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October 8, 2024
Kleinfelder Project No.: 25002014.001A

Mr. Jacob Brumbaugh, PE
Project Manager
RJN Group, Inc.
4150 S. 100th E. Avenue, Suite 106
Tulsa, Oklahoma 74146

**Subject:** **Report for Subsurface Investigation and Laboratory Testing Services**
**TMUA Spunky Creek Interceptor East Branch**
**From E. 6th Street Lift Station Extending 4,800 feet South**
**Tulsa, Oklahoma**

Dear Mr. Brumbaugh:

Kleinfelder has completed the authorized subsurface exploration and laboratory testing services for the above referenced project. Kleinfelder conducted the fieldwork by drilling a total of five (5) soil test borings (designated as A-01 through A-04 and B-01) on September 5 and 25, 2024. The borings were located in the field by a Kleinfelder representative using a hand-held Global Positioning System (GPS) with an accuracy of approximately 15 feet. The general site location and the approximate boring locations are shown on Figure 1, Exploration Location Plan and Vicinity Map.

**FIELD EXPLORATION PROGRAM**

The soil test borings were advanced with a Geoprobe 7822DT and a CME 550X rotary drill rig using hollow stem augers. Representative soil samples were obtained by split-barrel sampling procedures (ASTM D1586) at 5 feet intervals. The split-barrel sampling procedure utilizes a standard 2-inch O.D. split-barrel sampler that is driven into the bottom of the boring with a 140-pound auto-hammer (92.7% efficiency for the Geoprobe rig and 81% efficiency for the CME rig) falling 30 inches. Highly weathered to decomposed shale bedrock encountered in borings A-02, A-03, and A-04 were soft and not corable (results in low recovery and low RDQs if cored), and thus were drilled through and tested using SPT. Borings were terminated at auger refusal where encountered.

The collected soil samples were sealed and returned to our laboratory for further examination, classification, and testing. All the borings were backfilled in accordance with the appropriate Oklahoma Water Resources Board (OWRB) regulations.

Field logs included visual classification of the materials encountered during drilling, as well as drilling characteristics. Stratification boundaries indicated on the boring logs are based on observations during our fieldwork, an extrapolation of information obtained by examining samples from the borings, and comparisons of soils with similar engineering characteristics. Locations of these boundaries are approximate, and the transitions between material types may be gradual rather than clearly defined. The boring logs are attached in Attachment A.

## LABORATORY TESTING PROGRAM

Laboratory tests, including sieve gradations, Atterberg limits, and moisture contents, were performed on selected samples for classification purposes in general accordance with applicable standards. Soil samples were also visually classified in accordance with the Unified Soil Classification System (USCS). All the lab results are presented in Table B-1 in Attachment B and also are presented on each respective log.

## GROUNDWATER OBSERVATIONS

Groundwater depth observations were made and recorded during and after the completion of drilling operations, where applicable. Caving in boring A-04 was encountered at 14.5 feet below the existing ground surface after the completion of the drilling operation. The results of the groundwater observations are summarized in Table 1.

**Table 1. Groundwater Summary**

| Borings | Termination Depths (ft) | Groundwater Depth/Elevation During Drilling (ft) | Groundwater Depth/Elevation End of Drilling (ft) |
|---|---|---|---|
| A-01 | 11 | 8 | NE |
| A-04 | 20 | 1 | 10 |

NE=Not Encountered

The materials encountered in the test borings have a wide range of permeabilities and observations over an extended period through the use of piezometers or cased borings would be required to better define current groundwater conditions. Piezometers were not installed at the site during this subsurface exploration. Fluctuations in groundwater levels can occur due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

## SUBSURFACE CONDITIONS

Existing Pavement: Approximately 8.5 inches of asphaltic concrete was encountered at the surface in boring B-01. No aggregate base was encountered underneath the pavement.

Overburden Soil: Overburden soils, consisting of Silt, clay with varying amounts of sand, and sand with varying amounts of clay and gravel, were encountered underneath the topsoil/existing pavement and continued to depths ranging from 4 to 10.5 feet below the existing grade. The consistencies of the clay soils ranged from medium stiff to very stiff. The relative density of sandy soils ranged from loose to medium dense.




**KLEINFELDER** 12727 E 61st Street, Suite A, Tulsa, OK 74146 **p|** 918.627.6161 **f|** 918.627.6262

Bedrock: Shale, sandstone, and limestone bedrocks with varying degrees of weathering were encountered below the overburden soils at depths ranging from 4 to 10.5 feet below the existing grade. The bedrocks were predominantly gray and brown in color. The hardnesses of the bedrocks ranged from extremely weak to strong. A summary of the subsurface materials is also presented in Table 2.

**Table 2. Summary of Subsurface Materials**

| Borings | Offset | Surface Type | Overburden Soil | Depth to Weathered Rock (ft) | Depth to Competent Bedrock (ft) | Termination Depth (ft) |
|---|---|---|---|---|---|---|
| A-01* | - | Grass | CL+SC | NE | 10.5 | 11 |
| A-02 | - | Grass | SC | NE | 8.5 | 20 |
| A-03 | 30' S. of E. 11th St. | Grass | CL | 4 | 14.0 | 20 |
| A-04 | 75' NW of proposed boring | Grass | ML | 4 | NE | 20 |
| B-01* | - | AC 8.5" | CL | 7.5 | 8.5 | 8.5 |

NE=Not encountered
*Borings were terminated at auger refusal on top of bedrock prior to planned termination depths.

## EXCAVATION

Excavations of trenches for the proposed sanitary sewer line will most likely encounter weak to strong shale, sandstone, and limestone bedrocks. Auger refusal on hard sandstone and limestone bedrock was encountered in borings A-01 and B-01. However, these materials may also be encountered at other locations within the proposed alignment. Pneumatic hammer and/or blasting are likely to be required during construction. It is the contractor's responsibility to carefully review our boring logs and determine the appropriate excavation methods for the construction.

## LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions, and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two years from the date of this report. The work performed was based on project information provided by the Client.

## CLOSING

We appreciate the opportunity to be of service to you on this project. Please call us if you have any questions concerning the information presented within this letter.

Sincerely,

**KLEINFELDER, INC.**
*Certificate of Authorization #7292, Expires 6/30/25*

Subash Bhandari, EIT
Project Manager

Shiyun (Simon) Wang, PE
Program Manager

Attachments:

| | |
|---|---|
| Figure 1 | Exploration Location Plan and Vicinity Map |
| Attachment A | Field Exploration Program |
| Attachment B | Laboratory Testing Program |
| Attachment C | GBA Documents |

N

## LEGEND

SOIL BORING


VICINITY MAP

N

NOT TO SCALE

NOTES:
1. BASE MAPPING AND VICINITY MAP CREATED FROM LAYERS COMPILED BY ESRI PRODUCTS.
2. COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE OKLAHOMA NORTH FIPS 3501




0 500 1,000

1" = 500 SCALE IN FEET

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| | |
|---|---|
| PROJECT NO. | 25002014.001A |
| DRAWN BY: | SB |
| CHECKED BY: | SYW |
| DATE: | 10-02-2024 |

EXPLORATION LOCATION PLAN AND VICINITY MAP

TMUA Spunky Creek Interceptor East Branch
From E. 6th St. Lift Station South 4,800 ft.
Tulsa, Oklahoma

FIGURE

1

GIS FILE PATH: \\azrgisstorp03\working_clients_Automated_Exploration Plans\25002014.001A_TMUASpunkyCreekInterceptorEastBranch_20241002_sbhandari\APRX\
GIS FILE NAME: gINT_20241002_1547_sb
PLOTTED: 10/3/2024 10:35 AM BY: SBHANDARI

## DRILLING METHOD/SAMPLER TYPE GRAPHICS

- HOLLOW STEM AUGER
- STANDARD PENETRATION SPLIT SPOON SAMPLER (2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)

## GROUND WATER GRAPHICS

- WATER LEVEL (level where first observed)
- WATER LEVEL (level after stabilizing period)
- WATER LEVEL (additional levels after exploration)
- OBSERVED SEEPAGE

## NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Solid lines separating strata on the logs represent approximate boundaries only, dashed lines are inferred or extrapolated boundaries. Actual transitions may be gradual or differ from those represented.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System (ASTM D2488/D2487) designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., CL-ML, GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

**ABBREVIATIONS**

**$C_u$ -** Coefficients of Uniformity
**$C_c$ -** Coefficients of Curvature
**WOH -** Weight of Hammer
**WOR -** Weight of Rod


**REFERENCES**

1. American Society for Testing and Materials (ASTM), 2011, ASTM D2487: Classification of Soils for Engineering Purposes (Unified Soil Classification System).


## UNIFIED SOIL CLASSIFICATION SYSTEM[1]

| | | | Symbol | Description |
|---|---|---|---|---|
| **COARSE GRAINED SOILS** (More than 50% retained on No. 200 Sieve) | **GRAVELS** (More than 50% of coarse fraction retained on No. 4 Sieve) | CLEAN GRAVEL WITH <5% FINES | **GW** | WELL-GRADED GRAVEL, WELL-GRADED GRAVEL WITH SAND |
| | | | **GP** | POORLY GRADED GRAVEL, POORLY GRADED GRAVEL WITH SAND |
| | | GRAVELS WITH 5% TO 12% FINES | **GW-GM** | WELL-GRADED GRAVEL WITH SILT, WELL-GRADED GRAVEL WITH SILT AND SAND |
| | | | **GW-GC** | WELL-GRADED GRAVEL WITH CLAY (OR SILTY CLAY), WELL-GRADED GRAVEL WITH CLAY AND SAND (OR SILT CLAY AND SAND) |
| | | | **GP-GM** | POORLY GRADED GRAVEL WITH SILT, POORLY GRADED GRAVEL WITH SILT AND SAND |
| | | | **GP-GC** | POORLY GRADED GRAVEL WITH CLAY (OR SILTY CLAY), POORLY GRADED GRAVEL WITH CLAY AND (OR SILTY CLAY AND SAND) |
| | | GRAVELS WITH > 12% FINES | **GM** | SILTY GRAVEL, SILTY GRAVEL WITH SAND |
| | | | **GC** | CLAYEY GRAVEL, CLAYEY GRAVEL WITH SAND |
| | | | **GC-GM** | SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL WITH SAND |
| | **SANDS** (50% or more of coarse fraction passes the No. 4 Sieve) | CLEAN SANDS WITH <5% FINES | **SW** | WELL-GRADED SAND, WELL-GRADED SAND WITH GRAVEL |
| | | | **SP** | POORLY GRADED SAND, POORLY GRADED SAND WITH GRAVEL |
| | | SANDS WITH 5% TO 12% FINES | **SW-SM** | WELL-GRADED SAND WITH SILT, WELL-GRADED SAND WITH SILT AND GRAVEL |
| | | | **SW-SC** | WELL-GRADED SAND WITH CLAY (OR SILTY CLAY), WELL-GRADED SAND WITH CLAY AND GRAVEL (OR SILTY CLAY AND GRAVEL) |
| | | | **SP-SM** | POORLY GRADED SAND WITH SILT, POORLY GRADED SAND WITH SILT AND GRAVEL |
| | | | **SP-SC** | POORLY GRADED SAND WITH CLAY, POORLY GRADED SAND WITH CLAY AND GRAVEL (OR SILTY CLAY AND GRAVEL) |
| | | SANDS WITH > 12% FINES | **SM** | SILTY SAND, SILTY SAND WITH GRAVEL |
| | | | **SC** | CLAYEY SAND, CLAYEY SAND WITH GRAVEL |
| | | | **SC-SM** | SILTY, CLAYEY SAND, SILTY, CLAYEY SAND WITH GRAVEL |

| | | Symbol | Description |
|---|---|---|---|
| **FINE GRAINED SOILS** (50% or more passes the No. #200 sieve) | SILTS AND CLAYS (Liquid Limit less than 50) | **ML** | SILT, SILT WITH SAND, SILT WITH GRAVEL |
| | | **CL** | LEAN CLAY, LEAN CLAY WITH SAND, LEAN CLAY WITH GRAVEL |
| | | **CL-ML** | SILTY CLAY, SILTY CLAY WITH SAND, SILTY CLAY WITH GRAVEL |
| | | **OL** | ORGANIC CLAY, ORGANIC CLAY WITH SAND, ORGANIC CLAY WITH GRAVEL, ORGANIC SILT, ORGANIC SILT WITH SAND, ORGANIC SILT WITH GRAVEL |
| | SILTS AND CLAYS (Liquid Limit 50 or greater) | **MH** | ELASTIC SILT. ELASTIC SILT WITH SAND, ELASTIC SILT WITH GRAVEL |
| | | **CH** | FAT CLAY, FAT CLAY WITH SAND, FAT CLAY WITH GRAVEL |
| | | **OH** | ORGANIC CLAY, ORGANIC CLAY WITH SAND, ORGANIC CLAY WITH GRAVEL, ORGANIC SILT, ORGANIC SILT WITH SAND, ORGANIC SILT WITH GRAVEL |

**NOTE:** USE MATERIAL DESCRIPTION ON THE LOG TO DEFINE A GRAPHIC THAT MAY NOT BE PROVIDED ON THIS LEGEND.

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| | | | |
|---|---|---|---|
| PROJECT NO.: 25002014.001A | GRAPHICS KEY | FIGURE A-1 |
| DRAWN BY: SB | TMUA Spunky Creek Interceptor East Branch From E. 6th St. Lift Station South 4,800 ft. Tulsa, Oklahoma | |
| CHECKED BY: SYW | | |
| DATE: 10/2/2024 | | |

PLOTTED: 10/03/2024 01:24 PM BY: SBhandari

OFFICE FILTER: TULSA

PROJECT NUMBER: 25002014.001A

gINT FILE: Klf_gint_master_2025

gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2025.GLB [_KLF_GEO_LEG2_SOIL_DESC_KEY]

## GRAIN SIZE[1]

| DESCRIPTION | | SIEVE SIZE | GRAIN SIZE |
|---|---|---|---|
| Boulders | | >12 in. | >12 in. (304.8 mm.) |
| Cobbles | | 3 - 12 in. | 3 - 12 in. (76.2 - 304.8 mm.) |
| Gravel | coarse | 3/4 -3 in. | 3/4 -3 in. (19 - 76.2 mm.) |
| | fine | #4 - 3/4 in. | 0.19 - 0.75 in. (4.8 - 19 mm.) |
| Sand | coarse | #10 - #4 | 0.079 - 0.19 in. (2 - 4.9 mm.) |
| | medium | #40 - #10 | 0.017 - 0.079 in. (0.43 - 2 mm.) |
| | fine | #200 - #40 | 0.0029 - 0.017 in. (0.07 - 0.43 mm.) |
| Fines | | Passing #200 | <0.0029 in. (<0.07 mm.) |

## SECONDARY CONSTITUENT[1]

| Term of Use | AMOUNT | |
|---|---|---|
| | Secondary Constituent is Fine Grained | Secondary Constituent is Coarse Grained |
| Trace | <5% | <15% |
| With | ≥5 to <15% | ≥15 to <30% |
| Modifier | ≥15% | ≥30% |

## PLASTICITY[1]

| DESCRIPTION | CRITERIA |
|---|---|
| Non-Plastic | A 1/8 in. (3 mm) thread cannot be rolled at any water content. |
| Low | The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit. |
| Medium | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit. |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit. |

## MOISTURE CONTENT[1]

| DESCRIPTION | FIELD TEST |
|---|---|
| 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 |

## CONSISTENCY - FINE-GRAINED SOIL[2, 3]

| CONSISTENCY | SPT - N (# blows / ft) | Pocket Pen (tsf) | UNCONFINED COMPRESSIVE STRENGTH ($Q_u$)(psf) | VISUAL / MANUAL CRITERIA |
|---|---|---|---|---|
| Very Soft | <2 | PP < 0.25 | <500 | Easily penetrated several inches by fist |
| Soft | 2 - 4 | 0.25 ≤ PP <0.5 | 500 - 1,000 | Easily penetrated several inches by thumb |
| Medium Stiff | 4 - 8 | 0.5 ≤ PP <1 | 1,000 - 2,000 | Can be penetrated several inches by thumb with moderate effort |
| Stiff | 8 - 15 | 1 ≤ PP <2 | 2,000 - 4,000 | Readily indented by thumb but penetrated only with great effort |
| Very Stiff | 15 - 30 | 2 ≤ PP <4 | 4,000 - 8,000 | Readily indented by thumbnail |
| Hard | >30 | 4 ≤ PP | >8,000 | Indented by thumbnail with difficulty |

## APPARENT DENSITY - COARSE-GRAINED SOIL[2]

| APPARENT DENSITY | SPT-N (# blows / ft) |
|---|---|
| Very Loose | <4 |
| Loose | 4 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | >50 |

## STRUCTURE[1]

| DESCRIPTION | CRITERIA |
|---|---|
| Stratified | Alternating layers of varying material or color with layers at least 1/4-in. (6mm) thick, note thickness. |
| Laminated | Alternating layers of varying material or color with the layers less than 1/4-in. (6 mm) thick, note thickness. |
| Fissured | Breaks along definite planes of fracture with little resistance to fracturing. |
| Slickensided | Fracture planes appear polished or glossy, sometimes striated. |
| Blocky | Cohesive soil that can be broken down into small angular lumps which resist further breakdown. |
| Lensed | Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness. |
| Homogeneous | Same color and appearance throughout |

## ANGULARITY[1]

| DESCRIPTION | CRITERIA |
|---|---|
| Angular | Particles have sharp edges and relatively plane sides with unpolished surfaces. |
| Subangular | Particles are similar to angular description but have rounded edges. |
| Subrounded | Particles have nearly plane sides but have well-rounded corners and edges. |
| Rounded | Particles have smoothly curved sides and no edges. |

## REACTION WITH HYDROCHLORIC ACID[1]

| DESCRIPTION | FIELD TEST |
|---|---|
| None | No visible reaction |
| Weak | Some reaction, with bubbles forming slowly |
| Strong | Violent reaction, with bubbles forming immediately |

## CEMENTATION[1]

| DESCRIPTION | FIELD TEST |
|---|---|
| Weakly | Crumbles or breaks with handling or little finger pressure |
| Moderately | Crumbles or breaks with considerable finger pressure |
| Strongly | Will not crumble or break with finger pressure |

## REFERENCES


1. American Society for Materials and Testing (ASTM), 2017, ASTM D2488: Standard Practice for Description and Identification of Soils (Visual Manual Procedures).
2. Terzaghi, K and Peck, R., 1948, Soil Mechanics in Engineering Practice, John Wiley & Sons, New York.
3. United States Department of the Interior Bureau of Reclamation (USBR), 1998, Earth Manual, Part I.


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PROJECT NO.: 25002014.001A

DRAWN BY: SB

CHECKED BY: SYW

DATE: 10/2/2024

SOIL DESCRIPTION KEY
(For additional tables, see ASTM D2488)

TMUA Spunky Creek Interceptor East Branch
From E. 6th St. Lift Station South 4,800 ft.
Tulsa, Oklahoma

FIGURE

A-2

## INFILLING TYPE

| NAME | ABBR | NAME | ABBR |
|---|---|---|---|
| Albite | Al | Muscovite | Mus |
| Apatite | Ap | None | No |
| Biotite | Bi | Pyrite | Py |
| Clay | Cl | Quartz | Qz |
| Calcite | Ca | Sand | Sd |
| Chlorite | Ch | Sericite | Ser |
| Epidote | Ep | Silt | Si |
| Iron Oxide | Fe | Talc | Ta |
| Manganese | Mn | Unknown | Uk |

Kleinfelder modified from (FHWA, 2002)

## DENSITY/SPACING OF DISCONTINUITIES

| DESCRIPTION | SPACING CRITERIA |
|---|---|
| Unfractured | > 6 ft. (> 1.83 meters) |
| Slightly Fractured | 2 - 6 ft. (.061 - 1.83 meters) |
| Moderately Fractured | 8 in - 2 ft. (203.20 - 609.60 mm.) |
| Highly Fractured | 2 - 8 in. (50.80 - 203.30 mm.) |
| Intensely Fractured | < 2 in. (< 50.80 mm.) |

(USACE, 1994)

## BEDDING CHARACTERISTICS

| TERM | Thickness (in.) | Thickness (mm.) |
|---|---|---|
| Very Thick Bedded | > 36 | > 915 |
| Thick Bedded | 12 - 36 | 305 - 915 |
| Moderately Bedded | 4 - 12 | 102 - 305 |
| Thin Bedded | 1 - 4 | 25 - 102 |
| Very Thin Bedded | 0.4 - 1 | 10 - 25 |
| Laminated | 0.1 - 0.4 | 2.5 - 10 |
| Thinly Laminated | < 0.1 | < 2.5 |

Kleinfelder modified from (USBR, 1998)

| | |
|---|---|
| Bedding Planes | Planes dividing the individual layers, beds, or stratigraphy of rocks. |
| Joint | Fracture in rock, generally more or less vertical or traverse to bedding. |
| Seam | Applies to bedding plane with unspecified degree of weather. |

## APERTURE

| DESCRIPTION | CRITERIA [in.(mm.)] |
|---|---|
| Tight | < 0.04 (< 1) |
| Open | 0.04 - 0.20 (1 - 5) |
| Wide | > 0.20 (> 5) |

Kleinfelder modified from Rock Mass Rating Classification (Bieniawski, 1989)

## ADDITIONAL TEXTURAL ADJECTIVES

| DESCRIPTION | RECOGNITION |
|---|---|
| Pit (Pitted) | Pinhole to 0.03 ft. (3/8 in.) (>1 to 10 mm.) openings |
| Vug (Vuggy) | Small openings (usually lined with crystals) ranging in diameter from 0.03 ft. (3/8 in.) to 0.33 ft. (4 in.) (10 to 100 mm.) |
| Cavity | An opening larger than 0.33 ft. (4 in.) (100 mm.), size descriptions are required, and adjectives such as small, large, etc., may be used |
| Honeycombed | If numerous enough that only thin walls separate individual pits or vugs, this term further describes the preceding nomenclature to indicate cell-like form |
| Vesicle (Vesicular) | Small openings in volcanic rocks of variable shape and size formed by entrapped gas bubbles during solidification |

(USBR, 1994)

## DISCONTINUITY TYPE

| DESCRIPTION |
|---|
| Fault |
| Joint |
| Shear |
| Foliation |
| Vein |
| Bedding |

## INFILLING AMOUNT

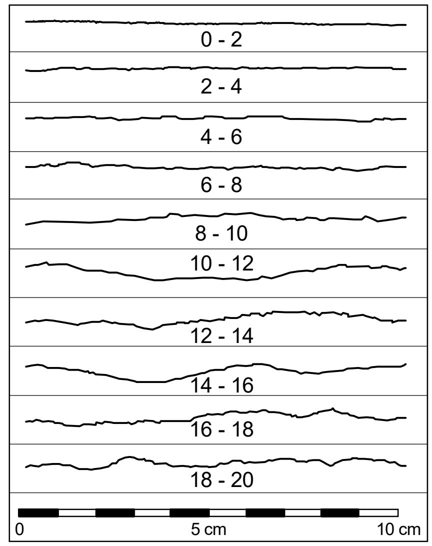
| DESCRIPTION |
|---|
| Surface Stain |
| Spotty |
| Partially Filled |
| Filled |
| None |

## ROCK QUALITY DESIGNATION (RQD)

| DESCRIPTION | RQD (%) |
|---|---|
| Very Poor | 0 - 25 |
| Poor | 25 - 50 |
| Fair | 50 - 75 |
| Good | 75 - 90 |
| Excellent | 90 - 100 |

(Deere and Deere, 1989; ASTM D 6032)

## JOINT ROUGHNESS COEFFICIENT (JRC)




(ISRM, 1978; Barton and Choubey, 1977)

RQD Rock-quality designation (RQD) Rough measure of the degree of jointing or fracture in a rock mass, measured as a percentage of the drill core in lengths of 10 cm. or more.

## DEGREES OF WEATHERING (USACE, 1994)

| DESCRIPTION | CRITERIA |
|---|---|
| Unweathered | No evidence of chemical/mechanical alternation; rings with hammer blow. |
| Slightly Weathered | Slight discoloration on surface; slight alteration along discontinuities; <10% rock volume altered. |
| Moderately Weathered | Discoloring evident; surface pitted and alteration penetration well below surface; Weathering "halos" evident; 10-50% rock altered. |
| Highly Weathered | Entire mass discolored; Alteration pervading most rock, some slight weathering pockets; some minerals may be leached out. |
| Decomposed | Rock reduced to soil with relic rock texture/structure; Generally molded and crumbled by hand. |

## RELATIVE HARDNESS / STRENGTH DESCRIPTIONS - FOR WEAKER SEDIMENTARY ROCKS IN COLORADO (USACE, 1994)

| SPT $N_{60}$ | HARDNESS |
|---|---|
| < 20 | Very Weak to Weathered |
| 20 - 39 | Weak |
| 40 - 49 | Moderately Strong |
| 50 - 50/6" | Strong |
| > 50/6" | Very Strong |

This table was developed by Kleinfelder based on project experience in Colorado for shale, claystone, siltstone, poorly cemented sandstone, and other weaker sedimentary rocks.

| | | | |
|---|---|---|---|
| KLEINFELDER Bright People. Right Solutions. | PROJECT NO.: 25002014.001A | ROCK DESCRIPTION KEY | FIGURE |
| | DRAWN BY: SB | TMUA Spunky Creek Interceptor East Branch From E. 6th St. Lift Station South 4,800 ft. Tulsa, Oklahoma | A-3 |
| | CHECKED BY: SYW | | |
| | DATE: 10/2/2024 | | |

PLOTTED: 10/03/2024 01:25 PM BY: SBhandari
OFFICE FILTER: TULSA
PROJECT NUMBER: 25002014.001A
gINT FILE: Klf_gint_master_2025
gINT TEMPLATE: E:KLF_STANDARD_GINT_LIBRARY_2025.GLB [_KLF_GEO_LEG3_ROCK_DESC_KEY_SED]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date Begin - End:** | 9/05/2024 | **Drilling Company:** | Aimright | | | **BORING LOG A-01** | |
| **Logged By:** | C. Latham | **Drill Crew:** | B. Baxter | | | | |
| **Hor.-Vert. Datum:** | NAD83 - Not Available | **Drilling Equipment:** | Geoprobe 7822DT | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. | | |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 92.7% | | |
| **Weather:** | 80° Sunny | **Auger Diameter:** | 6 in. O.D. | **Hammer Cal. Date:** | 4/24/2024 | | |

Latitude: 36.15071°
Longitude: -95.74552°
Surface Condition: Grass

| Depth (feet) | Lithologic Description | Sample Number | Blow Counts(BC)= Uncorr. Blows/6 in. | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TOPSOIL**: 6 inches | | | | | | | | | | | |
| | **Sandy Lean CLAY (CL)**: brown, moist, very stiff, with gray sandpockets, trace sandstone fragments | SS-1 | BC=5 7 9 | 18" | CL | 16.1 | | 94 | 60 | 47 | 26 | |
| 5 | | | | | | | | | | | | |
| | **Clayey SAND with Gravel (SC)**: reddish brown and gray, moist to wet, loose, trace of mottled reddish brown sandstone fragments | | | | | | | | | | | |
| ∇ | - wet below 8 feet | SS-2 | BC=2 3 3 | 18" | SC | 23.4 | | 79 | 41 | 41 | 21 | |
| 10 | | | | | | | | | | | | |
| | **SANDSTONE**: gray, weathered, very strong | SS-3 | BC=50/2" | 2" | | 14.7 | | | | | | |

The boring was terminated because of practical auger refusal (↑) at approximately 11 ft. below ground surface on sandstone.
The boring was backfilled with auger cuttings and bentonite on September 05, 2024.

GROUNDWATER LEVEL INFORMATION:
∇ Groundwater was observed at approximately 8 ft. below ground surface during drilling.
GENERAL NOTES:
A handheld GPS unit was used to locate the exploration with an accuracy of 15 feet.

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| | | |
|---|---|---|
| PROJECT NO.: 25002014.001A | BORING LOG A-01 | BORING |
| DRAWN BY: SB | TMUA Spunky Creek Interceptor East Branch From E. 6th St. Lift Station South 4,800 ft. Tulsa, Oklahoma | A-01 |
| CHECKED BY: SYW | | |
| DATE: 10/2/2024 | | PAGE: 1 of 1 |

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 9/25/2024 | **Drilling Company:** | Aimright | | |
| **Logged By:** | S. Bhandari | **Drill Crew:** | H. Wilson | | |
| **Hor.-Vert. Datum:** | NAD83 - Not Available | **Drilling Equipment:** | CME-550X | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 81.0% |
| **Weather:** | 58° Misty | **Auger Diameter:** | 6 in. O.D. | **Hammer Cal. Date:** | 4/24/2024 |

**BORING LOG A-02**

FIELD EXPLORATION — LABORATORY RESULTS

Latitude: 36.14873°
Longitude: -95.74503°
Surface Condition: Grass

| Depth (feet) | Lithologic Description | Sample Number | Blow Counts(BC)= Uncorr. Blows/6 in. | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **TOPSOIL**: 6 inches | | | | | | | | | | | |
| | **Clayey SAND (SC)**: brown, moist, medium dense<br>- light brown below 2 feet<br>- with olive, trace iron stains below 3.5 feet | SS-1 | BC=6 7 10 | 18" | SC | 11.5 | | 90 | 48 | 28 | 10 | |
| 5 | | | | | | | | | | | | |
| | **SHALE**: gray and brown, highly weathered to decomposed, laminated, fissured, strong | SS-2 | BC=50/3.5" | 3" | | | | | | | | |
| 10 | - gray, multiple seams of hard sandstone layers below 10 feet | | | | | | | | | | | |
| | | SS-3 | BC=50/2.5" | 2" | | | | | | | | |
| 15 | | | | | | | | | | | | |
| | | SS-4 | BC=50/2" | 2" | | | | | | | | |
| 20 | | | | | | | | | | | | |

The boring was terminated at approximately 18.5 ft. below ground surface. The boring was backfilled with auger cuttings and bentonite on September 25, 2024.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:
A handheld GPS unit was used to locate the exploration with an accuracy of 15 feet.

| | | | |
|---|---|---|---|
| KLEINFELDER Bright People. Right Solutions. | PROJECT NO.: 25002014.001A<br>DRAWN BY: SB<br>CHECKED BY: SYW<br>DATE: 10/2/2024 | BORING LOG A-02<br>TMUA Spunky Creek Interceptor East Branch From E. 6th St. Lift Station South 4,800 ft. Tulsa, Oklahoma | BORING A-02<br>PAGE: 1 of 1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Date Begin - End:** | 9/05/2024 | **Drilling Company:** | Aimright | | | **BORING LOG A-03** | |
| **Logged By:** | C. Latham | **Drill Crew:** | B. Baxter | | | | |
| **Hor.-Vert. Datum:** | NAD83 - Not Available | **Drilling Equipment:** | Geoprobe 7822DT | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. | | |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 92.7% | | |
| **Weather:** | 82° Sunny | **Auger Diameter:** | 6 in. O.D. | **Hammer Cal. Date:** | 4/24/2024 | | |

FIELD EXPLORATION — Latitude: 36.14584°; Longitude: -95.74469°; Location Offset: 30' south of E. 11th St.; Surface Condition: Grass

| Depth (feet) | Lithologic Description | Sample Number | Blow Counts(BC)= Uncorr. Blows/6 in. | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | **TOPSOIL**: 6 inches | | | | | | | | | | | |
| | **Sandy Lean CLAY (SC)**: grayish brown to light brown, moist | | | | | | | | | | | |
| | - dark brown, trace sandstone fragments below 3 feet | SS-1 | BC=2 10 16 | 12" | CL | 9.4 | | 95 | 63 | 25 | 10 | |
| | **Highly Weathered SHALE**: gray, laminated, fissured, weak to strong | | | | | | | | | | | |
| 5 | - increase in sandstone fragments below 6.5 feet | | | | | | | | | | | |
| | - strong below 8.5 feet | SS-2 | BC=26 50/4.5" | 10" | | 7.0 | | 96 | 92 | 24 | 2 | |
| 10 | | | | | | | | | | | | |
| | | SS-3 | BC=36 50/3" | 9" | | 5.6 | | | | | | |
| | **SHALE**: gray, highly weathered, laminated, fissured, strong | | | | | | | | | | | |
| 15 | | | | | | | | | | | | |
| | | SS-4 | BC=50/6" | 6" | | 6.1 | | | | | | |
| 20 | | | | | | | | | | | | |

The boring was terminated at approximately 19 ft. below ground surface. The boring was backfilled with auger cuttings and bentonite on September 05, 2024.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:
A handheld GPS unit was used to locate the exploration with an accuracy of 15 feet.

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| | | | |
|---|---|---|---|
| PROJECT NO.: 25002014.001A | BORING LOG A-03 | BORING | |
| DRAWN BY: SB | TMUA Spunky Creek Interceptor East Branch From E. 6th St. Lift Station South 4,800 ft. Tulsa, Oklahoma | A-03 | |
| CHECKED BY: SYW | | | |
| DATE: 10/2/2024 | | PAGE: 1 of 1 | |

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 9/05/2024 | **Drilling Company:** | Aimright | | **BORING LOG A-04** |
| **Logged By:** | C. Latham | **Drill Crew:** | B. Baxter | | |
| **Hor.-Vert. Datum:** | NAD83 - Not Available | **Drilling Equipment:** | Geoprobe 7822DT | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 92.7% |
| **Weather:** | 84° Sunny | **Auger Diameter:** | 6 in. O.D. | **Hammer Cal. Date:** | 4/24/2024 |

FIELD EXPLORATION | LABORATORY RESULTS

Latitude: 36.14508°
Longitude: -95.74480°
Location Offset: 75' NW of proposed boring
Surface Condition: Grass

| Depth (feet) | Graphical Log | Lithologic Description | Sample Number | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. | Recovery (NR=No Recovery) | USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **TOPSOIL**: 6 inches | | | | | | | | | | | | |
| | | **SILT (ML)**: brown and gray, moist, medium stiff | | | | | | | | | | | | |
| | | | SS-1 | | BC=7 13 26 | 18" | | 8.7 | | 100 | 95 | 31 | 6 | |
| 5 | | **Highly Weathered SHALE**: gray and light yellowish brown, laminated, weak to strong | | | | | | | | | | | | |
| | | - strong below 8.5 feet<br>- gray, fissured below 9 feet | SS-2 | | BC=23 50/3" | 9" | | 5.5 | | 95 | 89 | 24 | 3 | |
| 10 | | | | | | | | | | | | | | |
| | | | SS-3 | | BC=37 50/2.5" | 8" | | 5.8 | | | | | | |
| 15 | | | | | | | | | | | | | | |
| | | | SS-4 | | BC=13 50/5" | 11" | | 13.2 | | | | | | |
| 20 | | | | | | | | | | | | | | |

The boring was terminated at approximately 19.5 ft. below ground surface. The boring was backfilled with auger cuttings and bentonite on September 05, 2024.

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 16 ft. below ground surface during drilling.
▼ Groundwater was observed at approximately 10 ft. below ground surface at the end of drilling.

GENERAL NOTES:
A handheld GPS unit was used to locate the exploration with an accuracy of 15 feet.

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| | | | |
|---|---|---|---|
| PROJECT NO.: 25002014.001A | BORING LOG A-04 | | BORING |
| DRAWN BY: SB | TMUA Spunky Creek Interceptor East Branch From E. 6th St. Lift Station South 4,800 ft. Tulsa, Oklahoma | | A-04 |
| CHECKED BY: SYW | | | |
| DATE: 10/2/2024 | | | PAGE: 1 of 1 |

| | | | | | |
|---|---|---|---|---|---|
| **Date Begin - End:** | 9/05/2024 | **Drilling Company:** | Aimright | | **BORING LOG B-01** |
| **Logged By:** | C. Latham | **Drill Crew:** | B. Baxter | | |
| **Hor.-Vert. Datum:** | NAD83 - Not Available | **Drilling Equipment:** | Geoprobe 7822DT | **Hammer Type - Drop:** | 140 lb. Auto - 30 in. |
| **Plunge:** | -90 degrees | **Drilling Method:** | Hollow Stem Auger | **Hammer Efficiency:** | 92.7% |
| **Weather:** | 84° Sunny | **Auger Diameter:** | 6 in. O.D. | **Hammer Cal. Date:** | 4/24/2024 |

Latitude: 36.14808°
Longitude: -95.75201°
Surface Condition: Asphalt

| Depth (feet) | Graphical Log | FIELD EXPLORATION: Lithologic Description | Sample Number | Sample Type | Blow Counts(BC)= Uncorr. Blows/6 in. | Recovery (NR=No Recovery) | LABORATORY RESULTS: USCS Symbol | Water Content (%) | Dry Unit Wt. (pcf) | Passing #4 (%) | Passing #200 (%) | Liquid Limit | Plasticity Index (NP=NonPlastic) | Additional Tests/ Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **ASPHALT**: 8.5 inches | | | | | | | | | | | | |
| | | **Sandy Lean CLAY (CL)**: brown and gray, moist, stiff, trace of limestone fragments | | | | | | | | | | | | |
| | | - dark brown below 3 feet | SS-1 | | BC=6 6 7 | 18" | CL | 10.2 | | 90 | 67 | 32 | 15 | |
| 5 | | | | | | | | | | | | | | |
| | | **Highly Weathered LIMESTONE**: dark brown, weak | | | | | | | | | | | | |
| | | **LIMESTONE**: light gray, highly weathered to weathered, very strong | SS-2 | | BC=50/2.5" | 2" | | 2.8 | | | | | | |
| 10 | | | | | | | | | | | | | | |

The boring was terminated because of practical auger refusal (↑) at approximately 8.5 ft. below ground surface on limestone. The boring was backfilled with auger cuttings, bentonite and patched at surface on September 05, 2024.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.

GENERAL NOTES:
A handheld GPS unit was used to locate the exploration with an accuracy of 15 feet.

| Exploration ID | Depth (ft.) | Sample No. | Sample Description | Water Content (%) | Dry Unit Wt. (pcf) | Sieve Analysis (%) | | | Atterberg Limits | | | Additional Tests |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Passing 3/4" | Passing #4 | Passing #200 | Liquid Limit | Plastic Limit | Plasticity Index | |
| A-01 | 3.5 - 5.0 | SS-1 | SANDY LEAN CLAY (CL) | 16.1 | | 100 | 94 | 60 | 47 | 21 | 26 | |
| A-01 | 8.5 - 10.0 | SS-2 | CLAYEY SAND WITH GRAVEL (SC) | 23.4 | | 100 | 79 | 41 | 41 | 20 | 21 | |
| A-01 | 11.0 - 11.17 | SS-3 | | 14.7 | | | | | | | | |
| A-02 | 3.5 - 5.0 | SS-1 | CLAYEY SAND (SC) | 11.5 | | 100 | 90 | 48 | 28 | 18 | 10 | |
| A-03 | 3.5 - 5.0 | SS-1 | SANDY LEAN CLAY (CL) | 9.4 | | 100 | 95 | 63 | 25 | 15 | 10 | |
| A-03 | 8.5 - 9.38 | SS-2 | HIGHLY WEATHERED SHALE | 7.0 | | 100 | 96 | 92 | 24 | 22 | 2 | |
| A-03 | 13.5 - 14.25 | SS-3 | | 5.6 | | | | | | | | |
| A-03 | 18.5 - 19.0 | SS-4 | | 6.1 | | | | | | | | |
| A-04 | 3.5 - 5.0 | SS-1 | HIGHLY WEATHERED SHALE | 8.7 | | 100 | 100 | 95 | 31 | 25 | 6 | |
| A-04 | 8.5 - 9.25 | SS-2 | HIGHLY WEATHERED SHALE | 5.5 | | 100 | 95 | 89 | 24 | 21 | 3 | |
| A-04 | 13.5 - 14.21 | SS-3 | | 5.8 | | | | | | | | |
| A-04 | 18.5 - 19.42 | SS-4 | | 13.2 | | | | | | | | |
| B-01 | 3.5 - 5.0 | SS-1 | SANDY LEAN CLAY (CL) | 10.2 | | 100 | 90 | 67 | 32 | 17 | 15 | |
| B-01 | 8.5 - 8.71 | SS-2 | | 2.8 | | | | | | | | |

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic
NA = Not Available

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PROJECT NO.: 25002014.001A
DRAWN BY: SB
CHECKED BY: SYW
DATE: 10/2/2024

LABORATORY TEST RESULT SUMMARY

TMUA Spunky Creek Interceptor East Branch
From E. 6th St. Lift Station South 4,800 ft.
Tulsa, Oklahoma

TABLE B-1

# Important Information about This

# 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.**

**The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.**

## Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

## Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

*Do not rely on this report* if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

## Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

## You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

## Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

## This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

## This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

## Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

## Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

## Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org