Geotechnical Pipeline Investigation – Standard of Care

W. Eric Nichols, PE
Shawn Leyva, PE
Introduction

What we hope to accomplish today:

- General geotechnical thought process
- What Geotechnical Engineers consider important
- Drilling considerations

- Geotechnical concerns: where Geotech's earn their money

- Contracts and what to provide the contractor

- Summary
Initial Site Assessment – (not an ISA)

• Where to look?
  • Historical maps (topo, geologic, google earth, etc.) along the proposed pipeline alignment
  • Previous Geotechnical Reports
    • Near by bridges
    • Web Soil Survey

• What are we looking for?
  • Existing boring data
  • Red Flags
    • Peat
    • Fault line
    • Shallow Rock
Existing Boring Data – Supplement

- When will we use existing data to supplement our subsurface exploration?
  - How close is the boring data to the project?
    - Within 25 to 100 ft - typically okay
- Is the data reliable?
  - Depends on who drilled and logged the boring.
    - If we have several borings along the alignment then we can verify
- When was the soil boring completed?
  - Was a Cathead used?
Important Information On a Boring Log

- Material type
- Blow count
- Ground water elevation
- Sample method
- Laboratory test results
- Type of drill method
Important Information on a Boring Log
Field Work Considerations
Drilling – Frequency and Depth

- Open Cut Pipeline Alignment:
  - Typically every 500 ft – Geotech would like every 15 ft.
  - Depth: Minimum 10 ft below pipe placement

- Reasons to increase frequency
  - Sharp turns in the pipeline
  - Research indicates change in soil type
  - Example: Oxbo Marina – Peat/Levee/Fill/etc.
Drilling – Frequency and Depth

- Micro Tunneling and Jack and Bore:
  - At each jack and receiving pit location and a boring every 50 to 100 ft along the alignment
  - Depth: 10 ft below bottom of support location

- What we are looking for:
  - Soil type, bearing material, ground water table
Drilling – Frequency and Depth Cont.

- HDD – Horizontal Directional Drilling
  - Typically every 500 to 700 feet along the alignment (or where a change in material is anticipated)
  - Depth: 15 ft below bottom of pipe trench
  - Borings are usually offset from alignment
  - Backfill with grout – prevents fluid from escaping
Drilling – Seismic Lines

- Measure of the primary wave velocity through the upper soil/rock layers
- Provided to the contractor
- Rock rip ability using heavy equipment
Laboratory Tests

- Particle Size Analysis – Finer than No. 200 Sieve (ASTM D1140)
- Particle Size Analysis – Sieve and hydrometer (ASTM D422)
- In-Place Density and Moisture Content (ASTM D2216 and D2937)
- Atterberg Limits, LL-PL-PI (ASTM 4318)
- Direct Shear (ASTM D3080)
- Corrosivity Package
Geotechnical Considerations/Analysis
General Geotechnical Considerations:

- Soil Movement
  - Settlement - General
  - Soil Type: Clay, Peat
- Loading
- Slope Stability
- Seismic
  - Fault Rupture
  - Shaking
  - Settlement
  - Lateral Spreading
General Geotechnical Considerations Cont:

- Corrosivity
  - Depends on pipe material
  - Soil type
  - Water type (Costal)

- Groundwater:
  - How deep?
  - Seasonal fluctuation?
  - Floating a pipe
General Geotechnical Considerations Cont.:

- Excavation
  - Soil
    - Trench wall - Cal OSHA
    - Vertical vs. open cut
  - Rock
    - Heavy Equipment/Blasting
General Geotechnical Consideration
Cont:

- Trench Backfill:
  - Depends on pipe material
  - Pressure or gravity line
  - Required strength parameters
  - Soil Type (also slurry backfill)
    - Soil Modulus
Geotechnical Analysis:

- Hydraulic Fracturing Parameters
  - Unit Weight, Friction Angle, and Cohesion
    - Laboratory Tests
  - Soil Modulus/Poisson’s Ratio
    - Material types
    - Strength parameters
    - Correlations
    - Blow count

<table>
<thead>
<tr>
<th></th>
<th>Boring B1</th>
<th>Boring B3</th>
<th>Boring B4</th>
<th>Boring B5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Unit Weight (pcf)</td>
<td>115</td>
<td>125</td>
<td>125</td>
<td>115</td>
</tr>
<tr>
<td>Internal Friction Angle (deg)</td>
<td>30</td>
<td>32</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>Cohesion (ksf)</td>
<td>0.1</td>
<td>0.8</td>
<td>2.5</td>
<td>0.1</td>
</tr>
<tr>
<td>Soil Modulus (Es) (ksf)</td>
<td>150</td>
<td>300</td>
<td>270</td>
<td>150</td>
</tr>
<tr>
<td>Poisson's Ratio</td>
<td>0.35</td>
<td>0.4</td>
<td>0.4</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Geotechnical Analysis:

- Passive pressure, Active pressure
- Soil thrust block
- Soil loading
- Land slide consideration (not typical)
- Shoring design (contractor means)
  - Hydrostatic pressures
- Settlement
- Seismic liquefaction analysis
  - Use of flexible connections
What to Provide a Contractor
What Type of Geotechnical Information Should be Provided to a Contractor?

- Contractor typically uses the Geotechnical Report for information.
  - Geotechnical engineers collect and provide data for design, not necessarily for construction
  - Design Data vs. Construction Data
    - Baseline Reports – collects data for construction, what is important to a contractor might not always be important to a designer
    - Use data to address change conditions

- Typically a Geotechnical Report provides:
  - Boring logs
    - SPT data
  - Soil type
    - Soil type classification: A, B, or C
  - Laboratory test results
  - Ground water information
  - Construction considerations
    - Primary wave velocity
Unforeseen Conditions

- Rock elevations
- Rock encountered
- Soft soil/Hard Soil
- Higher than expected groundwater table
- Who you going to call?
  - The Geotechnical engineer on record
    - The Geotech should help alleviate design concerns
    - The Geotech should be willing to change/modify the project design based on unforeseen conditions
Summary

• Develop an appropriate scope for the pipeline alignment and installation method

• Communication among all team members

• During construction Geotechnical engineers should be retained just in case there is a design or site condition change

• Report provides Geotechnical
  • data for design
  • data for contractors use

• Enjoy a successful completion of a job!
Questions

Contact Information
Shawn Leyva
Senior Engineer
Crawford & Associates, Inc
shawn.leyva@crawford-inc.com
916 455 4225 x 108