APPENDIX I

BORING LOGS
1.25

4.5

ST

1

ST

2

NQ

1

NQ

2

NQ

3

0.5 ft

1.5 ft

6.0 ft

7.2 ft

16.0 ft

CFA - 4.5" O.D.

CORE BARREL - 2.0" I.D.

TOPSOIL, Grass Covered

LEAN CLAY, Brown, Soft, Moist (CL)

FAT CLAY, Shaley, Tan Brown, Stiff, Moist (CH)

- Percent Swell = 0.72%
- Swell Pressure = 0.57 TSF
- Very Stiff Below 4.0'

SANDSTONE, Brown Tan, Slightly Weathered, Fine Grained, Medium Hard

LIMESTONE, Gray, Slightly Weathered, Fine Crystalline, Medium Hard

DRY UNIT WT (pcf)

40

60

80

100

N VALUE

20

40

60

80

SHEAR STRENGTH (ksf)

1

2

3

4

Refusal at 6.0 feet.
Bottom of borehole at 16.0 feet.
CLIENT: Finley Engineering

PROJECT NO.: 224708

DATE STARTED: 11/6/14

SURFACE ELEVATION: 667.5 ft

DRILLER: MA

TWO-

GROUNDS WATER LEVELS

LOGGED BY: RA

CHECKED BY: BP

HAMMER TYPE: Cat Head

AT TIME OF DRILLING: None

AT END OF DRILLING:

NOTES:

GROUND WATER LEVELS AT TIME OF DRILLING: None

MATERIAL DESCRIPTION:

Unified Soil Classification System

0.5 ft

TOPSOIL, Grass Covered

LEAN TO FAT CLAY, Tan Brown, Stiff, Moist (CL-CH)
- Percent Swell = 1.18%
  Swell Pressure = 0.6 TSF

1.5 ft

1.5 ft

ST 1

92

2.0 ft

SPT 2

6-9-10 (19)

3.25

5.0 ft

FAT CLAY, Shaley, Tan, Stiff, Moist (CH)

8.3 ft

LIMESTONE, Gray, Slightly Weathered, Fine Crystalline, Medium Hard

Refusal at 8.3 feet.

Bottom of borehole at 18.3 feet.
### GEOTECHNICAL BORING LOG

**Boring Number:** 3

**Client:** Finley Engineering  
**Project Name:** Pryor Substation No. 3  
**Project Location:** Pryor, Oklahoma

**Date Started:** 11/6/14  
**Completed:** 11/6/14  
**Surface Elevation:** 666 ft  
**Benchmark EL:**

**Drill Rig:** BK-51 MB  
**Hammer Type:** Cat Head

**Logged By:** RA  
**Checked By:** BP

**NOTES**

---

**Ground Water Levels**

**At Time of Drilling:** None

**At End of Drilling:**

---

### Boring Log

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>DRILLING METHOD</th>
<th>STRATA SYMBOL</th>
<th>MATERIAL DESCRIPTION</th>
<th>Unified Soil Classification System</th>
<th>Sample Type Number</th>
<th>Recovery % (RQD %)</th>
<th>Corrected Blow Counts (N Value)</th>
<th>Pocket Pen. (psi)</th>
<th>Shear Strength (ksf)</th>
<th>Ground Water Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td></td>
<td></td>
<td>TOPSOIL, Grass Covered</td>
<td>0.5 ft</td>
<td>ST 1</td>
<td>100</td>
<td>1.25</td>
<td></td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td>LEAN CLAY, Brown, Soft, Moist (CL)</td>
<td>1.5 ft</td>
<td>ST 2</td>
<td>6-9-11 (20)</td>
<td>4.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td>LEAN TO FAT CLAY, Tan Brown, Stiff, Moist (CL-CH)</td>
<td>5.0 ft</td>
<td>ST 3</td>
<td>3-4-6 (10)</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.6</td>
<td></td>
<td></td>
<td>FAT CLAY, Shaley, Tan, Stiff, Moist (CH)</td>
<td>9.6 ft</td>
<td>ST 4</td>
<td>3-4-50/1* (10)</td>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.5</td>
<td></td>
<td></td>
<td>LIMESTONE, Gray, Slightly Weathered, Fine Crystalline, Medium Hard</td>
<td>10.5 ft</td>
<td>NQ 1</td>
<td>100</td>
<td>200</td>
<td>20</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>11.7</td>
<td></td>
<td></td>
<td>SANDSTONE, Brown Tan, Slightly Weathered, Fine Grained, Medium Hard</td>
<td>11.7 ft</td>
<td>NQ 2</td>
<td>100</td>
<td>200</td>
<td>20</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>15.0</td>
<td></td>
<td></td>
<td>LIMESTONE, Gray, Slightly Weathered, Fine Crystalline, Medium Hard</td>
<td>15.0 ft</td>
<td>NQ 3</td>
<td>100</td>
<td>200</td>
<td>20</td>
<td>40</td>
<td>60</td>
</tr>
</tbody>
</table>

---

*Bottom of borehole at 19.3 feet.*
Geotechnical Boring Log

**CLIENT**  Finley Engineering  
**PROJECT NO.**  224708  
**DATE STARTED**  11/6/14  
**DATE COMPLETED**  11/6/14  
**PROJECT NAME**  Pryor Substation No. 3  
**PROJECT LOCATION**  Pryor, Oklahoma  
**SURFACE ELEVATION**  669.5 ft  
**BENCHMARK EL.**  

**DRILLER**  MA  
**DRILL RIG**  BK-51 MB  
**HAMMER TYPE**  Cat Head  
**LOGGED BY**  RA  
**CHECKED BY**  BP  
**CFA - 4.5" O.D.**  
**CORE BARREL - 2.0" I.D.**

---

**MATERIAL DESCRIPTION**

- Topsoil, Grass Covered
- Lean Clay, Brown, Soft, Moist (CL)
- Lean to Fat Clay, Tan Brown, Stiff, Moist (CL-CH)
- Fat Clay, Shaley, Brown Tan Gray, Stiff, Moist (CH)
- Sandstone, Brown Tan, Slightly Weathered, Fine Grained, Medium Hard
- Limestone, Gray, Slightly Weathered, Fine Crystalline, Medium Hard
- Weathered Shale Layer From 12.2' to 13.1'

**GROUND WATER LEVELS**

- None

**NOTES**

- Refusal at 6.0 feet.
- Bottom of borehole at 18.5 feet.
APPENDIX II

PHOTOGRAPHS OF ROCK CORE SPECIMENS
FINLEY ENGINEERING
Substation No. 3
Pryor, Oklahoma

Boring # 1 Date: 11/4/14
Box 1 Of 1 Boxes

Run 1: Depth 60" to 69" REC: 100 % RQD 0 %
Run 2: Depth 69" to 119" REC: 90 % RQD 73 %
Run 3: Depth 119" to 160" REC: 100 % RQD 90 %
FINLEY ENGINEERING
Substation No. 3
Pryor, Oklahoma

Boring # 2
Date: 11/6/14

Box 1 Of 1 Boxes

Run 1: Depth 8.3" to 12.0" REC: 100% ROD 98%

Run 2: Depth 12.0" to 17.0" REC: 100% ROD 95%

Run 3: Depth 17.0" to 18.3" REC: 80% ROD 80%
Finley Engineering
Substation No. 3
Pryor, Oklahoma

Boring # 3
Box 1 Of 1 Boxes

Date: 11/6/14

Run 1: Depth 9' 6" to 11' 8"
REC: 100% ROD: 42%

Run 2: Depth 11' 8" to 14' 8"
REC: 100% ROD: 92%

Run 3: Depth 14' 8" to 19' 3"
REC: 100% ROD: 100%
FINLEY ENGINEERING
Substation No. 3
Pryor, Oklahoma

Boring # 41   Date: 11/6/14
Box 1 Of 1 Boxes

Run 1: Depth 86" to 118"  REC: 100%  RQD 95%
Run 2: Depth 118" to 168"  REC: 100%  RQD 95%
Run 3: Depth 168" to 186"  REC: 100%  RQD 77%
## SOIL PROPERTIES & DESCRIPTIONS

### COHESIVE SOILS

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Unconfined Compressive Strength (Qu) (psf)</th>
<th>Pocket Penetrometer Strength (tsf)</th>
<th>N-Value (blows/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Soft</td>
<td>&lt;500</td>
<td>&lt;0.25</td>
<td>0-1</td>
</tr>
<tr>
<td>Soft</td>
<td>500-1000</td>
<td>0.25-0.50</td>
<td>2-4</td>
</tr>
<tr>
<td>Medium Stiff</td>
<td>1001-2000</td>
<td>0.50-1.00</td>
<td>5-8</td>
</tr>
<tr>
<td>Stiff</td>
<td>2001-4000</td>
<td>1.00-2.00</td>
<td>9-15</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>4001-8000</td>
<td>2.00-4.00</td>
<td>16-30</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;8000</td>
<td>&gt;4.00</td>
<td>31-60</td>
</tr>
<tr>
<td>Very Hard</td>
<td></td>
<td></td>
<td>&gt;60</td>
</tr>
</tbody>
</table>

- **Group Symbol**: Group Name
- **Plasticity**: Moisture

#### Plasticity

<table>
<thead>
<tr>
<th>Group Symbol</th>
<th>Group Name</th>
<th>Plasticity</th>
<th>Moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL</td>
<td>Lean Clay</td>
<td>&lt;45%</td>
<td>Dry</td>
</tr>
<tr>
<td>ML</td>
<td>Silt</td>
<td>45-49%</td>
<td>Moist</td>
</tr>
<tr>
<td>OL</td>
<td>Organic Clay</td>
<td>≥50%</td>
<td>Wet</td>
</tr>
<tr>
<td>CH</td>
<td>Fat Clay</td>
<td>≥50%</td>
<td>Wet</td>
</tr>
<tr>
<td>MH</td>
<td>Elastic Silt</td>
<td>≥50%</td>
<td>Wet</td>
</tr>
<tr>
<td>OH</td>
<td>Organic Clay</td>
<td>≥50%</td>
<td>Wet</td>
</tr>
<tr>
<td>PT</td>
<td>Peat</td>
<td>≥50%</td>
<td>Wet</td>
</tr>
<tr>
<td>CL-CH</td>
<td>Lean to Fat Clay</td>
<td>≥50%</td>
<td>Wet</td>
</tr>
</tbody>
</table>

#### Moisture Condition

- **Descriptive Term**: Guide
- **Relative Densities**: N-Value

<table>
<thead>
<tr>
<th>Relative Density</th>
<th>N-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0-4</td>
</tr>
<tr>
<td>Loose</td>
<td>5-10</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>11-24</td>
</tr>
<tr>
<td>Dense</td>
<td>25-50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>≥51</td>
</tr>
</tbody>
</table>

#### Fine Grained Soil Subclassification

- **Terms**: SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT
- **Primary Constituent**: Percent (by weight) of Total Sample

### NON-COHESIVE (GRANULAR) SOILS

#### Grain Size Identification

<table>
<thead>
<tr>
<th>Name</th>
<th>Size Limits</th>
<th>Familiar Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>12 in. or more</td>
<td>Larger than basketball</td>
</tr>
<tr>
<td>Coarse Gravel</td>
<td>3 in. to 12 in.</td>
<td>Grapefruit</td>
</tr>
<tr>
<td>Fine Gravel</td>
<td>¼-in. to 3 in.</td>
<td>Orange or lemon</td>
</tr>
<tr>
<td>Coarse Sand</td>
<td>No. 4 sieve to ¾-in.</td>
<td>Grape or pea</td>
</tr>
<tr>
<td>Medium Sand</td>
<td>No. 10 sieve to No. 4 sieve</td>
<td>Rock salt</td>
</tr>
<tr>
<td>Fine Sand*</td>
<td>No. 200 sieve to No. 40 sieve</td>
<td>Sugar, table salt</td>
</tr>
<tr>
<td>Fines</td>
<td>Less than No. 200 sieve</td>
<td>Powdered sugar</td>
</tr>
</tbody>
</table>

**Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 in.**

#### Course Grained Soil Subclassification

- **Terms**: GRAVEL, SAND, COBBLES, BOULDERS
- **Primary Constituent**: Percent (by weight) of Total Sample

<table>
<thead>
<tr>
<th>Term</th>
<th>Primary Constituent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy, gravelly, abundant cobbles, abundant boulders with gravel, with sand, with cobbles, with boulders scattered gravel, scattered sand, scattered cobbles, scattered boulders a trace gravel, a trace sand, a few cobbles, a few boulders</td>
<td>&gt;30-50</td>
</tr>
<tr>
<td>Silty (MH &amp; ML)<em>, clayey (CL &amp; CH)</em> (with silt, with clay)* (trace silt, trace clay)*</td>
<td>5-15</td>
</tr>
</tbody>
</table>

*Index tests and/or plasticity tests are performed to determine whether the term “silt” or “clay” is used.

---

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987*
GENERAL NOTES

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)

<table>
<thead>
<tr>
<th>Description of Rock Quality</th>
<th><strong>RQD (%)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Poor</td>
<td>&lt; 25</td>
</tr>
<tr>
<td>Poor</td>
<td>25-50</td>
</tr>
<tr>
<td>Fair</td>
<td>50-75</td>
</tr>
<tr>
<td>Good</td>
<td>75-90</td>
</tr>
<tr>
<td>Excellent</td>
<td>90-100</td>
</tr>
</tbody>
</table>

*RQD is defined as the total length of sound core pieces 4 in. or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

SCALE OF RELATIVE ROCK HARDNESS

<table>
<thead>
<tr>
<th>Term</th>
<th>Field Identification</th>
<th>Approx. Unconfined Compressive Strength (tsf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Soft</td>
<td>Can be indented by thumbnail</td>
<td>2.6-10</td>
</tr>
<tr>
<td>Very Soft</td>
<td>Can be peeled by pocket knife</td>
<td>10-50</td>
</tr>
<tr>
<td>Soft</td>
<td>Can be peeled with difficulty by pocket knife</td>
<td>50-260</td>
</tr>
<tr>
<td>Medium Hard</td>
<td>Can be grooved 2 mm deep by firm pressure of knife</td>
<td>260-520</td>
</tr>
<tr>
<td>Moderately Hard</td>
<td>Requires one hammer blow to fracture</td>
<td>520-1040</td>
</tr>
<tr>
<td>Hard</td>
<td>Can be scratched with knife or pick only with difficulty</td>
<td>1040-2610</td>
</tr>
<tr>
<td>Very Hard</td>
<td>Cannot be scratched by knife or sharp pick</td>
<td>&gt;2610</td>
</tr>
</tbody>
</table>

DEGREE OF WEATHERING

<table>
<thead>
<tr>
<th>Slightly Weathered</th>
<th>Rock generally fresh, joints stained and discoloration extends into rock up to 25mm (1 in), open joints may contain clay, core rings under hammer impact.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weathered</td>
<td>Rock mass is decomposed 50% or less, significant portions of rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.</td>
</tr>
<tr>
<td>Highly Weathered</td>
<td>Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.</td>
</tr>
</tbody>
</table>

GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS)

<table>
<thead>
<tr>
<th>Description</th>
<th>Diameter (mm)</th>
<th>Field Identification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Coarse Grained</td>
<td>&gt;4.76</td>
<td>Individual grains can easily be distinguished by eye.</td>
</tr>
<tr>
<td>Coarse Grained</td>
<td>2.0-4.76</td>
<td>Individual grains can be distinguished by eye.</td>
</tr>
<tr>
<td>Medium Grained</td>
<td>0.42-2.0</td>
<td>Individual grains can be distinguished by eye.</td>
</tr>
<tr>
<td>Fine Grained</td>
<td>0.074-0.42</td>
<td>Individual grains cannot be distinguished by unaided eye.</td>
</tr>
<tr>
<td>Very Fine Grained</td>
<td>&lt;0.074</td>
<td>Individual grains cannot be distinguished by unaided eye.</td>
</tr>
</tbody>
</table>

VOIDS

<table>
<thead>
<tr>
<th>Pits</th>
<th>Voids barely seen with naked eye to 6mm (¼-in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vugs</td>
<td>Voids 6 to 50mm (¼ to 2 in) in diameter</td>
</tr>
<tr>
<td>Cavity</td>
<td>50 to 6000mm (2 to 24 in) in diameter</td>
</tr>
<tr>
<td>Caves</td>
<td>&gt;600mm</td>
</tr>
</tbody>
</table>

BEDDING THICKNESS

| Very Thick Bedded         | > 3’ thick                                   |
| Thick Bedded              | 1’ to 3’ thick                               |
| Medium Bedded             | 4’ to 1’ thick                               |
| Thin Bedded               | 1¼’ to 4’ thick                              |
| Very Thin Bedded          | ½’ to 1¼’ thick                              |
| Thickly Laminated         | ⅛’ to ¼’ thick                               |
| Thinly Laminated          | ⅛’ or less (paper thin)                      |

DRILLING NOTES

Drilling and Sampling Symbols

<table>
<thead>
<tr>
<th>NQ – Rock Core (2-in. diameter)</th>
<th>CFA – Continuous Flight (Solid Stem) Auger</th>
</tr>
</thead>
<tbody>
<tr>
<td>HQ – Rock Core (3 in. diameter)</td>
<td>SS – Split Spoon Sampler</td>
</tr>
<tr>
<td>HSA – Hollow Stem Auger</td>
<td>ST – Shelby Tube</td>
</tr>
</tbody>
</table>

Soil Sample Types

- Shelby Tube Samples: Relatively undisturbed soil samples were obtained from the borings using thin wall (Shelby) tube samplers pushed hydraulically into the soil in advance of drilling. This sampling, which is considered to be undisturbed, was performed in accordance with the requirements of ASTM D 1587. This type of sample is considered best for the testing of “in-situ” soil properties such as natural density and strength characteristics. The use of this sampling method is basically restricted to soil containing little to no chert fragments and to softer shale deposits.

- Split Spoon Samples: The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The “N” value corresponds to the number of blows required to drive the last 1 foot of an 18-in. long, 2-in. O.D. split-barrel sampler with a 140 lb. hammer falling a distance of 30 in. The Standard Penetration Test is carried out according to ASTM D-1586.

Water Level Measurements

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, shallow groundwater may indicate a perched condition. Caution is merited when interpreting short-term water level readings from open bore holes. Accurate water levels are best determined from piezometers.

Automatic Hammer

Palmerston and Parrish’s CME’s are equipped with automatic hammers. The conventional method used to obtain disturbed soil samples used a safety hammer operated by company personnel with a cat head and rope. However, use of an automatic hammer allows a greater mechanical efficiency to be achieved in the field while performing a Standard Penetration resistance test based upon automatic hammer efficiencies calibrated using dynamic testing techniques.

*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987
APPENDIX IV

IMPORTANT INFORMATION REGARDING YOUR GEOTECHNICAL REPORT
Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.
While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

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

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

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors
Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:
- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

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

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

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

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

**A Geotechnical Engineering Report Is Subject to Misinterpretation**

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

**Do Not Redraw the Engineer's Logs**

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

**Give Contractors a Complete Report and Guidance**

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

**Read Responsibility Provisions Closely**

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

**Geoenvironmental Concerns Are Not Covered**

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

**Obtain Professional Assistance To Deal with Mold**

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

**Rely, On Your ASFE-Member Geotechnical Engineer for Additional Assistance**

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

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APPENDIX V

ITEMS FOR INCLUSION IN DRILLED PIER SPECIFICATIONS
Items to Include in the Drilled Pier Section of the Specifications

The following items include both design considerations and items that may be included in the project specifications for the drilling contractor's use.

1. The piers may be designed using a contact pressure of 40 ksf on acceptable bedrock.

2. The piers should extend into fresh sound bedrock a minimum of 1 ft. The final bottom should be a flat level plane without steps.

3. A 2-inch diameter probe hole should be drilled in the bottom of each pier to a depth of at least 1.5 times the pier diameter, but no less than 5 ft. A scratch test should reveal that the seams and voids encountered meet the following criteria:
   a. No open seams or voids in the top 3 ft.
   b. No individual seam or void greater than 1/4 in. in the next 3 ft.
   c. Total accumulation of open seams or voids shall not exceed 1/2 inch.

4. A minimum of two (2) exploratory probe holes should be required for pier shafts with a 4 ft. or greater diameter.

5. Soft wet soil is common above the top of rock in the site area. These conditions should be expected. The drilling contractor should provide casing capable of being screwed or drilled into the bedrock to seal out the wet, soft soils.

6. The completion of the foundation system may require the penetration of several feet of bedrock in various piers. The drilling contractor should expect to perform both rock excavation and water removal by pumping.

7. An effort should be made to restrict the number of shaft sizes. The minimum shaft diameter in which a man can drill the probe hole and check the rock quality is about 30 in.

8. The bottom of the pier should be cleaned of all loose soil and rock fragments at the time of concrete placement. No more than 2 or 3 inches of clean water should be present in the bottom when concrete is introduced into the shaft. Casing extraction should proceed slowly during the concrete placement so that at least a 3-ft. head of concrete is always present above the bottom of casing during extraction. In some cases more than 3 ft. of head may be required.

9. Method of concrete placement and vibration should be selected by the structural engineer consistent with the placement requirements on the other portions of the structure. The required strength and mix design characteristics should also be specified by the design team.

10. Clays overlying the bedrock can be jointed. While this jointing pattern does not materially affect the soils supporting strength, it does affect its "stand-up" time in pier excavations. Lateral stability of the soils surrounding the pier shaft may be low.

11. To assure plumbness of pier shafts, plumbness should be checked using a string and plumb bob. Shafts should be out of plumb no more than 2 percent of shaft length.