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May 9, 2017
Job No. 16-005

Great River Economic Development
Mississippi County
4701 Memorial Drive
Blytheville, Arkansas 72315

Attn: Ms. Tamika Jenkins
Project Coordinator

# RESULTS of GEOTECHNICAL FEASIBILITY STUDY
# 525-ACRE SITE INDUSTRIAL DEVELOPMENT
# OSCEOLA, ARKANSAS

## INTRODUCTION

Submitted herein are the final results of the geotechnical feasibility study performed for the potential industrial development on the subject 525-acre site in Osceola, Arkansas. This geotechnical investigation was originally authorized by Ms. Tamika Jenkins on January 7, 2016. At that time, the field studies were hampered by wet conditions associated with agricultural irrigation activities and wet season conditions. The project was then deferred for about 10 months until access had improved. The project was reauthorized in November 2016. This study has subsequently been performed in general accordance with our proposal of September 16, 2015 (GHBW Proposal No. 15-132).

We understand the industrial development is currently in the conceptual planning phase. The approximately 525-acre site east of Interstate 55 and north of State Highway 140 is presently being considered for the development. Specific information on facilities, structures, and/or pavement areas for the industrial development has not been provided. However, the development would ultimately be expected to include buildings, pavements, and infrastructure.

The purposes of this geotechnical investigation were to perform a limited exploration of subsurface conditions at the subject site and to develop information to guide planning and preliminary design for the project. We accomplished these purposes by performing a site reconnaissance, drilling sample borings to explore subsurface conditions, and performing a limited laboratory testing program. These data were used to develop conclusions regarding feasible foundation systems, pavement design, site grading concerns and construction considerations.

## SUBSURFACE EXPLORATION

Subsurface conditions at the subject site were explored by drilling three (3) sample borings to 50-ft depth and one (1) sample boring to 100-ft depth. The site vicinity is shown on the attached Plate 1. The approximate boring locations are shown on the Plan of Borings, Plate 2. Boring logs, presenting descriptions of the subsurface strata encountered and the results of field and laboratory tests are included as Plates 3 through 7. A key to the terms and symbols used on the logs is included as Plate 8. The approximate latitude and longitude of the sample borings, obtained using hand-portable GPS data, are shown on the logs.

The borings were drilled with a truck-mounted Mobil B-53 rotary-drilling rig using dry-auger drilling techniques or a combination of dry-auger and rotary-wash procedures. Soil samples were obtained at 2-ft intervals to 10-ft depth, 5-ft intervals to 50-ft depth, and at 10-ft intervals thereafter. Samples were typically obtained using a 2-in.-diameter split-barrel sampler driven into the strata by blows of a 140-lb safety hammer with 30-in. drop in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 in. of an 18-in. total drive, or a portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

Selected undisturbed samples of cohesive soils were obtained using a 3-in.-diameter thin-walled tube hydraulically advanced into the soil. Undrained shear strength of the cohesive soils was estimated in the field using a calibrated hand penetrometer. Estimated shear strength values are plotted on the log forms, in tons per sq ft, as circles enclosing an "x".

All samples were removed from sampling tools in the field, examined and visually classified by the geotechnical technician or field geologist. Samples were then placed in appropriate containers to prevent moisture loss and/or change in condition during transfer to our laboratory for further examination and testing.

The borings were advanced using dry-auger drilling procedures to the extent possible in order to facilitate groundwater observations. Observations regarding groundwater are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining final water level measurements.

## LABORATORY TESTING

To evaluate pertinent physical and engineering characteristics of the foundation and subgrade soils, laboratory tests consisting of natural water content determinations and classification tests were performed on selected representative soil samples.

Soil shear strength was estimated in the field using hand penetrometer and SPT results. In addition, laboratory strength testing included four (4) unconsolidated-undrained triaxial compression tests. Undrained shear strength (cohesion) determined from the results of the compression tests is plotted at the appropriate depth, in tons per sq ft, as an open triangle. Unit dry weight and natural water content were also determined as a part of each strength test.

A total of 40 natural water content determinations were performed to develop data on *in-situ* soil water contents. The results of these tests are plotted on the logs as solid circles in accordance with the scale and symbols shown in the legend located in the upper-right corner.

To verify field classification and to evaluate soil plasticity, 15 liquid and plastic (Atterberg) limit determinations, 12 single-sieve analyses (percent passing the No. 200 mesh) and three (3) full-sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as pluses inter-connected with a dashed line using the water content scale. The percent of soil passing the No. 200 Sieve is noted in the "–No. 200%" column on the log forms. Classification test results and the full sieve analyses plots, as well as soil classification by the Unified Soil Classification System and AASHTO classification system, are summarized in Appendix A.

## GENERAL SITE and SUBSURFACE CONDITIONS

### Site Conditions

The subject site is located on the east side of Interstate 55 and is bounded on the north by State Highway 119 and on the south by State Highway 140 and the existing Denso Manufacturing facility. Generally, the site terrain is relatively flat, cultivated land. Surface drainage is generally poor.

### Site Geology

The project is located within the Mississippi Embayment physiographic province. The site is located within the geologically recent Mississippi River flood plain. The Geologic Map of Arkansas indicates the alignment to be in an area of alluvial deposits of the Holocene Epoch of the Quaternary

Period (0 to 10,000 years ago). The alluvial deposits characteristically consist of an upper zone of clay and silt underlain by sand and gravel units. Locally, the alluvial units are a result of channel fill, natural levee and backswamp activity. The alluvium in this area overlies well-consolidated Tertiary and Cretaceous sediments at varying depth. Bedrock is reported to be in excess of 2700-ft depth in the project locale.

Seismic Conditions

According to the Arkansas Building Authority (2005), the Mississippi County site is located in Seismic Zone 3, i.e. the zone of greatest seismic potential. Based on the average subsurface conditions encountered in the borings and the local geology, a Seismic Site Class D (stiff soil profile) is considered appropriate for the boring locations with respect to the criteria of the International Building Code (IBC 2012). The liquefaction potential of the silty clay, clay and clayey silt at shallow to intermediate depth and the dense sands at depth encountered in the borings is considered low.

The seismic site class must be confirmed when the specific site of the new facility or facilities has been selected, facility layout and grading information is available, and additional subsurface data are available.

Subsurface Conditions

Based on the results of the borings, the soils extending to depths of 25 to 37 ft are typically soft to very stiff brown, gray and dark brown clay, silty clay, and clayey silt. These cohesive soils exhibit variable low to high plasticity. The shrink-swell potential associated with the highly-plastic clay units is considered low due to the high *in-situ* water contents. The cohesive soils have low to moderate shear strength with moderate to high compressibility.

Underlying the clayey soils are granular soil units of medium dense to very dense brown and gray silty fine sand and fine to medium sand. The sand units contain minor amounts of coarse sand and/or fine gravel and occasional clay or lignite pockets. The sandy soils apparently extend to depths in excess of 100 feet. The sand units exhibit medium to high relative density and low compressibility.

Groundwater Conditions

Groundwater was encountered at 18-ft depth in January 2016 and at 23- to 26-ft depth in November 2016. Groundwater levels will vary with seasonal precipitation, surface runoff and infiltration, and stream levels in nearby waterways and drainage features.

## ANALYSES and RECOMMENDATIONS

### Foundation Considerations

Foundation design for the potential structures must satisfy two (2) basic and independent design criteria. First, the maximum bearing pressure transmitted to the supporting strata must not exceed the allowable bearing pressure based on an allowable factor of safety with respect to bearing stratum shear strength. Secondly, foundation movements resulting from consolidation, shrinkage, or swelling of the supporting strata should be within tolerable limits for the structure. Construction factors such as foundation construction fill placement, excavation procedures, and surface and groundwater conditions must also be considered. Considerations for various foundation alternatives are discussed in the following report sections.

### Shallow Foundation Systems

Based on the results of the borings, shallow foundation systems such as footings or mats are considered a viable alternative for relatively light to moderate structural loads. However, the bearing capacity of shallow foundation elements could be limited by the settlement or shrink-swell potential. Some undercut and replacement could be required to improve bearing capacity and mitigate the settlement or shrink-swell potential.

Conventional footings or mats would be expected to utilize net allowable bearing pressures on the order of 2000 to 3500 lbs per sq foot. Continuous footings should have a minimum width of 18 in. and individual footings a minimum dimension of 24 inches. A minimum footing depth for perimeter or unheated areas would be expected to be 1.5 ft below the lowest adjacent grade for embedment and frost protection. For interior spaces, it is feasible that footings could be supported at shallower depth as dictated by structural requirements for thickness.

### Deep Foundations – Moderate to Heavy Loads

Deep foundations, either drilled auger cast piles or driven piling are considered suitable for support of moderate to heavy foundation loads at the planned industrial facilities. Deep foundations may also be utilized for support of structures or units sensitive to uplift loads associated with localized areas of expansive clay.

Deep foundation elements should extend through the upper zones of clayey soils into the dense to very dense sand units typically present at depths ranging from 25 ft to 37 feet. Auger-cast concrete (ACP) piles, concrete piles, and steel shell piles are considered appropriate piling alternatives. Preliminary allowable pile capacities are summarized in Appendix B for 18- and 24-in.-diameter steel shell piles, 16-in.-sq and 18-in.-sq concrete piles, and 18- and 24-in.-diameter auger cast piles (ACP's). The preliminary pile capacity curves are provided for information and planning purposes only. Specific pile design should be based on a project-specific geotechnical investigation with foundation layout and site grading information considered.

Preliminary static pile capacities have been determined from the soil stratigraphy revealed by the borings and the assumption that piles are installed from a depth about 5 ft below the existing surface. Pile lengths are anticipated to range from 25 ft to 37 ft in order to bear on the dense sand stratum. The pile lengths will vary with the site conditions. Difficult driving or drilling conditions are anticipated to achieve pile embedment to depths below 40 to 45 ft in the dense to very dense granular units. Post-construction settlement of properly installed piles extending to the dense sand units is expected to be less than 0.5 inch.

Computed pile capacities for the driven piles are based on driving the piles to the required penetration, rather than the use of jetting or other methods. When jetting or other methods are used to aid pile installation, the conditions used in the capacity calculations may not be met and, therefore, the calculated load capacity would require to be adjusted.

The allowable capacities are based on single, isolated foundations. Typically, piles spaced closer than about three (3) pile diameters will develop lower individual capacity due to group effects. If the design pile layout is less than three (3) diameters (center to center), the bearing capacity should be re-evaluated. The allowable capacities shown in Appendix B are provided as preliminary information only and include a minimum factor of safety of 2.5 for compression and 3.0 for uplift.

If site grades are raised significantly, some settlement with attendant negative skin friction (down drag) could develop on piles. In some areas of highly-compressible soils at shallow depth and more than about 2 to 4 ft of fill is planned, design loading and calculated pile capacities should be developed with respect to downdrag loads. Where the heave potential due to expansive clay is high or structures/units are sensitive to heave, use of a void space below grade beams may be warranted.

Floor Slabs

Slab-on-ground floor slab systems will be suitable for new buildings. Depending on the specific subsurface conditions at any particular location, the potential for heave associated with highly-plastic clay may require mitigation by raising grades, undercutting or a combination of these. Alternatively, a structural floor slab system with void space may be considered.

The potential for subgrade heave associated with highly-plastic clay must be evaluated for the final design of any at-grade slab system. To mitigate the heave potential, some undercutting of the clay and/or raising grades may be needed. Alternatively, a structural slab with void space may be warranted for areas where the heave potential is a significant design concern.

For the design of slabs placed on a properly prepared subgrade of the on-site soils, a preliminary subgrade modulus (k) of 75 per sq in. per in. is considered appropriate. For slabs supported on a minimum 12 in. of crushed stone aggregate base, an improved k value of 160 lbs per sq in. per in. is preliminarily recommended.

Considerations for Pavement Subgrade Support

The on-site soils anticipated for pavement subgrade classify as A-6 and A-7-6 by the AASHTO classification system (AASHTO M-145). These soil classifications correlate with poor to fair subgrade support. Given the variable classification of the on-site soil, preliminary values for subgrade support are recommended below.

- Preliminary design California Bearing Ratio (CBR): 3
- Preliminary design modulus of subgrade reaction (k): 75 lbs per cu inch
- Preliminary resilient modulus ($M_R$): 3000 lbs per sq in.

Depending on the seasonal site conditions and specific grading plans, some undercut and replacement of unsuitable subgrade soils could be warranted for subgrade preparation in pavement areas. Undercuts on the order of 2 to 3 ft, more or less, could be warranted. We recommend that the upper 12 to 18 in. of subgrade soils have a maximum plasticity index (PI) of 18 unless the subgrade is modified with stabilization additives.

Also, improved subgrade support could be developed with lime or cement treatment of the subgrade soils. Reinforcement of the subgrade with geotextiles is also possible. In lieu of undercutting and replacing unsuitable soils, consideration may be given to using additives to improve soil workability and stabilize weak areas. Hydrated lime, quick lime, Portland cement, fly ash, or suitable alternate materials may be used as verified by appropriate testing and approved by the Engineer. Additives can be effective where the depth of unstable soils is relatively shallow. Treatment will be less effective in areas where the zone of unstable soils is deep. The optimum application rate of stabilization additive must be determined by specific laboratory tests performed on the alignment subgrade soils. Chemical modification of the surface stratum can also be beneficial in providing a weather-proof working surface to facilitate construction.

Given the predominance of clayey, fine-grained subgrade soils including silty clay and clay, AASHTO A-6 to A-7-6, it is expected that lime modification would be the most effective subgrade stabilization additive. Alternative additive agents, including lime and Portland cement and lime and fly ash, could be considered as well.

Lime or cement modified subgrade construction consists of mixing the on-site or imported soils with hydrated lime, quicklime, or Portland cement. The specific amount of additive required to achieve an appropriate level of modification must be determined by laboratory testing. Based on the soil classification, we recommend assuming 8 percent lime or cement addition by soil dry weight for use in estimating quantities. For 8 percent lime or cement by dry weight, an application weight on the order of 6 lbs lime or cement per sq yd per in. treatment depth would be anticipated. We recommend a minimum treatment depth of 8 in. for durability. Consequently, an application rate of 48 lbs per sq yd per 8 in. treatment depth may be used for estimation.

Site Grading Considerations

Site preparation should typically begin with the stripping and removal of all soft and organic surface soils. A stripping depth of 6 to 9 in. is anticipated but could be greater in wooded areas or areas previously farmed and windrowed.

After stripping performing any cuts, and prior to placing any fill, the subgrade should be proof-rolled with a pneumatic-tired roller, loaded tandem-wheeled dump truck, or similar equipment. Soft or loose soil zones, unstable soils, or areas which exhibit deep rutting should be undercut and be reprocessed and re-compacted, replaced with select fill, or stabilized with additive addition (see Considerations for Pavement Subgrade Support). Depending on seasonal site conditions and final grading plans, localized undercuts on the order of 2 to 3 ft, more or less could be warranted for site preparation. Alternatively, subgrade modification with lime or cement may be considered.

Generally, the on-site silty clay and clay is not suitable for use as select fill or backfill in building or pavement areas. Imported borrow for use as select fill and backfill in building and pavement areas should consist of approved select clayey sand (SC), sandy clay (CL), or clayey gravel (GC) with a liquid limit less than 40 and maximum plasticity index of 18. Where grades are raised in building areas, sand (SP, SP-SM, SM, or SW) and gravel (GP, GW, GM, or GP-GM), or approved alternates may be utilized to raise grades.

All fill and backfill must be free of organics and/or debris with a maximum PI of 18. A maximum particle size of about 3-in. dimension is recommended for fill and backfill. The top 18 in. of fills should have a maximum particle dimension limited to 1.5 inches. All fill and backfill material should be approved by the Geotechnical Engineer prior to fill placement.

For preliminary consideration of earthwork specifications, fill and backfill in building and pavement areas should be compacted to a minimum of 98 percent of the maximum Standard Proctor (ASTM D-698) maximum dry density within a water content range of minus 2 to plus 3 percent of the optimum value. Fill and backfill should be placed in horizontal, nominal 6- to 8-in.-thick loose lifts. Each lift of fill and backfill should be properly compacted, tested and approved prior to placing subsequent lifts.

## CLOSURE

The report has been prepared to provide preliminary information regarding site and subsurface conditions. The conclusions and comments contained herein have been developed based on a discrete number of widely spaced borings. This information is intended for use in planning and conceptual design only. Specific design recommendations must be based on an appropriate geotechnical study utilizing project-specific site grading plans, building layout, traffic and structure loading information. We are available to assist with developing an appropriate scope of work for further geotechnical investigation as plans for the industrial facility are developed.

The following illustrations are attached and complete this report.

| | |
|---|---|
| Plate 1 | Site Vicinity |
| Plate 2 | Plan of Borings |
| Plates 3 through 7 | Boring Logs |
| Plate 8 | Key to Terms and Symbols |
| Appendix A | Laboratory Test Results |
| Appendix B | Preliminary Allowable Pile Capacity |

* * * *

We appreciate the opportunity to be of service to you during this phase of the project. Should you have any questions regarding this report, or if we may be of additional assistance during design or construction, please call on us.

Sincerely,

GRUBBS, HOSKYN,
BARTON & WYATT, INC.

Blaine M. Orth, P.E.
Senior Project Engineer

STATE OF ARKANSAS REGISTERED PROFESSIONAL ENGINEER No. 7791 MARK E. WYATT

Mark E. Wyatt, P.E.
President

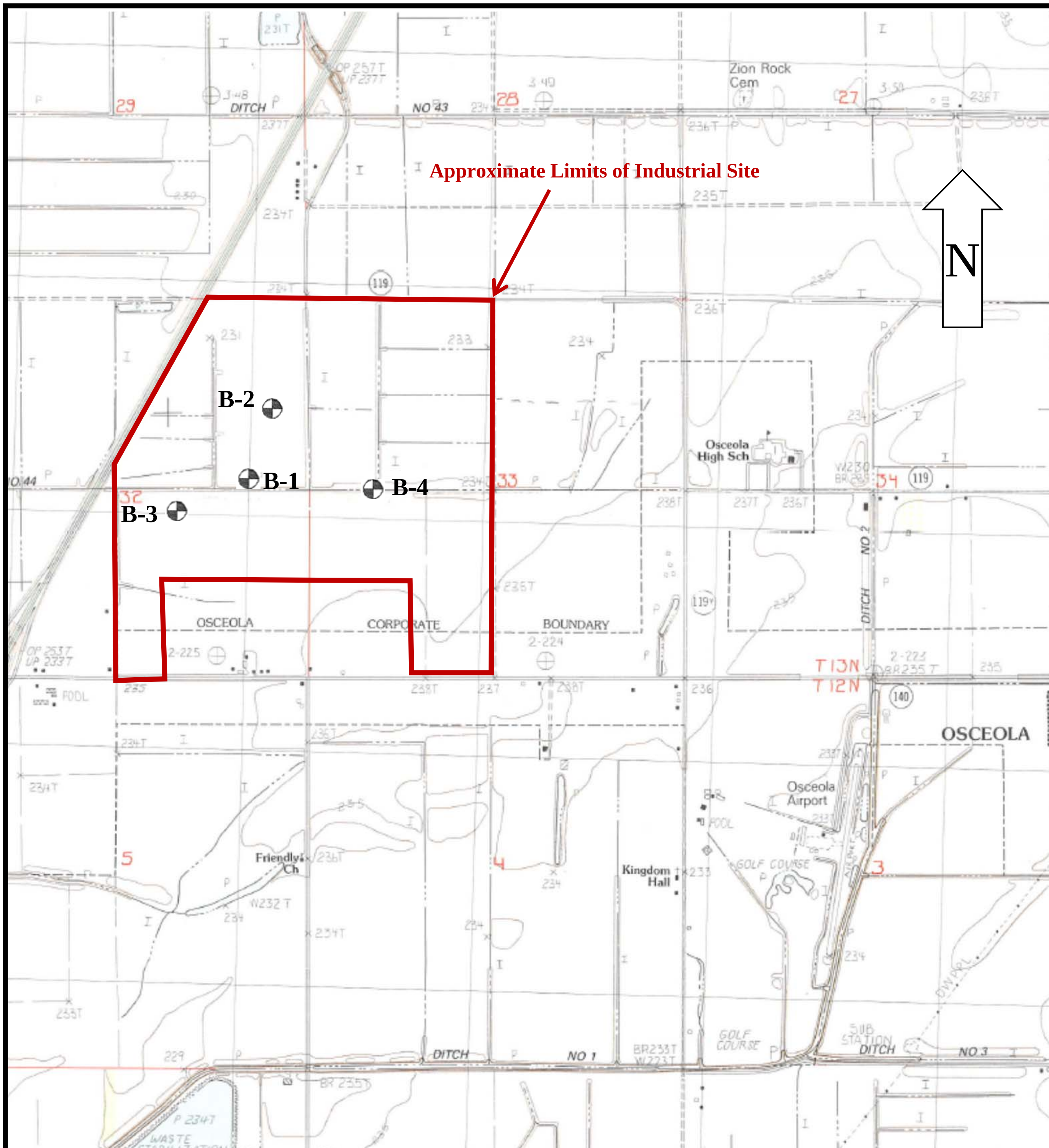
BMO/MEW:jw

Copies submitted: Great River Economic Development Foundation
Attn: Ms. Tamika Jenkins (3+email)
Attn: Mr. Clifton Chitwood (1-email)


Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

**Site Vicinity Map**
**Industrial Site Feasibility Study**
**Osceola, Arkansas**

| | |
|---|---|
| **Job No.: 16-005** | **Plate 1** |




**Scale: 1" = 24,000' ±**

| | | |
|---|---|---|
| Grubbs, Hoskyn, Barton & Wyatt, INC. CONSULTING ENGINEERS | **PLAN OF BORINGS**<br>**Industrial Site Feasibility Study**<br>**Osceola, Arkansas** | **Scale: As Shown**<br>**Job No. 16-005**<br>**Plate 2** |

**Grubbs, Hoskyn, Barton & Wyatt, Inc.**
Consulting Engineers

# LOG OF BORING NO. 1

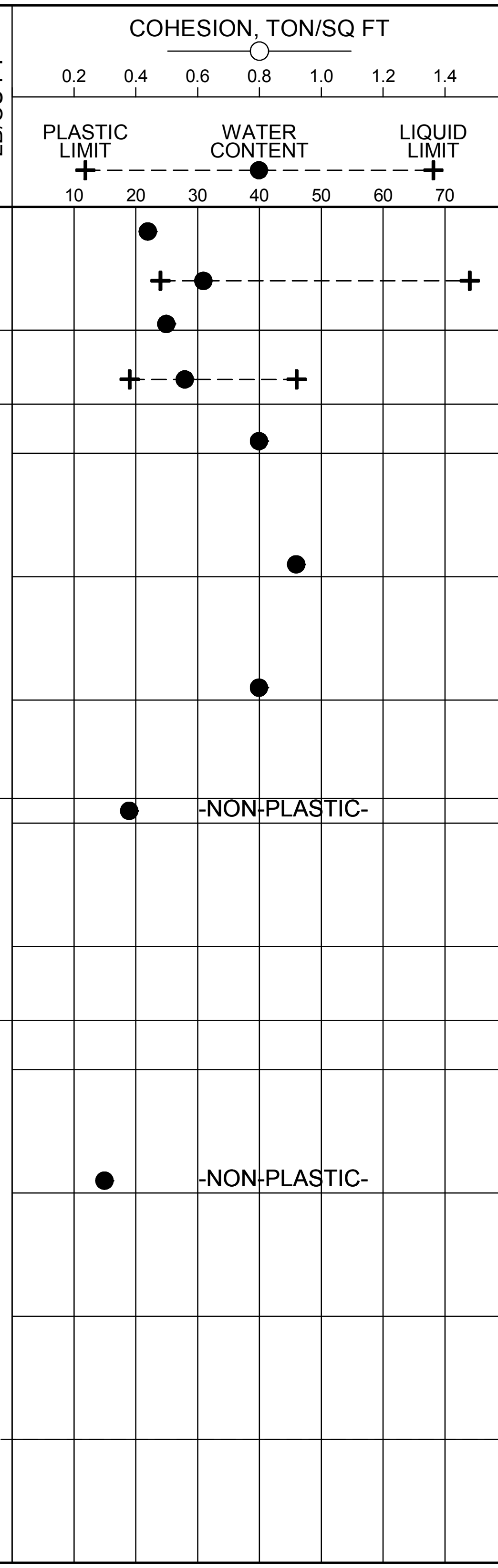
Feasibility Study for Industrial Site
Osceola, Arkansas

TYPE: Auger

LOCATION: See Plate 2 - 35. 705598°N, -90.037792°W

SURF. EL.:

| DEPTH, FT | DESCRIPTION OF MATERIAL | BLOWS PER FT | UNIT DRY WT LB/CU FT | - No. 200 % |
|---|---|---|---|---|
| 0–5 | Stiff dark brown clay | 20 | | |
| | | 29 | | 98 |
| | | 13 | | |
| 5–8 | Stiff brown and gray silty clay | 13 | | 96 |
| 8–24 | Firm to stiff gray and brown clay | 10 | | |
| | - stiff below 13 ft<br>- with organic inclusions at 14 ft | 13 | | |
| | | 14 | | |
| 24–33 | Dense to very dense brown and gray silty fine sand w/occasional silt pockets | 50/9" | | 16 |
| | - dense below 28 ft | 41 | | |
| 33–50 | Dense gray fine to medium sand | 45 | | |
| | | 50/11" | | 3 |
| | - with occasional clay pockets and lignite inclusions below 40 ft | 50/10" | | |
| | | 50/8" | | |




COMPLETION DEPTH: 50.0 ft
DATE: 11-3-16

DEPTH TO WATER
IN BORING: 26 ft

DATE: 11/3/2016

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16-005

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# LOG OF BORING NO. 2

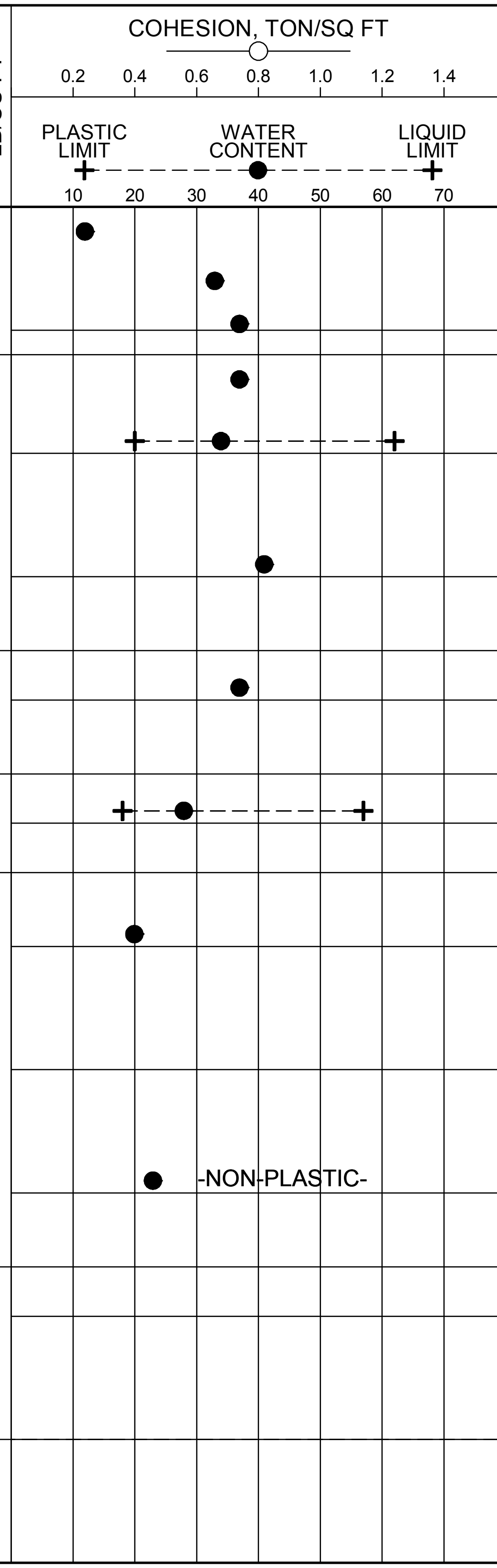
Feasibility Study for Industrial Site
Osceola, Arkansas

TYPE: Auger to 10 ft /Wash

LOCATION: See Plate 2 - 35.709067°N, -90.036494°W

SURF. EL.:

| DEPTH, FT | DESCRIPTION OF MATERIAL | BLOWS PER FT | UNIT DRY WT LB/CU FT | - No. 200 % |
|---|---|---|---|---|
| 0–6 | Stiff dark brown clay | 16 | | |
| | - dark brown and gray below 2 ft | 20 | | |
| | | 22 | | |
| 6–18 | Stiff gray and brown clay | 12 | | |
| | | 14 | | 97 |
| | - firm to stiff below 13 ft | 10 | | |
| 18–23 | Firm gray clayey silt | 9 | | |
| 23–27 | Very stiff gray clay, slightly sandy | 27 | | 89 |
| 27–43 | Dense brown and gray silty fine sand w/occasional silt pockets | 42 | | |
| | - gray with occasional clay pockets and lignite inclusions below 33 ft | 48 | | |
| | - dense to very dense below 3 ft | 50/8" | | 12 |
| 43–50 | Dense to very dense brownish gray fine to medium sand, slightly silty | 50/9" | | |
| | | 50/8" | | |




COMPLETION DEPTH: 50.0 ft
DATE: 11-3-16

DEPTH TO WATER IN BORING: 23 ft
DATE: 11/3/2016

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16-005

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# LOG OF BORING NO. 3

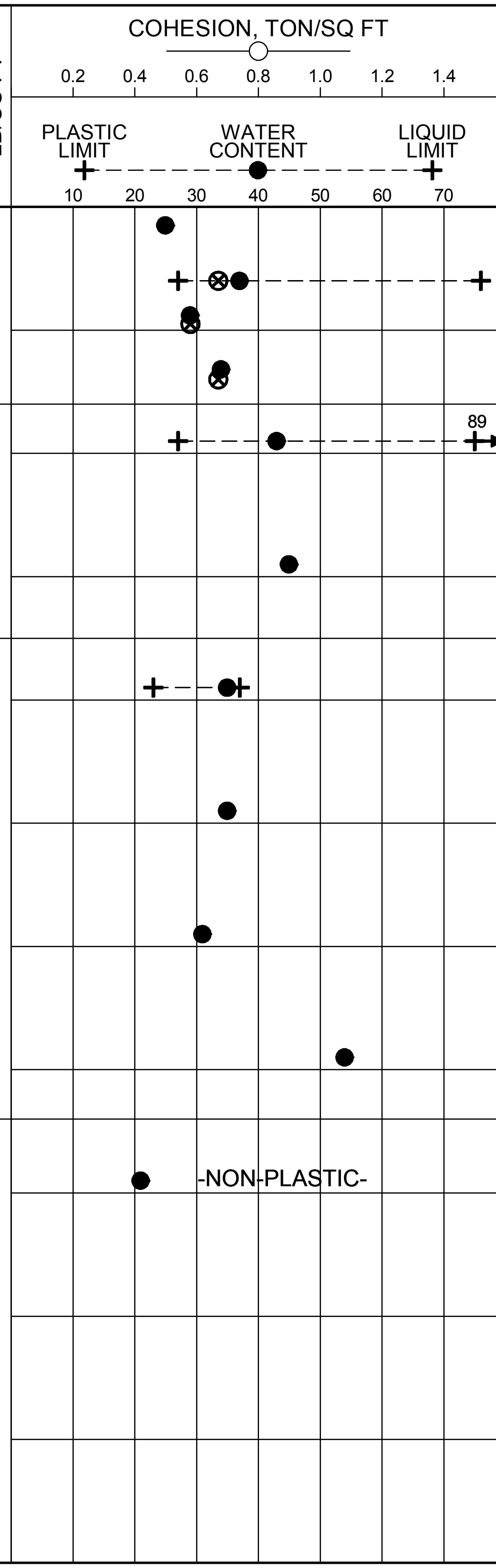
Feasibility Study for Industrial Site
Osceola, Arkansas

TYPE: Auger

LOCATION: See Plate 2 - 35.705250°N, -90.041084°W

SURF. EL:

| DEPTH, FT | DESCRIPTION OF MATERIAL | BLOWS PER FT | UNIT DRY WT LB/CU FT | - No. 200 % |
|---|---|---|---|---|
| 0 | Firm brown and gray clay w/organic stains | 7 | | |
| | - stiff below 2 ft | | | 98 |
| 8 | Stiff gray and tan clay w/ferrous nodules and stains | 14 | | 99 |
| | - firm below 13 ft | 8 | | |
| 17.5 | Soft tan and gray silty clay | 6 | | 99 |
| | - firm with some clay pockets and seams below 22 ft | 8 | | |
| | - soft with some fine sand seams at 28 to 33 ft | 6 | | |
| | - firm with occasional organic inclusions below 33 ft | 8 | | |
| 37 | Medium dense brown and gray fine to medium sand, slightly silty | 24 | | 9 |
| | - dense below 42 ft | 34 | | |
| | - medium dense, fine to coarse below 48 ft | 29 | | |




COMPLETION DEPTH: 100.0 ft
DATE: 1-27-16

DEPTH TO WATER
IN BORING: 18 ft

DATE: 1/27/2016

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# LOG OF BORING NO. 3

Feasibility Study for Industrial Site
Osceola, Arkansas

TYPE: Auger

LOCATION: See Plate 2 - 35.705250°N, -90.041084°W

| DEPTH, FT | SYMBOL | SAMPLES | DESCRIPTION OF MATERIAL (continued) | BLOWS PER FT | UNIT DRY WT LB/CU FT | COHESION, TON/SQ FT (0.2–1.4); PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10–70) | - No. 200 % |
|---|---|---|---|---|---|---|---|
| 58–60 | | X | - dense below 58 ft | 30 | | Water content ≈ 16; -NON-PLASTIC- | 5 |
| 70 | | X | | 50 | | | |
| 75 | | | - dense to very dense below 75 ft | | | | |
| 80 | | X | | 50/9" | | | |
| 90 | | X | | 50/8" | | | |
| 100 | | X | | 50/8" | | | |

COMPLETION DEPTH: 100.0 ft
DATE: 1-27-16

DEPTH TO WATER
IN BORING: 18 ft

DATE: 1/27/2016

16-005

**Grubbs, Hoskyn, Barton & Wyatt, Inc.**
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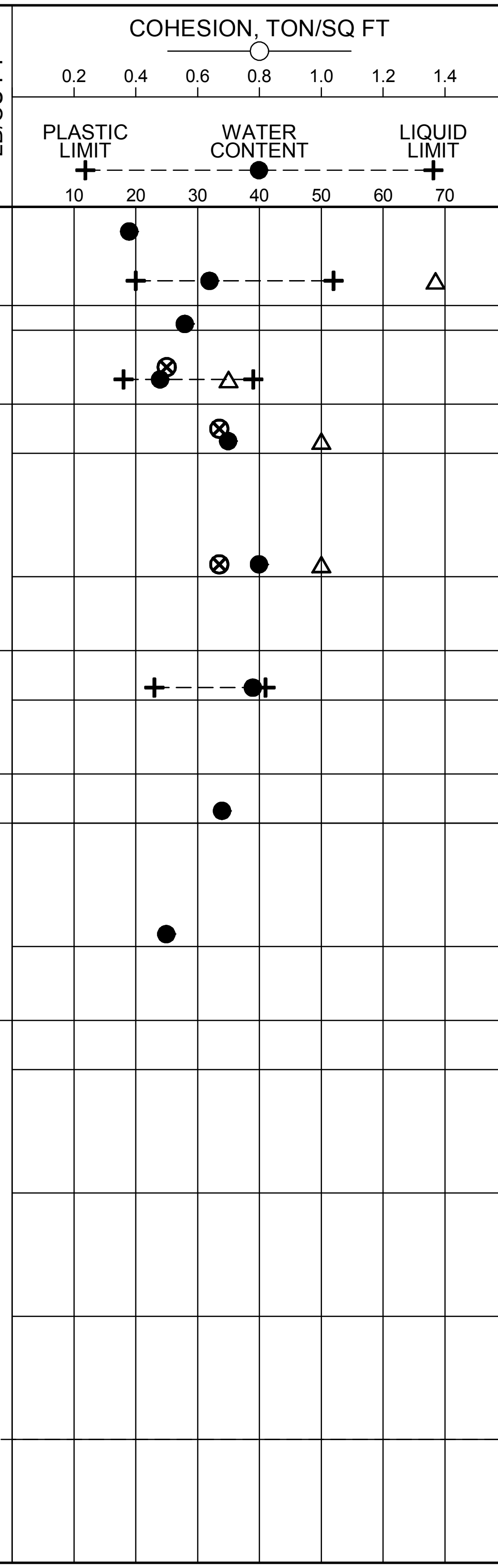
# LOG OF BORING NO. 4

Feasibility Study for Industrial Site
Osceola, Arkansas

TYPE: Auger to 10 ft /Wash

LOCATION: See Plate 2 - 35.705596°N, -90.030686°W

| DEPTH, FT | DESCRIPTION OF MATERIAL (SURF. EL.:) | BLOWS PER FT | UNIT DRY WT LB/CU FT | - No. 200 % |
|---|---|---|---|---|
| 0–4 | Stiff dark brown clay w/trace fine sand | 20 | 86 | 91 |
| 4–8 | Stiff gray and brown silty clay, slightly sandy | 16 | 93 | 87 |
| 8–18 | Stiff grayish brown clay | | 84, 81 | |
| 18–23 | Firm gray silty clay w/occasional organic inclusions | 9 | | 100 |
| 23–25 | Very stiff gray clay | 28 | | |
| 25–33 | Dense brown and gray silty fine sand w/occasional clay pockets | 38 | | |
| 33–50 | Dense gray fine to medium sand, slightly silty | 46, 50/10" | | |
| | - dense to very dense with trace fine gravel and occasional silt pockets below 43 ft | 50/9", 50/8" | | |




COMPLETION DEPTH: 50.0 ft
DATE: 11-3-16

DEPTH TO WATER IN BORING: 23 ft
DATE: 11/3/2016

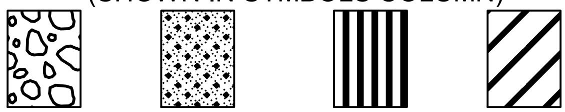
LGBNEW 16-005.GPJ 5-5-17

**Grubbs, Hoskyn, Barton & Wyatt, Inc.**
**Consulting Engineers**

# SYMBOLS AND TERMS USED ON BORING LOGS

## SOIL TYPES

(SHOWN IN SYMBOLS COLUMN)

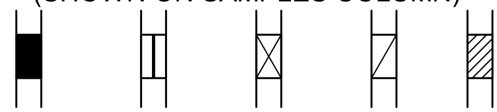


Gravel Sand Silt Clay

Predominant type shown heavy

## SAMPLER TYPES

(SHOWN ON SAMPLES COLUMN)



Shelby Tube, Rock Core, Split Spoon, No Recovery, Cutting

## TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

| DESCRIPTIVE TERM | N-VALUE | RELATIVE DENSITY |
|---|---|---|
| VERY LOOSE | 0-4 | 0-15% |
| LOOSE | 4-10 | 15-35% |
| MEDIUM DENSE | 10-30 | 35-65% |
| DENSE | 30-50 | 65-85% |
| VERY DENSE | 50 and above | 85-100% |

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

| DESCRIPTIVE TERM | UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT. |
|---|---|
| VERY SOFT | Less than 0.25 |
| SOFT | 0.25-0.50 |
| FIRM | 0.50-1.00 |
| STIFF | 1.00-2.00 |
| VERY STIFF | 2.00-4.00 |
| HARD | 4.00 and higher |

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

## TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance.
FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
LAMINATED - composed of thin layers of varying color and texture.
INTERBEDDED - composed of alternate layers of different soil types.
CALCAREOUS - containing appreciable quantities of calcium carbonate.
WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.
POORLY GRADED - predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.

Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

KEY 5-27-16

# APPENDIX A

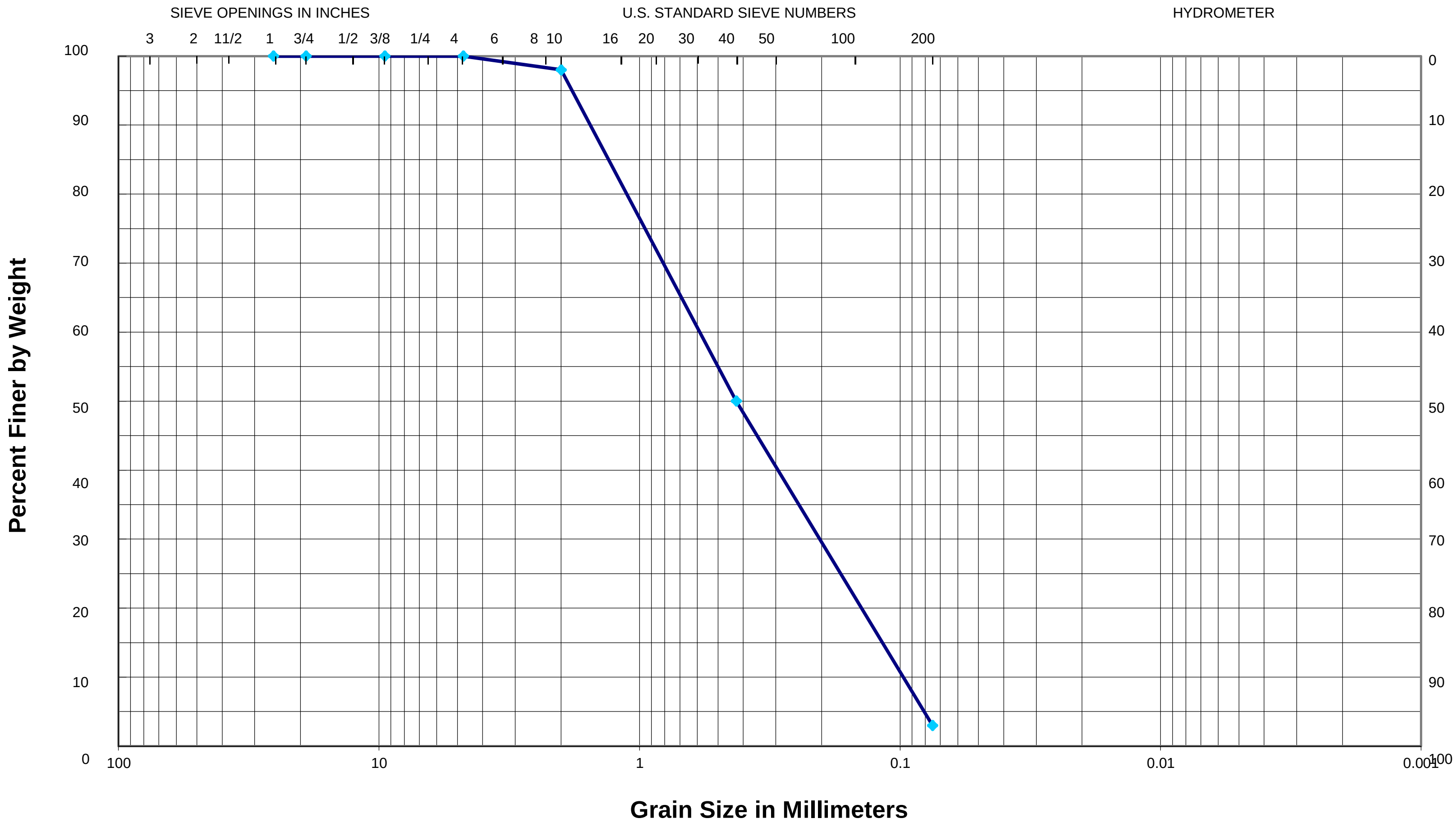
# SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: Feasibility Study for Industrial Site
LOCATION: Osceola, Arkansas
JOB NUMBER: 16-005

| BORING NO. | SAMPLE DEPTH (ft) | WATER CONTENT (%) | ATTERBERG LIMITS | | | SIEVE ANALYSIS | UNIFIED CLASS. | AASHTO CLASS. |
|---|---|---|---|---|---|---|---|---|
| | | | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | #200, % | | |
| | | | | | | | | |
| 1 | 2.5 - 3.5 | 31 | 74 | 24 | 50 | 98 | CH | A-7-6 |
| 1 | 6.5 - 7.5 | 28 | 46 | 19 | 27 | 96 | CL | A-7-6 |
| 1 | 24 -25 | 19 | -NON-PLASTIC- | | | 16 | SM | A-2-4 |
| 1 | 38.5 - 39.5 | 15 | -NON-PLASTIC- | | | 3 | SP | A-1-b |
| | | | | | | | | |
| 2 | 9 -10 | 34 | 62 | 20 | 42 | 97 | CH | A-7-6 |
| 2 | 24 - 25 | 28 | 57 | 18 | 39 | 89 | CH | A-7-6 |
| 2 | 38.5 - 39.5 | 23 | -NON-PLASTIC- | | | 12 | SP-SM | A-2-4 |
| | | | | | | | | |
| 3 | 2.5 - 3 | 37 | 76 | 27 | 49 | 98 | CH | A-7-6 |
| 3 | 9 - 10 | 43 | 89 | 27 | 62 | 99 | CH | A-7-6 |
| 3 | 19 - 20 | 35 | 37 | 23 | 14 | 99 | CL | A-6 |
| 3 | 39 - 40 | 21 | -NON-PLASTIC- | | | 9 | SP-SM | A-3 |
| 3 | 59 - 60 | 16 | -NON-PLASTIC- | | | 5 | SW-SM | A-1-b |
| | | | | | | | | |
| 4 | 3 - 3.5 | 32 | 52 | 20 | 32 | 91 | CH | A-7-6 |
| 4 | 6.5 - 7.5 | 22 | 39 | 18 | 21 | 87 | CL | A-6 |
| 4 | 14.5 - 15 | 40 | 99 | 25 | 74 | 98 | CH | A-7-6 |
| 4 | 19 - 20 | 39 | 41 | 23 | 18 | 100 | CL | A-7-6 |
| | | | | | | | | |

**16-005**

# GRAIN SIZE CURVE



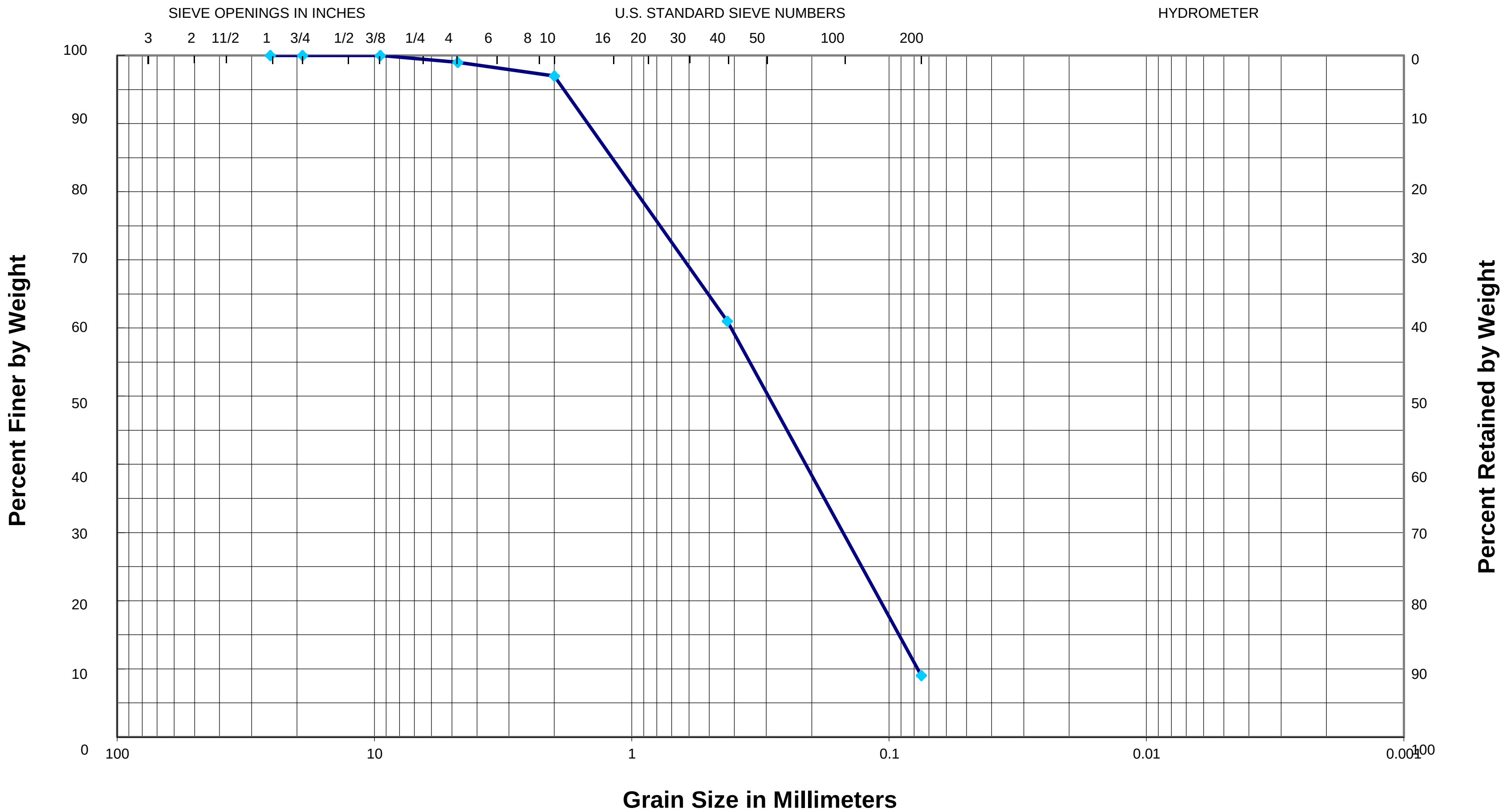

| GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|
| COARSE | FINE | COARSE | MEDIUM | FINE | |

Sample: Boring 1, 38.5 - 39.5 ft; Non-Plastic
Description: Gray fine to medium sand with trace silt

**USCS = SP**
**A ASHTO = A-1-b**

**16-005**

# GRAIN SIZE CURVE



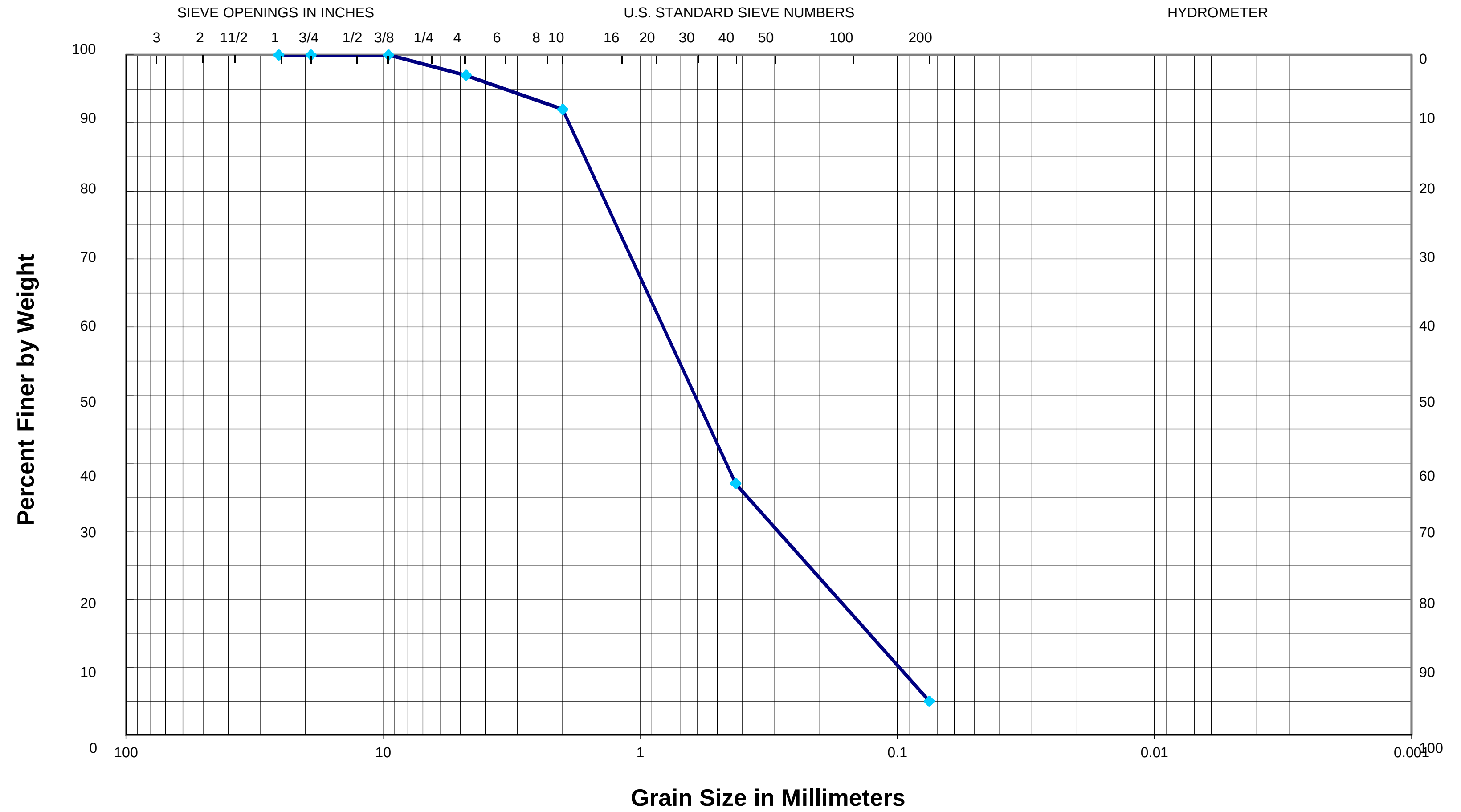

| GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|
| COARSE | FINE | COARSE | MEDIUM | FINE | |

Sample: Boring 3, 39 - 40 ft; Non-Plastic
Description: Brown and gray fine to medium sand, slightly silty

**USCS = SP-SM**
**AASHTO = A-3**

**16-005**

# GRAIN SIZE CURVE

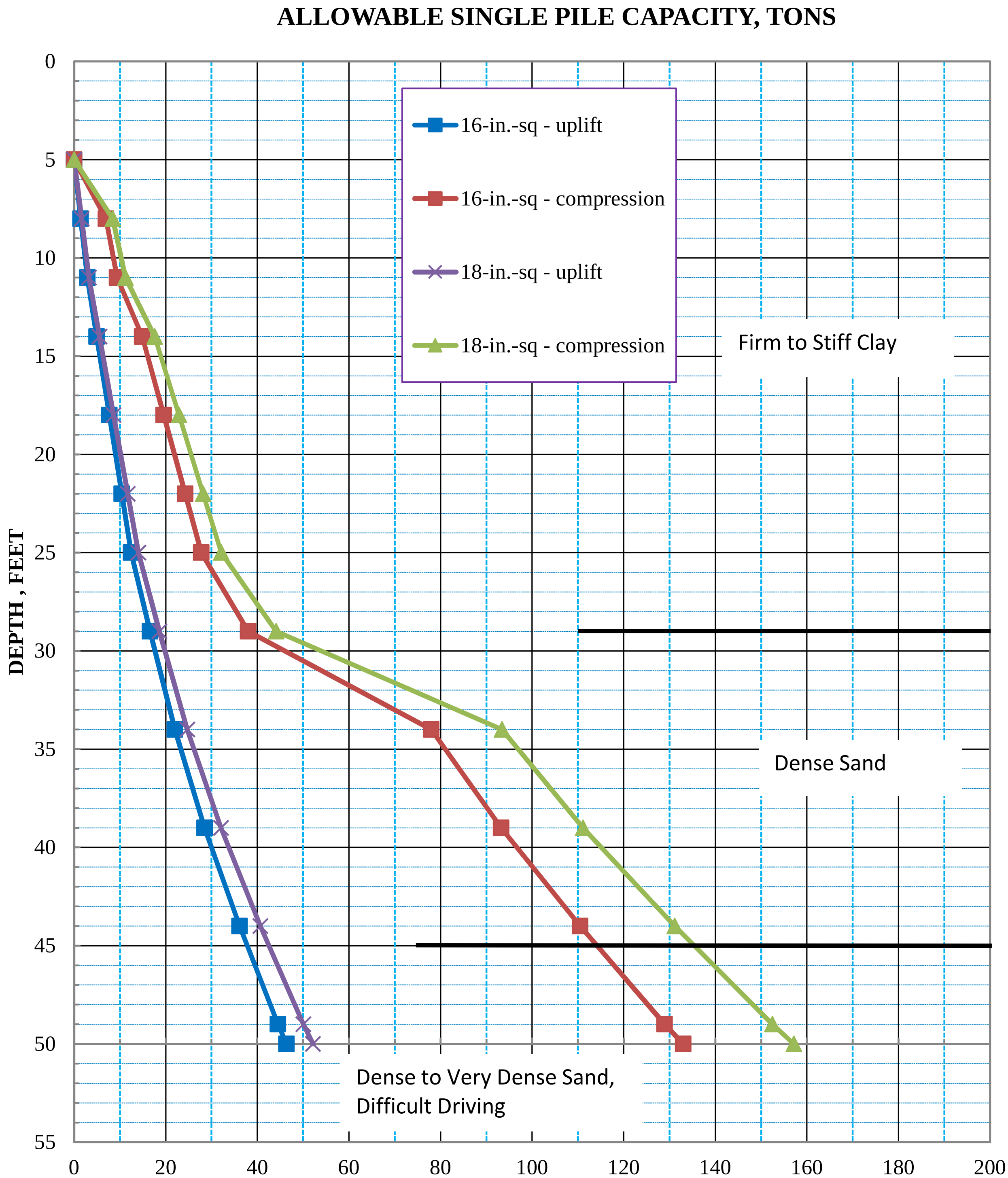



| GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|
| COARSE | FINE | COARSE | MEDIUM | FINE | |

Sample: Boring 3, 59 - 60 ft; Non-Plastic
Description: Brown and gray fine to medium sand with trace coarse sand and fine gravel

**USCS = SW-SM**
**AASHTO = A-1-b**

# APPENDIX B




**PRELIMINARY ALLOWABLE SINGLE PILE CAPACITY, TONS**

Driven Concrete Piles

Feasibility Study for Industrial Site - Osceola, AR

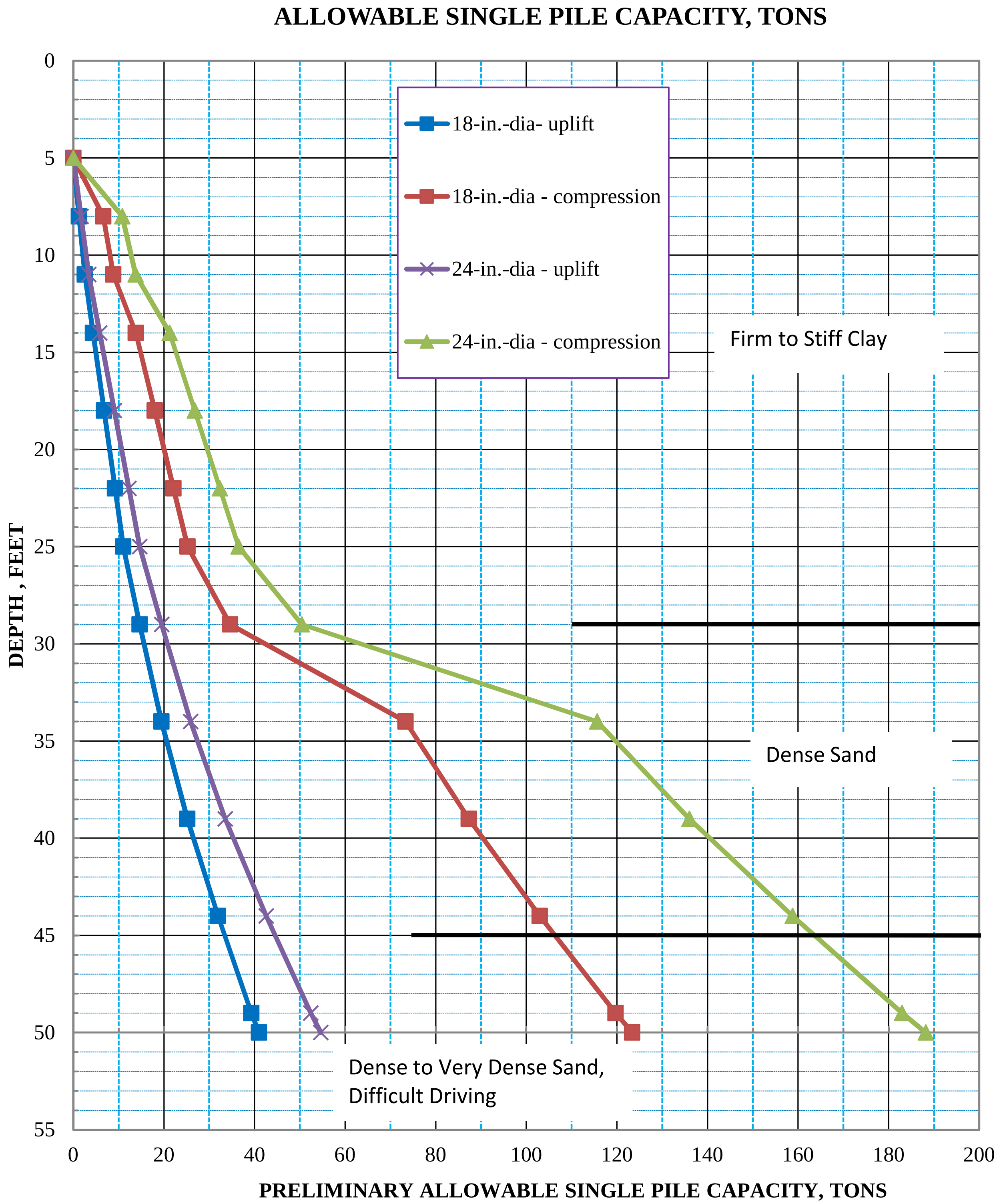
GHBW Job No. 16-005

Compression: FS=2.5; Uplift: FS=3.0

Note: Piles driven from bottom of pile cap, estimated at 5 feet below grade

**FOR INFORMATION ONLY**

**Grubbs, Hoskyn,**
**Barton & Wyatt, Inc.**
CONSULTING ENGINEERS




Driven Steel Shell Piles

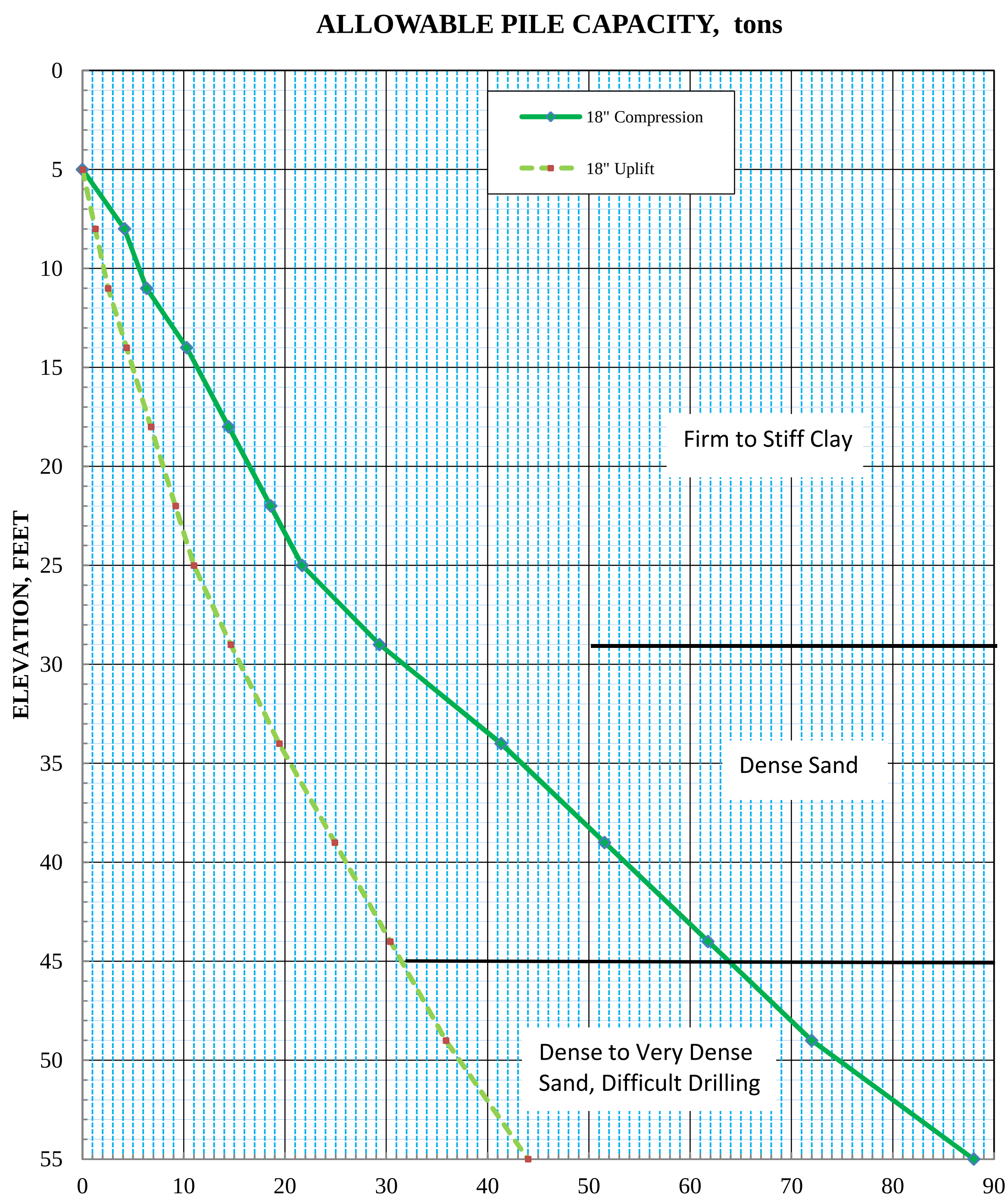
Feasibility Study for Industrial Site - Osceola, AR

GHBW Job No. 16-005

Compression: FS=2.5; Uplift: FS=3.0

Note: Piles driven from bottom of pile cap, estimated at 5 feet below grade

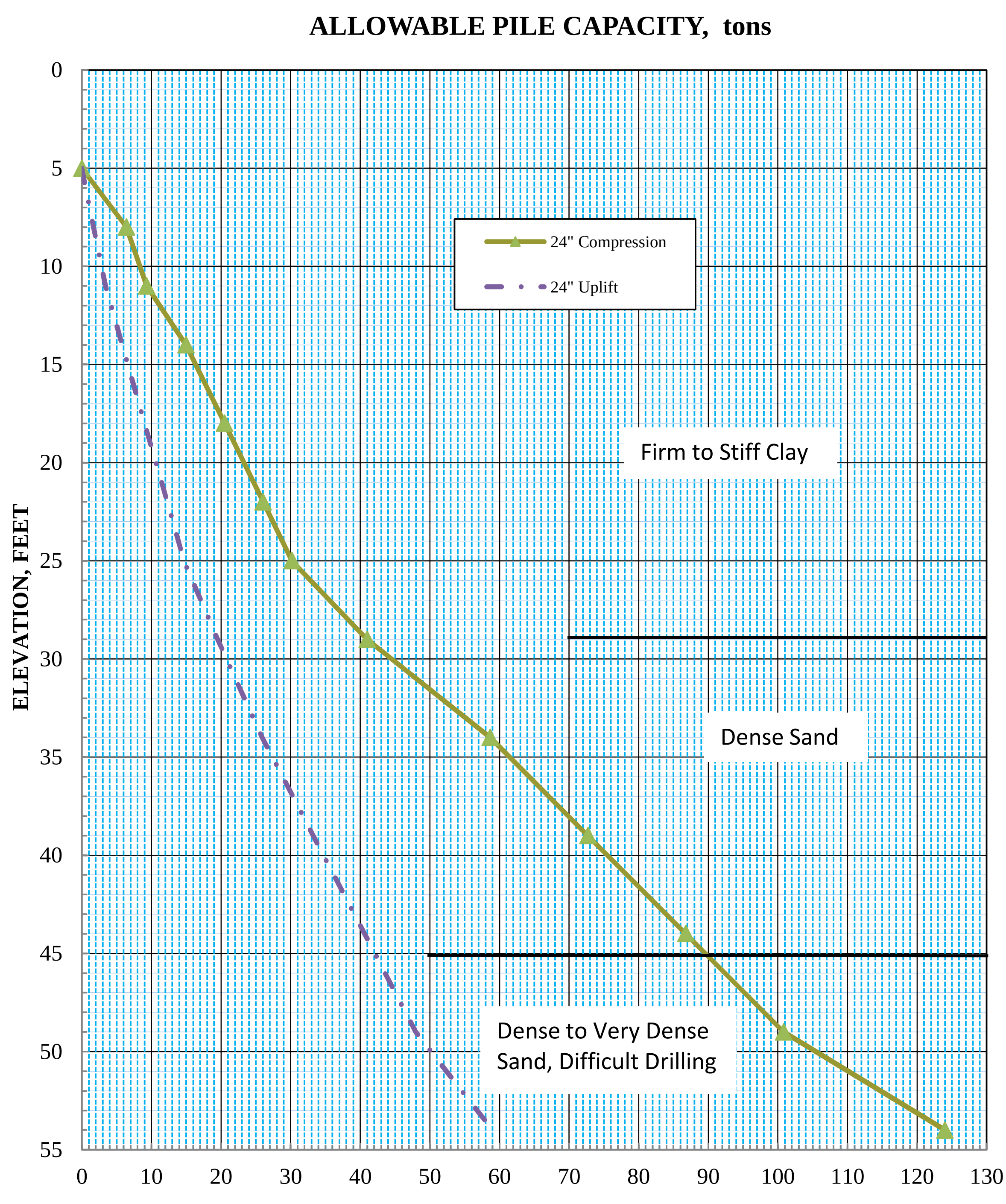
**FOR INFORMATION ONLY**




**PRELIMINARY ALLOWABLE SINGLE PILE CAPACITY, tons**
18-in.-Diameter AUGER CAST PILES
Feasibility Study for Industrial Site
Osceola, Arkansas
GHBW Job No. 16-005

**FACTORS OF SAFETY**
Uplift = 3.0
Compression = 2.5
**FOR INFORMATION ONLY**

**Grubbs, Hoskyn,**
**Barton & Wyatt, Inc.**
CONSULTING ENGINEERS




**PRELIMINARY ALLOWABLE SINGLE PILE CAPACITY, tons**

24-in.-Diameter AUGER CAST PILES

Feasibility Study for Industrial Site

Osceola, Arkansas

GHBW Job No. 16-005

**FACTORS OF SAFETY**

Uplift = 3.0

Compression = 2.5

**FOR INFORMATION ONLY**