Preparing for the Geotechnical Field Investigation

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Office of Drilling Services

Where do I start?
Review Memo To Designers 1-35

1-35 FOUNDATION RECOMMENDATION AND REPORTS

3. Overview

The purpose of this study is to provide the Designers with information on the geotechnical conditions at the site. The investigation will include soil borings, cone penetration tests, and other geotechnical investigations. The results of these investigations will be used to determine the appropriate foundation system for the project.

The foundation system recommended for the project is a driven steel pile foundation. The piles will be driven to a depth that ensures stability and prevents settlement. The design of the piles will be based on the results of the soil borings and cone penetration tests.

The foundation recommendations are subject to change based on the final design of the project. The Designers are encouraged to review the foundation report and provide any necessary modifications.
Memo To Designers 1-35
Defines the roles of Structure Design and Geotechnical Services design staff during the project development process

<table>
<thead>
<tr>
<th>Memo To Designers 1-35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successful implementation of this process is completely dependent on the collaboration of the two design groups.</td>
</tr>
</tbody>
</table>

Establish a good working relationship.

Communicate, Communicate, Communicate ......
Review Memo To Designers 4 1 Spread Footings
and
Memo To Designers 3 1 Deep Foundations

Dry Creek Bridge (REP)
SD Request for Foundation Recommendations and Report
Dry Creek Bridge (REP)

Shallow Foundation Design and Load Data Tables

(included with the FR Request)

**Table 1. Shallow Foundation General Data**

<table>
<thead>
<tr>
<th>Support No.</th>
<th>Design Method</th>
<th>Finished Grade Elevation (ft)</th>
<th>BOF Elevation (ft)</th>
<th>Footing Size (ft)</th>
<th>Permissible Settlement under Service Load (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abut 1</td>
<td>WSD</td>
<td>480.5</td>
<td>476.5</td>
<td>15</td>
<td>52.67</td>
</tr>
<tr>
<td>Abut 4</td>
<td>WSD</td>
<td>475.5</td>
<td>471.5</td>
<td>15</td>
<td>47.67</td>
</tr>
</tbody>
</table>

**Table 2. Shallow Foundation Load Data**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Abut 1</td>
<td>3245</td>
<td>13.7</td>
<td>N/A</td>
<td>2503</td>
<td>14.3</td>
</tr>
<tr>
<td>Abut 4</td>
<td>3225</td>
<td>13.8</td>
<td>N/A</td>
<td>2629</td>
<td>14.5</td>
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</tbody>
</table>
### Dry Creek Bridge (REP)

Deep Foundation Design Data Table (included with the FR Request)

#### Table 3. Deep Foundation General Information

<table>
<thead>
<tr>
<th>Support No.</th>
<th>Design Method</th>
<th>Pile Type</th>
<th>Finished Grade Elevation (ft)</th>
<th>Cut-off Elevation (ft)</th>
<th>Pile Cap Size (ft)</th>
<th>Permissible Settlement under Service Load (in)</th>
<th>Number of Piles per Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abut 1</td>
<td>WSD</td>
<td>24” CIDH</td>
<td>480.5</td>
<td>476.75</td>
<td>9.0</td>
<td>52.67</td>
<td>1”</td>
</tr>
<tr>
<td>Per 2 Alt. 1</td>
<td>LRFD</td>
<td>24” CIDH</td>
<td>483.5</td>
<td>466.25</td>
<td>28</td>
<td>39</td>
<td>1”</td>
</tr>
<tr>
<td>Per 2 Alt. 2</td>
<td>LRFD</td>
<td>96” CIDH</td>
<td>483.5</td>
<td>472.0</td>
<td>N/A</td>
<td>N/A</td>
<td>1”</td>
</tr>
<tr>
<td>Per 3 Alt. 1</td>
<td>LRFD</td>
<td>24” CIDH</td>
<td>482.0</td>
<td>466.25</td>
<td>28</td>
<td>39</td>
<td>1”</td>
</tr>
<tr>
<td>Per 3 Alt. 2</td>
<td>LRFD</td>
<td>96” CIDH</td>
<td>482.0</td>
<td>472.0</td>
<td>N/A</td>
<td>N/A</td>
<td>1”</td>
</tr>
<tr>
<td>Abut 4</td>
<td>WSD</td>
<td>24” CIDH</td>
<td>475.5</td>
<td>471.75</td>
<td>9.0</td>
<td>47.67</td>
<td>1”</td>
</tr>
</tbody>
</table>

### Dry Creek Bridge (REP)

Deep Foundation Load Data Tables (included with the FR Request)

#### Table 4. Deep Foundation Load Data

<table>
<thead>
<tr>
<th>Support No.</th>
<th>Service-1 Lane State (kips)</th>
<th>Permanent Loads</th>
<th>Extremes Event Lane State (kips)</th>
<th>Extremes Event Lane State (Controlling Group, kips)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Load</td>
<td>Permanent Load</td>
<td>Compression</td>
<td>Tension</td>
</tr>
<tr>
<td></td>
<td>Per Support</td>
<td>Max. Per Pile</td>
<td>Per Support</td>
<td>Max. Per Pile</td>
</tr>
<tr>
<td>Abut 1</td>
<td>2318</td>
<td>140</td>
<td>1776</td>
<td>N/A</td>
</tr>
<tr>
<td>Per 2 Alt. 1</td>
<td>8533</td>
<td>N/A</td>
<td>6587</td>
<td>10624</td>
</tr>
<tr>
<td>Per 2 Alt. 2</td>
<td>6075</td>
<td>N/A</td>
<td>4129</td>
<td>7835</td>
</tr>
<tr>
<td>Per 3 Alt. 1</td>
<td>9824</td>
<td>N/A</td>
<td>7875</td>
<td>12101</td>
</tr>
<tr>
<td>Per 3 Alt. 2</td>
<td>6699</td>
<td>N/A</td>
<td>4750</td>
<td>8649</td>
</tr>
<tr>
<td>Abut 4</td>
<td>2635</td>
<td>140</td>
<td>2039</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Dry Creek Bridge (REP)

Scour Data Table
(included with the FR Request)

<table>
<thead>
<tr>
<th>Support No.</th>
<th>Long Term Scour Elevation (Degradation and Contraction) (ft)</th>
<th>Short Term Scour Depth (Local) (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abut 1</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Pier 2</td>
<td>477</td>
<td>5</td>
</tr>
<tr>
<td>Pier 3</td>
<td>477</td>
<td>5</td>
</tr>
<tr>
<td>Abut 4</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

What do I need and how do I get it?

I want a drill rig now! I want, I want, I want…
Hold on partner, not so fast!

Do your homework first. Familiarize yourself with the available data.
Contact Structure Design. Introduce yourself.
Determine who your District Contacts are. You will need their assistance.
Verify the PY's (hours) resourced for this project.

Schedule a field trip to the site

And No Drive by’s, Walk the Site!
On your way there don’t forget to …
visit the nearest hospital to the site

and when you reach the site …
check for cell phone reception.

Dry Creek Bridge (REP)
Overview Image   Looking West

Proposed replacement bridge will be offset 50 feet east of the existing structure centerline.
Dry Creek Bridge (REP)
Abutment 1

Cut Slope at Abutment 1 location with sandstone outcrop.

South access to Abutment 1 location.

Dry Creek Bridge (REP)
Abutment 4

Looking SW across Abutment 4 location.

North access to Abutment 4 location.
Dry Creek Bridge (REP)

Don’t forget to look for hazards.

Abutment 1 location.

Overhead electrical lines observed.

Abutment 4 location.

Buried electrical, natural gas pipeline and fiber optic line markers just off the roadway.

Dry Creek Bridge (REP)

Pier 2

Looking east at Pier 2 location.

Sensitive wetland habitat with year round creek adjacent to Pier 2.
Dry Creek Bridge (REP)

Pier 3

Looking east at proposed Pier 3 location.

Pier 3 location is adjacent to sensitive wetlands habitat

Dry Creek Bridge (REP)

Watch Out Partner! Varmints!

Cute little fella s, aren t they……
Back from the initial site visit……

time to plan the plan

• Submit sandstone outcrop hand samples to the lab for point load index testing
• Contact Structure Design and confirm data
• Develop a subsurface exploration plan (for design and construction).

Planning the Subsurface Investigation (Drilling)
Dry Creek Bridge (REP) Site Summary

• Sandstone rock outcrop adjacent to Abutment 1
• Unknown depth to bedrock at Piers 2, 3, and Abutment 4. Loose sand and silt covers these 3 locations, unknown soil types below OG (original ground).
• Creek flows year round but is controlled by a small dam upstream
• No As Built Log of Test Borings for the existing bridge
• Abutment 1 of existing bridge is on spread footing, remaining piers and abutment supported on 10 to 40 foot driven timber piles
Planning the Subsurface Investigation (Drilling)
Dry Creek Bridge (REP)
Guidelines for Determining Number of Test Borings and Where

- FHWA recommends a minimum of one test boring per bridge pier or abutment foundation less than 30 meters (100 feet) wide

- Single (non redundant) CIDH (Drilled Shaft) pile foundations at bridge supports also warrant a minimum of one test boring

Planning the Subsurface Investigation (Drilling)

What are we investigating for?

Abutments  Spread Footing or 24 in. CIDH piles (Class 200)

Piers 2 and 3  24 in. CIDH piles (Class 200) or Single 96 in. CIDH (Drilled Shaft) piles

Retaining Wall @ Abut 1  Spread Footing or 24 in. CIDH piles (Class 90)

Embankment Fill  ≤ 6 ft. @ Abut 1, 10 ft @ Abut 4
Drilled Shaft (Pile)

Drilled Shaft (Pile) type of CIDH (Cast in Drilled Hole) Pile built (drilled) directly into rock

Planning the Subsurface Investigation (Drilling)

Dry Creek Bridge (REP) Test Boring Layout

A minimum of (4) Test Borings, one at each support location would:

- adequately characterize the subsurface geology
- provide for a sufficient number of samples to determine geotechnical soil and rock properties
Planning the Subsurface Investigation (Drilling)

Dry Creek Bridge (REP)  Type of Test Borings

the use of Mud Rotary drilling is indicated for all (4) test borings as the site thus far has been characterized as sand and silt soil overlying bedrock.

Planning the Subsurface Investigation (Drilling)

Dry Creek Bridge (REP)  Sampling Plan

Perform Standard Penetration Tests (SPT s) at 5 foot intervals until encountering top of rock.

• bore hole in situ test that allows you to collect soil samples (disturbed) for both field logging and laboratory classification

• the recorded blow count values per foot (N) are used to describe the apparent density of granular, non cohesive soils (sand, silt and gravel)

• corrected blow count values (N̂) can be used to estimate soil strength and soil unit weight for non cohesive soils

• SPT s performed in cohesive (clay) soils are less reliable for strength estimates

• these data can be used in the computation of soil bearing capacity and settlement for spread footing and pile design, embankment stability and liquefaction analysis
Planning the Subsurface Investigation (Drilling)
Dry Creek Bridge (REP)  Sampling Plan

Take Undisturbed 2.0 or 2.5 in. Brass Tube Samples at select intervals in cohesive (clay) soils for laboratory testing.

- Laboratory tests to consider for cohesive soils -

  • PI (Plasticity Index) classification
  • UU (Unconsolidated Undrained) undrained compressive strength
  • C (Consolidation) estimates the magnitude and rate of settlement

Planning the Subsurface Investigation (Drilling)
Dry Creek Bridge (REP)  Sampling Plan

Additional soils testing

- Required Laboratory tests -

  CR (Corrosion)  soil pH, chloride and sulfate concentrations, plus resistivity

- Field tests for cohesive soils -

  • Pocket Penetrometer  unconfined compressive strength
  • Pocket Torvane  undrained shear strength
Planning the Subsurface Investigation (Drilling)
Dry Creek Bridge (REP)  Sampling Plan

Continuous Rock Core (94mm or Hxb) will be required once top of rock is reached

- Laboratory test for select intact rock core -
  • UC (Unconfined Compression) compressive strength

Determine %Recovery and Rock Quality Designation (RQD) from recovered rock core at each boring location.

\[
RQD = \frac{\text{Sum of length of pieces } \geq 3.3 \text{ ft (1m)}}{\text{total length of core run}} \times 100 = \frac{2.4}{4.7} \times 100 = 51 \%
\]

Measured in the field immediately after recovery from test boring
How deep should I drill?

Not too deep and not too shallow

Geotechnical Drilling is a very expensive business ($1,000 s/day) and resources are limited

Remember, it’s labeled exploratory for a reason

Planning the Subsurface Investigation (Drilling)

Dry Creek Bridge (REP)

Guidelines for Determining Test Boring Depths

- Spread Footings where \( L \) is less than twice \( W \), depth would be twice \( W \) below bearing level,
  where \( L \) is greater than 5 times \( W \), depth would be 4 times \( W \) below bearing level.

- Drilled Shafts three times the pile diameter below the anticipated shaft tip elevation or twice the maximum shaft group dimension, whichever is greater

- Retaining Walls on spread footing 1.5 times the maximum wall height

- Embankment twice the embankment height

Note: from AASHTO Standard Specifications for Design of Highway Bridges
## Planning the Subsurface Investigation (Drilling)

### Dry Creek Bridge (REP)

### Estimated Test Boring Depths

<table>
<thead>
<tr>
<th>Support</th>
<th>Foundation Type</th>
<th>Calculated Test Boring Depth</th>
<th>Scour</th>
<th>Est. Boring Depths</th>
<th>Actual Depths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abut 1</td>
<td>Spread Footing</td>
<td>40 feet</td>
<td>NA</td>
<td>50 feet</td>
<td>40 feet</td>
</tr>
<tr>
<td>Ret Wall 19’ H</td>
<td>Spread Footing</td>
<td>39 feet</td>
<td>NA</td>
<td>30 feet</td>
<td></td>
</tr>
<tr>
<td>Pier 2</td>
<td>24” CIDH Pile Group</td>
<td>76 feet</td>
<td>21</td>
<td>80 feet</td>
<td>85 feet</td>
</tr>
<tr>
<td>Pier 2</td>
<td>Single 95” CIDH Pile</td>
<td>overlying soil + 54 feet Rock Core</td>
<td>21</td>
<td>75 feet</td>
<td></td>
</tr>
<tr>
<td>Pier 3</td>
<td>24” CIDH Pile Group</td>
<td>76 feet</td>
<td>21</td>
<td>80 feet</td>
<td>52 feet</td>
</tr>
<tr>
<td>Pier 3</td>
<td>Single 95” CIDH Pile</td>
<td>overlying soil + 57 feet Rock Core</td>
<td>21</td>
<td>80 feet</td>
<td></td>
</tr>
<tr>
<td>Abut 4</td>
<td>Spread Footing</td>
<td>42 feet</td>
<td>NA</td>
<td>50 feet</td>
<td></td>
</tr>
<tr>
<td>Abut 4</td>
<td>24” CIDH Pile Group</td>
<td>96 feet</td>
<td>NA</td>
<td>100 feet</td>
<td>100 feet</td>
</tr>
</tbody>
</table>