic history for the site.

B.2. Boring Results

Table 2 provides a summary of the soil boring results, in the general order we encountered the strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology sheets in the Appendix include definitions of abbreviations used in Table 2.

Table 2. Subsurface Profile Summary*

Strata		Soil Type - ASTM Classification	Range of Penetration Resistances	Commentary and Details
I	Fat Clay	CH	34 to 77 blows per foot (BPF) 2.25 to 4.5+ tsf	▪ Dark gray to gray, brown to yellowish brown and dark brown in color. ▪ Very stiff to hard in relative consistency. ▪ Encountered from the surface to depths ranging from 23 to 38 feet.
II	Bedrock	Marl	91 (BPF) to 50 blows for 3 inches of penetration 4.5+ tsf	▪ Dark gray in color. ▪ Encountered at 38 feet to the termination depth in Boring ST-2 to ST-4 and at 23 feet to the termination depth in Boring ST-1.

*Abbreviations defined in the attached Descriptive Terminology sheets.

B.3. Groundwater

Table 3 summarizes the depths where we observed groundwater; the attached Log of Boring sheets in the Appendix also include this information and additional details.

Table 3. Groundwater Summary

Location	Approximate Surface Elevation	Approximate Depth to Groundwater During Drilling (ft)	Corresponding Approximate Groundwater Elevation After Auger Withdrawal (ft)
ST-1	346	26	320
ST-2	366	27	339
ST-3	364	28	336
ST-4	349	28	321

If the project team identifies a need for long-term groundwater readings, piezometers can be installed. Project planning should anticipate seasonal and annual fluctuations of groundwater.

B.4. Laboratory Test Results

The boring logs included in the Appendix show the results of the Atterberg limits, moisture content, and percent finer than the No. 200 sieve tests we performed, next to the tested sample depth. Table 4 below shows the range of the test results.

Table 4. Laboratory Tests – Range of Results

Soil Type	Moisture Content Range (%)	Percent Passing a #200 Sieve	Liquid Limit Range (%)	Plastic Limit Range (%)	Plasticity Index Range (%)
Fat Clay (CH)	11 to 42	83 to 98	58 to 85	15 to 24	43 to 64

One-dimensional free swell tests were conducted to further review the shrink/swell potential. The measured swell values are provided in Table 5:

Table 5. Free Swell Test Results

Boring Location	Depth, ft	PI	Moisture Content		Percent Swell
			Initial	Final	
ST-1	8-10	64	32.4	35.5	1.5
ST-3	4-6	52	27.5	30.5	1.2
ST-4	6-8	56	28.0	34.0	1.5

C. Preliminary Findings

C.1. Design and Construction Discussion

Based on results of our field exploration, laboratory testing, and our understanding of the proposed project, it is our opinion that the overall subsurface conditions are suitable for the construction of the proposed new warehouse building. Our results also show that the clay soils have the potential to shrink and swell due to moisture fluctuations within the surficial active zone (see additional discussion in the following Section). However, such soils can be readily stabilized using several techniques, including replacement, moisture conditioning, water injection, chemical stabilization, and rammed aggregate piers within the active zone. Shallow foundations (individual and continuous footings and grade beams), and deep foundations (straight or underreamed drilled shafts) may be used. The relatively hard clays and deeper bedrock or marl represent ideal conditions for drilled shafts for unusually heavy column loads. The most cost-effective method will depend on loads and foundation movement restrictions.

Again, additional borings will need to be performed for final design. Section C.1.b below provides prospective options regarding the foundation system design along with subgrade improvements below the building footprint.

C.1.a. Expansive Soil Conditions/Potential Vertical Movements (PVM)

The explored site stratigraphy generally consists of very stiff to hard fat clay, underlain by deeper deposits of fat clay and marl. While these strata have ideal characteristics for load support, the upper zone of the clay has high potential to shrink and swell due to moisture fluctuations, predominantly due to seasonal rainfall and temperature changes, but also potentially affected by surface drainage and topographic changes due to grading and other factors. These shrink-swell cycles can cause unsatisfactory performance of the foundation system if not properly mitigated.

Potential Vertical Movement (PVM) values were estimated using the McDowell's Method of potential vertical rise and from the free swell tests performed in the laboratory. The PVM from soil borings in the planned foundation area was calculated to be on the order of 6 to 7 3/4 inches from a dry condition. However, the dry condition represents an extreme condition that will likely not be realized, and is not anticipated based on laboratory testing. At the current soil moisture level, total swell movements were estimated to be less, approximately 5 to 6 1/2 inches. The free swell tests indicated swell values of up to 1.5 percent which is consistent with this range of movement. The swell test results indicate the soils are currently in a moderate state of swell and would be expected to undergo only moderate additional swell at their current moisture conditions.

Actual soil movements that will occur depend on various factors, including the prevailing soil moisture conditions as outlined above. Such soil "heave" movements are a result not only of the soil stratigraphy, but also the climate. For example, the highly-expansive clay soils of North Central Texas (including the Dallas-Fort Worth metroplex) can result in actual observed PVM of up to 10 to 12 inches, primarily due to more extreme climate variations (dry to wet). These more extreme soil conditions are routinely stabilized for a variety of warehouse and manufacturing facilities using the methods mentioned above.

If significant rainfall is anticipated during construction, the site should be graded to intercept surface water flow, drain water from the construction area to an appropriate collection point, and prevent accumulation of water within excavations. After grading, the soil surface should be compacted with a smooth drum roller to attempt to lower infiltration. After the rain, construction traffic should be limited until the surface has dried somewhat, to prevent traffic from mixing water that has accumulated at the surface into lower portions of the soil.

C.1.b. Foundations and Floor Slabs

We have performed a preliminary evaluation of potential vertical movements and earthwork by assuming the nature of construction. The following foundation and subgrade improvement options are typical for the explored soil conditions, and represent means for support of structural loads and for reducing potential vertical movements as mentioned above.

C.1.b.1. Straight (or Underreamed) Drilled Shafts and Suspended Floor

Foundations consisting of deep drilled shafts "socketed" into dark gray Marl in conjunction with a structurally suspended slab would provide support for heavy loads, and is the most effective way to limit settlement and heave movement to very low tolerances. Based on our preliminary calculations, shaft lengths between 30 to 40 feet could be used for such support. Allowable end bearing values on the order of 15 to 20 ksf are available at these depths, with allowable side friction on the order of 2 ksf. Underreams are feasible within the clay strata. Further analysis of the site is required to determine the actual embedment depths of the shafts for differing loads. Using drilled shafts, and suspending the floor slab represents a very conservative design approach, and is not usually needed except for very stringent foundation movement criteria, and very heavy loading. Nevertheless, based on the borings, the site offers this advantage and benefit if needed.

C.1.b.2. Straight (or Underreamed) Drilled Shafts and Ground-Supported Floor Slab

This is the same as above except the floor would be ground-supported. Subgrade treatment would be required to limit PVM to 1 inch or less; refer to the next section below. Usually an isolation joint is provided between the floor slab and columns to accommodate slight movements.

C.1.b.3. Subgrade Removal/Replacement with Select Fill

In order to reduce PVM to 1 inch or less, removal and replacement the highly plastic clays could be performed. Based on our preliminary calculations, removals on the order of 8 to 12 feet below existing grade could be expected for planning purposes. The excavation should then be backfilled with select fill to design grades. Select fill should consist of clayey sands or sandy lean clays with a plasticity index of between 8 to 18 and a maximum of 60 percent passing the number 200 sieve. Additional suggestions for select fill material specifications would be provided in the final geotechnical evaluation. In addition, further analysis of the site will be required to determine actual removal depths to limit PVM to less than 1 inch at the specific building location. This option is consistent with either shallow foundations or deep foundations.

C.1.b.4. Moisture Conditioning Existing Subgrade Soils with Fill Cap

As an alternative to removal and replacement with select fill, moisture conditioning the native on-site soils can be used for reducing PVM to 1 inch or less. Moisture conditioning consists of removing the on-site soils below the building footprint and pre-swelling them by increasing the moisture content of the soils to about 4 to 5 percentage points above their optimum moisture contents and recompacting them to project specifications (typically between 92 to 98 percent of the standard Proctor maximum dry density). This is typically accomplished by excavating and stockpiling the soils on site, then replacing them in layers. Each individual layer is "watered" and mixed, then compacted. Based on our preliminary calculations, our estimates indicate that moisture conditioning would need to be performed to a depth of 11 feet below existing grades. If the moisture conditioning method is chosen, at least one (1) foot of select fill or crushed aggregate roadway base should be used to cap the pad to preserve the moisture, and to provide a stable working surface for construction.

C.1.b.5. Electrochemical Injection of Existing Soils

As an alternative to removal/replacement or moisture conditioning, the on-site soils can be electrochemically injected. The purpose of the electrochemical pressure injection is to modify the underlying clay soils and reduce the swell potential through chemical reaction to within the desired performance criteria. The main benefit of this process is that it does not require the removal of the existing soils. To achieve the required electrochemical stabilization performance criteria of 1 inch, an estimated injection depth of 12 to 15 feet would be required. This process does require confirmation testing during the injection process to confirm that the soils meet the design swell criteria.

C.1.b.6. Water Injection of Existing Soils

Another alternative for subgrade treatment to reduce potential heave is to inject the soils with water. This pre-swells the soils, and is accomplished by inserting steel rods with an end nozzle into the ground using hydraulic pressure and injecting water into the soil. Typically an initial depth of 12 inches is used, and water is injected through the rod and end nozzle at 200 psi pressure. The injection continues until "refusal" is observed; "refusal" is surfacing of water around the injection rig, in addition to some water surfacing around the injector rods. Once refusal occurs, the injector rods are pushed one foot deeper and water injected again until refusal occurs. This process is repeated until the full injection depth is reached.

Once an injection "station" is completed to full depth, the rig moves 4 feet and the process is repeated until the entire site is injected by one pass of the injector rig. Several passes are usually required; the injector stations are offset with each pass to improve coverage. The injection contractor will typically bid the project based on review of the boring logs and allowable movement criteria. Four (4) to six (6) passes are typical. Most injection contractors use several rigs and may work "24/7" under night lighting. This process also does not require the removal of the existing soils. To achieve the required stabilization performance criteria of 1 inch or less, an estimated injection depth of 10 feet is anticipated.

Once all passes are completed, verification testing is required by a geotechnical consultant, based on free swell test results of undisturbed samples. If the tests fail, additional passes are required, then re-sampling and testing. Due to significant mob/demob costs, most injection contractors will leave the rigs at the site until passing tests are obtained. The process results in a very wet, soft surface; some projects use chemical additives such as hydrated lime or flyash to stabilize the upper 1 to 2 feet, which will reduce the required depth of stabilization. Another method of surface stabilization is to place about 2 feet of select fill or crushed aggregate base material. These “caps” also serve to reduce loss of soil moisture while waiting on slabs and perimeter paving to be placed. While water injection is not a common practice in the project area, it is used extensively for large projects throughout North Central Texas.

C.1.b.7. Rammed Aggregate Piers by Geopier

Rammed aggregate piers (RAPs) installed through a portion of the active zone can also be used to stabilize the active clay zone. Geopier provides engineering, and construction through an approved contractor. They will determine feasibility and provide a bid to construct the stabilization RAPs based on review of the logs of the final geotechnical report and relevant project details.

C.1.c. Filling On Slopes

Where fill will be placed on slopes steeper than 4:1 (H:V), we recommend benching the new fills into the existing slope in order to tie the new fills into the existing soils. The “stair step”-shaped benches are recommended to key the fill into existing slopes and reduce the risk of fill instability. Fill should be placed starting at the bottom of the slope and working up toward the top. Benches should be a minimum of 4 feet wide (or wider as necessary to accommodate compaction equipment), with the heights dependent upon the existing slope.

C.1.d. Allowable Bearing Capacity

For planning purposes, we anticipate that a maximum allowable bearing pressure of approximately 2,500 psf bearing in select fill or 1,250 psf bearing in moisture conditioned or water injected native soils may be used to proportion shallow foundations such as individual and continuous footings and grade beams. For soil bearing capacity of drilled shafts, refer to Sections C.1.b.1 and C.1.b.2 above.

C.1.e. Existing Trees

The near surface soils in the area of the existing trees will likely require moisture conditioning prior to being used as backfill and fill at this site. The effects of evapotranspiration from nearby trees can adversely affect the foundation soils by removing moisture during dry periods through their extensive root systems, resulting in shrinkage or subsidence of the subgrade in the tree-structure proximity. Therefore, Braun Intertec recommends the following:

- Trees around planned slabs be no closer than 50 percent (50%) of the mature height of the tree.
- The new building should not be positioned within the vertical projection of mature tree canopies or drip lines.
- If trees and large bushes are placed within closer proximity of the new slab foundation, vertical root barriers to a depth of at least four (4) feet below ground should be installed to inhibit the movement of the tree's roots systems under the foundation.

C.1.c. Reuse of On-Site Soils

The surface vegetation, root zones and soils with an organic content greater than 3 percent should not be used as backfill or fill in the proposed building areas or the upper 3 feet of the pavement areas. Those materials should be used in landscaped areas or hauled off-site.

Based on the results of the laboratory analysis, the encountered on-site soils do not comply with select fill criteria and should not be considered for reuse in select fill applications. Soils intended for select fill should be verified through laboratory analysis and approved prior to reuse. Contract documents should also include the associated costs of using an approved imported select fill material.

C.2. Pavement

Pavement areas should be stripped of topsoil, organic soils, and any remnant construction debris. Once stripped the soils should be inspected by a qualified geotechnical technician to observe the area is free of deleterious materials. Performing a sulfate content test is recommended prior to stabilization, to indicate whether on site soils have exposure to sulfate attack.

Prior to placing any pavement components, the subgrade should be prepared, compacted and evidence stability to a thickness or depth of at least 6 inches. The subgrade may require treatment with hydrated lime, cement, or flyash, depending on the anticipated traffic.

For rigid (concrete) sections, we anticipate that a thickness of 5 inches will meet light-duty requirements (auto and occasional trucks). Typical heavy-duty paving would consist of 7 inches of concrete. All concrete paving should be reinforced for "temperature and shrinkage", usually No. 3 deformed bars on 18" centers each way.

For flexible (asphaltic) sections, 2 inches of asphaltic concrete would be placed on 7 to 8 inches of crushed aggregate roadway base for light-duty use. For heavy-duty asphaltic paving, at least 3 inches of asphaltic surface course would be supported by 10 inches or more of roadway base, again, depending also on planned traffic.

C.2.a. Lime Treated Subgrade

Due to the presence of highly-plastic clay subgrades at this site, a minimum of 6 inches (compacted thickness) of lime stabilization is recommended for budgeting purposes. Lime stabilization should be performed in general accordance with Arkansas Department of Transportation Standard Specifications. A lime percentage of between 8 and 10 percent (by dry weight) could also be assumed for budgeting purposes. Additional lime might be needed to account for losses associated with dusting, blowing, overmixing, or other field losses. Additional laboratory testing will be required to determine the actual lime percentage required for this site.   In addition, sulfate testing should be performed to determine if sulfate interaction will have a negative effort on the stabilizing materials.

D. Procedures

D.1. Penetration Test Borings

We drilled the borings with an all-terrain floatation tire drill rig. Soils were sampled using the Standard Penetration Test (SPT) split spoon barrel in accordance with ASTM D1587. Soils samples were taken at 2-foot vertical intervals in the upper 10 feet and at 5-foot intervals thereafter. The boring log show the actual sample intervals and corresponding depths.

D.2. Exploration Logs

D.2.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our penetration test borings. The logs identify and describe the penetrated geologic materials, and present the results of penetration resistance tests performed. The logs also present the results of laboratory tests performed on penetration test samples, and groundwater measurements. The Appendix also includes a Fence Diagram intended to provide a summarized cross-sectional view of the soil profile across the site.

We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. Because we did not perform continuous sampling, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may occur as gradual rather than abrupt transitions.

D.2.b. Geologic Origins

We assigned geologic origins to the materials shown on the logs and referenced within this report, based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance and other in-situ testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

D.3. Material Classification and Testing

D.3.a. Visual and Manual Classification

We visually classified the soils encountered in the borings in accordance with ASTM D2488. The Appendix includes a chart explaining the classification system.

D.3.b. Laboratory Testing

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. The remaining laboratory test results follow the exploration logs. We performed the tests in general accordance with ASTM or AASHTO procedures.

D.4. Groundwater Measurements

The drillers checked for groundwater while advancing the test borings, and again after auger withdrawal. We then backfilled the boreholes as noted on the boring logs.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

We developed our evaluation, analyses and findings from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata to vary in depth, elevation and thickness, away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

E.1.b. Groundwater Levels

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our findings. We should be retained to provide the final geotechnical investigation, and review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

E.2.b. Construction Observations and Testing

After completion of the final geotechnical investigation, we should be retained to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

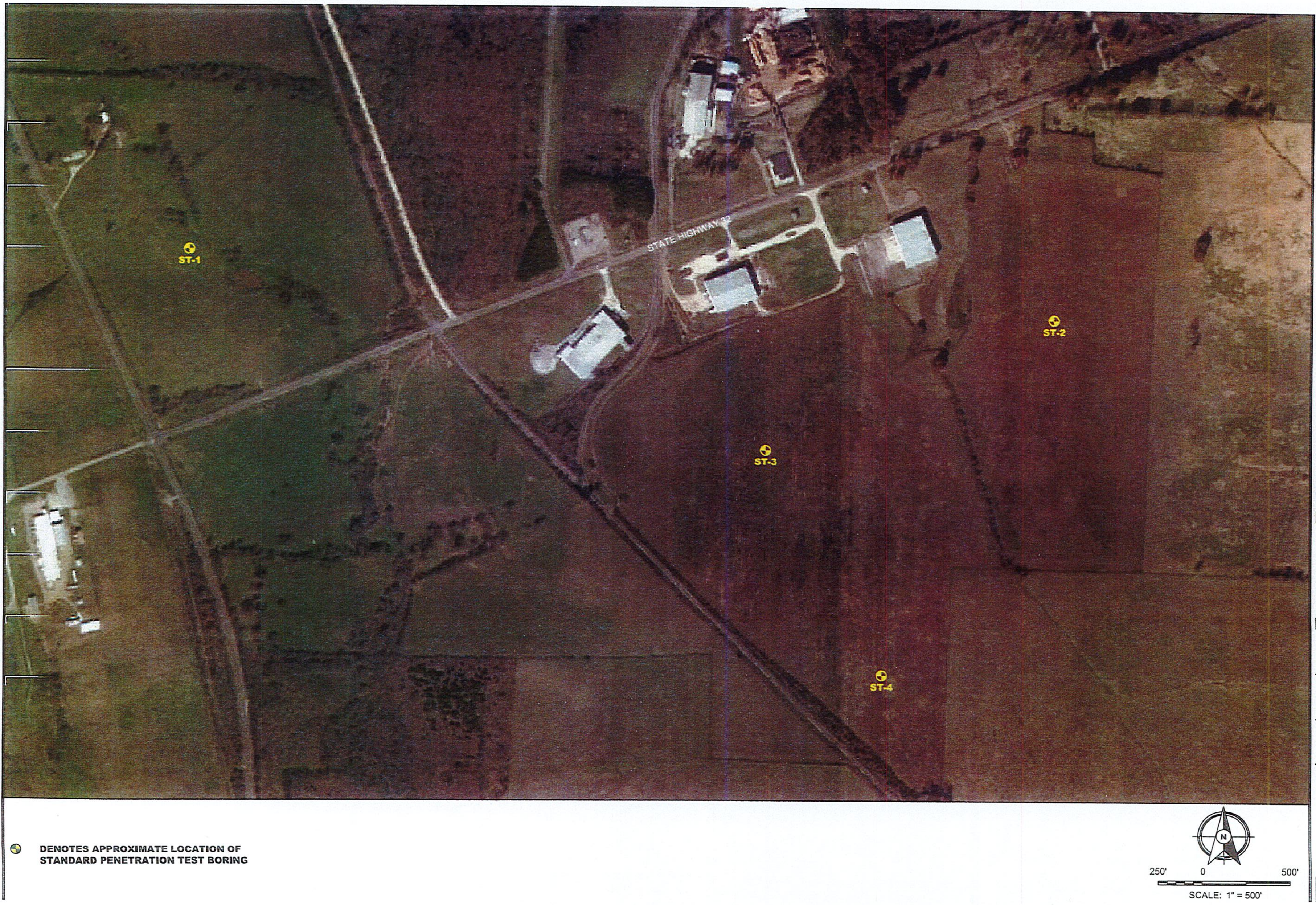
E.3. Use of Report

This report is for the exclusive use of the addressed parties. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and findings may not be appropriate for other parties or projects.

E.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix



DENOTES APPROXIMATE LOCATION OF
STANDARD PENETRATION TEST BORING

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Drawing Information

Project No:
B1907122

Drawing No:
B1907122

Drawn By:	LAO
Date Drawn:	8/28/19
Checked By:	RE
Last Modified:	8/28/19

Project Information

Hempstead County
Economic Development
Site

State Highway 32

Hope, Arkansas

Soil Boring Location Sketch

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122 **Geotechnical Evaluation** **Hempstead County Economic Development Site** **State Highway 32** **Hope, Arkansas**		BORING: **ST-1** LOCATION: See attached sketch	
		LATITUDE: 33.72514	LONGITUDE: -93.64691
DRILLER: J. Mitchell	LOGGED BY: J. Mitchell	START DATE: 08/13/19	END DATE: 08/13/19
SURFACE ELEVATION: 346.0 ft	RIG: 7501 METHOD: SSA	SURFACING:	WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
		FAT CLAY (CH), dark gray to gray, very stiff to hard			>4.5	25	LL=81, PL=22, PI=59 P200=96%
					3.5	30	
					3.5	28	
		Trace calcarious particles with pockets of ferrous material, gray to yellowish brown			3.75	26	
		Yellowish brown to tan			>4.5	30	LL=84, PL=20, PI=64 P200=98%
					>4.5	25	
		Trace gypsum and calcarious particles			>4.5	24	
323.0 23.0		Marl, trace gypsum particles, tan to dark gray			>4.5	25	LL=70, PL=19, PI=51 P200=98%
	▽						
					>4.5	25	

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122
Geotechnical Evaluation
Hempstead County Economic Development Site
State Highway 32
Hope, Arkansas

BORING: **ST-1**
LOCATION: See attached sketch
LATITUDE: 33.72514
LONGITUDE: -93.64691
DRILLER: J. Mitchell
LOGGED BY: J. Mitchell
START DATE: 08/13/19
END DATE: 08/13/19
SURFACE ELEVATION: 346.0 ft
RIG: 7501
METHOD: SSA
SURFACING:
WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
		Marl, trace gypsum particles, tan to dark gray	■		>4.5	24	
306.0 40.0		END OF BORING Boring immediately backfilled	☒	30-47-50/-4" (REF) 16"			Water observed at 26.0 feet while drilling.

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122
Geotechnical Evaluation
Hempstead County Economic Development Site
State Highway 32
Hope, Arkansas

BORING: **ST-2**

LOCATION: See attached sketch

LATITUDE: 33.72428
LONGITUDE: -93.63068

DRILLER: J. Mitchell
LOGGED BY: J. Mitchell
START DATE: 08/13/19
END DATE: 08/13/19

SURFACE ELEVATION: 366.0 ft
RIG: 7501
METHOD: SSA
SURFACING:
WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
		FAT CLAY (CH), trace Sand, brown to yellowish brown, very stiff to hard			3.75	20	
					4	24	LL=58, PL=15, PI=43 P200=90%
		5			4	33	
		With pockets of ferrous material			3	28	
					>4.5	21	
		10					
		Trace calcarious particles			4	23	LL=67, PL=18, PI=49 P200=89%
		15					
					>4.5	26	
		20					
					>4.5	22	
		25					
	▽						
					>4.5	24	
		30					

Continued on next page

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122
Geotechnical Evaluation
Hempstead County Economic Development Site
State Highway 32
Hope, Arkansas

BORING:	**ST-2**		
LOCATION: See attached sketch			
LATITUDE:	33.72428	LONGITUDE:	-93.63068
DRILLER: J. Mitchell	LOGGED BY: J. Mitchell	START DATE: 08/13/19	END DATE: 08/13/19
SURFACE ELEVATION: 366.0 ft	RIG: 7501	METHOD: SSA	SURFACING:
WEATHER:			

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
328.0 38.0		FAT CLAY (CH), trace Sand, brown to yellowish brown, very stiff to hard	■		4.5	24	
326.0 40.0		Marl, dark gray	⌛	36-44-50/-3" (REF) 15"		16	Water observed at 27.0 feet while drilling.
		END OF BORING Boring immediately backfilled					

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122 **Geotechnical Evaluation** **Hempstead County Economic Development Site** **State Highway 32** **Hope, Arkansas**	BORING: **ST-3** LOCATION: See attached sketch

LATITUDE: 33.72214	LONGITUDE: -93.63604		
DRILLER: J. Mitchell	LOGGED BY: J. Mitchell	START DATE: 08/13/19	END DATE: 08/13/19
SURFACE ELEVATION: 364.0 ft	RIG: 7501	METHOD: SSA	SURFACING:
WEATHER:			

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
		FAT CLAY (CH), dark brown, very stiff to hard	■		4.25	24	
			■		3	25	
		Trace ferrous material, tan to gray	■				
5			■		3.5	25	LL=72, PL=20, PI=52 P200=83%
		Trace calcarious particles	■		2.25	22	
			■		2.25	29	
10							
		Yellowish brown	■		2.5	32	LL=80, PL=23, PI=57 P200=93%
15							
		Trace sand	■		>4.5	13	
20							
			⧖	13-13-26 (39)		27	
25							
	▽						
			⧖	10-13-21 (34)		26	
30							

Continued on next page

LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122
Geotechnical Evaluation
Hempstead County Economic Development Site
State Highway 32
Hope, Arkansas

BORING: **ST-3**

LOCATION: See attached sketch

LATITUDE: 33.72214

LONGITUDE: -93.63604

DRILLER: J. Mitchell

LOGGED BY: J. Mitchell

START DATE: 08/13/19

END DATE: 08/13/19

SURFACE ELEVATION: 364.0 ft

RIG: 7501

METHOD: SSA

SURFACING:

WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	qp tsf	MC %	Tests or Remarks
		FAT CLAY (CH), dark brown, very stiff to hard	⊠	23-36-41 (77)		30	
326.0 38.0		Marl, dark gray	⊠	33-41-50 (91)		20	Water observed at 28.0 feet while drilling.
324.0 40.0		END OF BORING Boring immediately backfilled					

35
40
45
50
55
60

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122
Geotechnical Evaluation
Hempstead County Economic Development Site
State Highway 32
Hope, Arkansas

BORING: **ST-4**
LOCATION: See attached sketch
LATITUDE: 33.71859
LONGITUDE: -93.63379
DRILLER: J. Mitchell
LOGGED BY: J. Mitchell
START DATE: 08/13/19
END DATE: 08/13/19
SURFACE ELEVATION: 349.0 ft
RIG: 7501
METHOD: SSA
SURFACING:
WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
		FAT CLAY (CH), trace roots, and fibers, dark brown, very stiff to hard			>4.5	18	
		Trace sand			2.5	25	LL=65, PL=18, PI=47 P200=93%
5					2.5	27	
		Brown to yellowish brown			2.75	26	LL=74, PL=18, PI=56 P200=85%
		Pockets of ferrous materials			3	26	
10							
		Yellowish brown			>4.5	30	LL=85, PL=24, PI=61 P200=94%
15							
					>4.5	11	
20							
		Trace gypsum particles			>4.5	18	
25							
	▽						
					>4.5	23	
30							

Continued on next page

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LOG OF BORING

See Descriptive Terminology sheet for explanation of abbreviations

Project Number B1907122 **Geotechnical Evaluation** **Hempstead County Economic Development Site** **State Highway 32** **Hope, Arkansas**	BORING: **ST-4** LOCATION: See attached sketch LATITUDE: 33.71859 LONGITUDE: -93.63379

DRILLER: J. Mitchell	LOGGED BY: J. Mitchell			START DATE: 08/13/19	END DATE: 08/13/19
SURFACE ELEVATION: 349.0 ft	RIG: 7501	METHOD: SSA		SURFACING:	WEATHER:

Elev./ Depth ft	Water Level	Description of Materials (Soil-ASTM D2488 or 2487; Rock-USACE EM 1110-1-2908)	Sample	Blows (N-Value) Recovery	q_p tsf	MC %	Tests or Remarks
311.0		FAT CLAY (CH), trace roots, and fibers, dark brown, very stiff to hard	■		>4.5	42	
38.0 309.0		Marl, dark gray	⌛	26-38-50/-4" (REF) 16"		17	Water observed at 28.0 feet while drilling.
40.0		END OF BORING Boring immediately backfilled					

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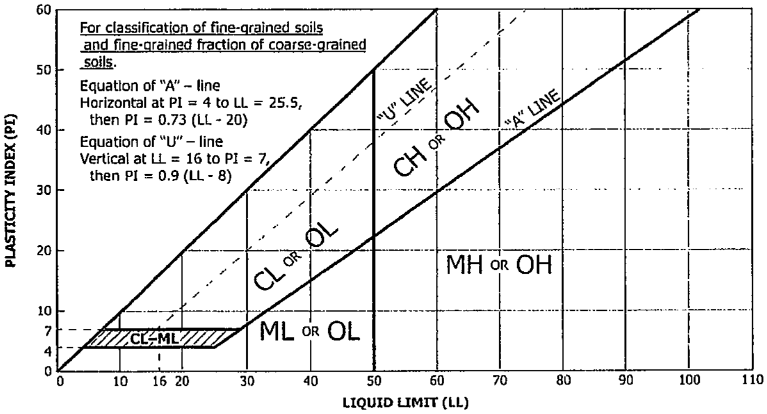
Descriptive Terminology of Soil

Based on Standards ASTM D2487/2488
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-grained Soils (more than 50% retained on No. 200 sieve)	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines[C])	$C_u \geq 4$ and $1 \leq C_c \leq 3$[D]	GW	Well-graded gravel[E]
			$C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$)[D]	GP	Poorly graded gravel[E]
		Gravels with Fines (More than 12% fines[C])	Fines classify as ML or MH	GM	Silty gravel[E F G]
			Fines Classify as CL or CH	GC	Clayey gravel[E F G]
	Sands (50% or more coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines[H])	$C_u \geq 6$ and $1 \leq C_c \leq 3$[D]	SW	Well-graded sand[I]
			$C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$)[D]	SP	Poorly graded sand[I]
		Sands with Fines (More than 12% fines[H])	Fines classify as ML or MH	SM	Silty sand[F G I]
			Fines classify as CL or CH	SC	Clayey sand[F G I]
Fine-grained Soils (50% or more passes the No. 200 sieve)	Silts and Clays (Liquid limit less than 50)	Inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K L M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K L M]
		Organic	$\frac{\text{Liquid Limit - oven dried}}{\text{Liquid Limit - not dried}} < 0.75$	OL	Organic clay [K L M N] Organic silt [K L M O]
	Silts and Clays (Liquid limit 50 or more)	Inorganic	PI plots on or above "A" line	CH	Fat clay[K L M]
			PI plots below "A" line	MH	Elastic silt[K L M]
		Organic	$\frac{\text{Liquid Limit - oven dried}}{\text{Liquid Limit - not dried}} < 0.75$	OH	Organic clay [K L M P] Organic silt [K L M Q]
Highly Organic Soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

A. Based on the material passing the 3-inch (75-mm) sieve.
B. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C. Gravels with 5 to 12% fines require dual symbols:
    GW-GM well-graded gravel with silt
    GW-GC well-graded gravel with clay
    GP-GM poorly graded gravel with silt
    GP-GC poorly graded gravel with clay
D. $C_u = D_{60} / D_{10}$ $\quad C_c = (D_{30})^2 / (D_{10} \times D_{60})$
E. If soil contains ≥ 15% sand, add "with sand" to group name.
F. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
G. If fines are organic, add "with organic fines" to group name.
H. Sands with 5 to 12% fines require dual symbols:
    SW-SM well-graded sand with silt
    SW-SC well-graded sand with clay
    SP-SM poorly graded sand with silt
    SP-SC poorly graded sand with clay
I. If soil contains ≥ 15% gravel, add "with gravel" to group name.
J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
K. If soil contains 15 to < 30% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
L. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
M. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
N. PI ≥ 4 and plots on or above "A" line.
O. PI < 4 or plots below "A" line.
P. PI plots on or above "A" line.
Q. PI plots below "A" line.



Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3" (19.00 mm to 75.00 mm)
Fine	No. 4 to 3/4" (4.75 mm to 19.00 mm)
Sand	
Coarse	No. 10 to No. 4 (2.00 mm to 4.75 mm)
Medium	No. 40 to No. 10 (0.425 mm to 2.00 mm)
Fine	No. 200 to No. 40 (0.075 mm to 0.425 mm)
Silt	No. 200 (0.075 mm) to .005 mm
Clay	< .005 mm

Relative Proportions[L, M]

trace	0 to 5%
little	6 to 14%
with	≥ 15%

Inclusion Thicknesses

lens	0 to 1/8"
seam	1/8" to 1"
layer	over 1"

Apparent Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils	Blows Per Foot	Approximate Unconfined Compressive Strength
Very soft	0 to 1 BPF	< 0.25 tsf
Soft	2 to 4 BPF	0.25 to 0.5 tsf
Medium	5 to 8 BPF	0.5 to 1 tsf
Stiff	9 to 15 BPF	1 to 2 tsf
Very Stiff	16 to 30 BPF	2 to 4 tsf
Hard	over 30 BPF	> 4 tsf

Moisture Content:

Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp but no visible water.
Wet: Visible free water, usually soil is below water table.

Drilling Notes:

Blows/N-value: Blows indicate the driving resistance recorded for each 6-inch interval. The reported N-value is the blows per foot recorded by summing the second and third interval in accordance with the Standard Penetration Test, ASTM D1586.

Partial Penetration: If the sampler could not be driven through a full 6-inch interval, the number of blows for that partial penetration is shown as #/x" (i.e. 50/2"). The N-value is reported as "REF" indicating refusal.

Recovery: Indicates the inches of sample recovered from the sampled interval. For a standard penetration test, full recovery is 18", and is 24" for a thinwall/shelby tube sample.

WOH: Indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WOR: Indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

Water Level: Indicates the water level measured by the drillers either while drilling (▽), at the end of drilling (▼), or at some time after drilling (▼).

Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %	**LL**	Liquid limit
WD	Wet density, pcf	q_p	Pocket penetrometer strength, tsf	**PL**	Plastic limit
P200	% Passing #200 sieve	**MC**	Moisture content, %	**PI**	Plasticity index
		q_U	Unconfined compression test, tsf		