

# STRUCTURE GEOTECHNICAL REPORT

BRIDGE REPLACEMENT  
BRIDGE STREET OVER I-72

SECTION (74-68)BR  
PIATT COUNTY, IL  
CONTRACT NO. 70D61  
PTB 197/031  
EXISTING STRUCTURE NO. 074-0065  
PROPOSED STRUCTURE NO. 074-0089

Prepared For:  
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January 2023  
Revised March 2023





# Abbreviated Structure Geotechnical Report

Original Report Date: 1/26/2023 Proposed SN: 074-0089 Route: Bridge St.; FAU 7531/FAP 756  
 Revised Date: 3/9/2023 Existing SN: 074-0065 Section: (74-68)BR  
 Geotechnical Engineer: BJS County: Piatt County  
 Structural Engineer: \_\_\_\_\_ Contract: 70D61

**Indicate the proposed structure type, substructure types, and foundation locations (attach plan and elevation drawing):** The proposed structure is a two-span 48" web plate girder bridge on integral abutments and pile-supported spread footing at the pier. Attached (TSL-UPDATED-APPROVED-2-23-2023). Reported estimated factored loads attached.

**Discuss the existing boring data, existing plans foundation information, new subsurface exploration and need for any additional exploration to be provided with SGR Technical Memo (attach all data and subsurface profile plot):** Borings, core, and laboratory analysis were developed, supervised, and performed by IDOT and subsequently provided to us for review. Preliminary structure plans were performed by Greene & Bradford and provided to us for our review. It appears the geotechnical data provided to us is sufficient to develop geotechnical recommendations - boring logs, core photos attached.

**Provide the location and maximum height of any new soil fill or magnitude of footing bearing pressure. Estimate the amount and time of the expected settlement. Indicate if further testing, analysis, and/or ground improvement/treatment is necessary:** We understand increase in grade at the site will be less than 1 foot, therefore settlement induced, if any, by the minimal grade change will not influence the design. No settlement issues are anticipated. No consideration of downdrag loss or load is required. No further testing or analysis is necessary. The abutments and pier will be supported by piling.

**Identify any new cuts or fill slope angles and heights. Estimate the factor of safety against slope failure. Indicate if further testing, analysis or ground improvement/treatment is necessary:** Based on the provided plans, existing slopes at the site will remain undisturbed and new concrete slopewalls will be cast in place against the existing undisturbed embankment. No existing slope stability problems are observed at the site and no significant loading adjustments are anticipated at the head or foot of the slope, therefore slope stability analysis was not performed. Slope stability issues are not anticipated.

**Indicate at each substructure, the 100-year and 200-year total scour depths in the Hydraulics report, the non-granular scour depth reduction, the proposed ground surface, and the recommended foundation design scour elevations:** There is no waterway crossing at this site, therefore scour is not applicable for this project.

**Determining the seismic soil site class, the seismic performance zone, the 0.2 and 1.0 second design spectral accelerations and indicate if that the soils are liquefiable:** Site class is determined to be Soil Site Class D - see attached. In accordance with AASHTO LRFD, the numeric seismic design value at 0.2s value SDS = 0.24, and the numeric seismic design value at 1.0s value SD1 = 0.144 - see attached. SD1 is less than 0.15, therefore this site falls within the definition of seismic performance zone 1 and no additional seismic analysis is required.

**Confirm feasibility of the proposed foundation or wall type and provide design parameters. Attach a pile design table indicating feasible pile types, various nominal required bearings, factored resistances available and corresponding estimated lengths at locations where piles will be used. Provide factored bearing resistance and unit sliding resistance at various elevations and confirm no ground improvement/treatment is necessary where spread footings are proposed. Estimated top of rock elevations as well as preliminary factored unit side and tip resistance values shall be indicated when drilled shafts are proposed:** Deep foundations consisting of 14" diameter pipe piles, as shown in the plans for the abutments are sufficient. 16" diameter pipe piles have been reported for selection under the pier. Soils with Qu values greater than 3.0 tsf were encountered below the bottom of the Abutment cap elevation at the North Abutment. To allow the use of integral abutments, the piles at this location will need to be driven through precored holes extending 10 ft below the bottom of Abutment cap elevation. For Metal Shell piles, these precore holes should have a diameter of 24 inches and the space outside the pile needs to be filled with bentonite according to the manufacturer's recommendations to achieve a Qu of 1.5 tsf. Based on the Integral Abutment Feasibility calculations, precoring is only required under the north abutment. See the attached Integral Abutment Feasibility calculations. See the pile design table, graph, and calculations for available resistance and estimated depths - pile design attached. The maximum nominal required bearing for the selected pile type is presented on the attached pile bearing graph for each location, showing the depth at which it is estimated to be achieved.

**Calculate the estimated water surface elevation and determine the need for cofferdams (type 1 or 2), and seal coat:** There is no waterway crossing at this site, therefore cofferdams and seal coats are not applicable for this project.

**Assess the need for sheeting or soil retention or temporary construction slope and provide recommendation for other construction concerns:** Staged construction is proposed at this site to allow traffic flow. Temporary sheet piling is recommended during stage removal and construction with boring data suggesting a cantilever sheet pile wall is applicable. Assuming 7.5 feet of retained soil height the required embedment for both abutments is 5.6 feet below the excavation base. The minimum required section modulus is 3.1 inches cubed per foot for the southeast abutment (SB#1), while for the northwest abutment (SB#2) the minimum required section modulus is 2.7 inches cubed per foot. See attached calculations for reference or adjustment based on actual retained height.

Test piles are recommended at each substructure unit. Due to the presence of hard tills and dense sands with high blow counts, conical pile tips for metal shell piles are recommended.

Soil conditions, based on the available soil boring data provided to us, have been reviewed for the proposed approach pavement footings. Based on experience, the soil's estimated bearing capacity for either approach is estimated to be greater than required for the anticipated bearing requirements. Settlement is not anticipated to be a concern considering the approach footings are anticipated to be constructed on undisturbed soil.

Ground improvement is not anticipated to be required.

According to Illinois State Geological Survey, there has been no coal mining activity in Piatt County.

In accordance with section 3.10.1.10 Bridge Manual 2023, when lateral loads exceed 3 kips a lateral load analysis of the piles should be performed. The reported lateral loading per pile is 7 kips per pile, therefore an analysis will be required. The SGR provides assistance in identifying the foundation soil's capacity to resist lateral pile loading, therefore, soil parameters and L-Pile parameters have been recommended, based on the subsurface soil conditions, for use in the final design lateral analysis. L-Pile parameters are developed from published tables in the L-Pile user's manual, and they are based on the soils encountered from the locations of the structure borings. The recommended estimated soil parameter values are attached and may be used for lateral analysis at the specific boring location area.

Benchmark: Survey Marker on top of the concrete median at the south side of the bridge along the centerline of Bridge Street, STA. 48+00 - Elevation = 695.45.

Existing Structure: S.N. 074-0065 was originally built in 1975 by the state of Illinois as FAI Route 72, Section 74-68BR-1 at STA. 1359+51.04 at Monticello in Piatt County, IL. The existing superstructure is 2-span with nine 48" steel plate girders supporting an 8" R.C. deck. The superstructure is supported by two-sandfilled, vaulted abutments and one-multi column trapezoidal pier. The existing structure measures 250'-4" from back to back of approach bents and 68'-0" out to out of deck. The horizontal clearance is 64'-6" from face to face of parapet including 24'-3" of clear roadway for each direction and a 16'-0" vaulted median. The structure underwent repairs in April 2009 to install protective shield and in May 2019 for a full-depth patch and several chip sealing of the HMA wearing surface. During new construction, traffic to be maintained utilizing Stage Construction.

**HIGHWAY CLASSIFICATION**  
 F.A.I. Rte. 72 - Bridge Street  
 Functional Class: Other Principal Arterial  
 ADT: 2,300 (2021); 2550 (2041)  
 ADTT: 184 (2021); 204 (2041)  
 DHV: 260 (2041)  
 Design Speed: 50 m.p.h.  
 Posted Speed: 45 m.p.h.  
 Two-Way Traffic  
 Directional Distribution: 50:50

**HIGHWAY CLASSIFICATION**  
 F.A.I. Rte. 72 - I-72  
 Functional Class: Interstate  
 ADT: 11,700 (2021); 13,800 (2041)  
 ADTT: 2457 (2021); 2898 (2041)  
 DHV: 1,075 (2041)  
 Design Speed: 75 m.p.h.  
 Posted Speed: 70 m.p.h.  
 Two-Way Traffic  
 Directional Distribution: 50:50

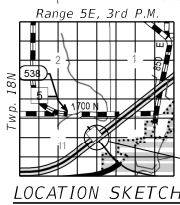
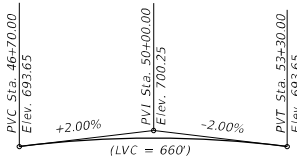
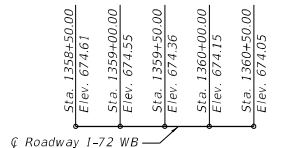
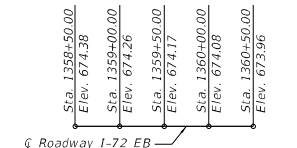
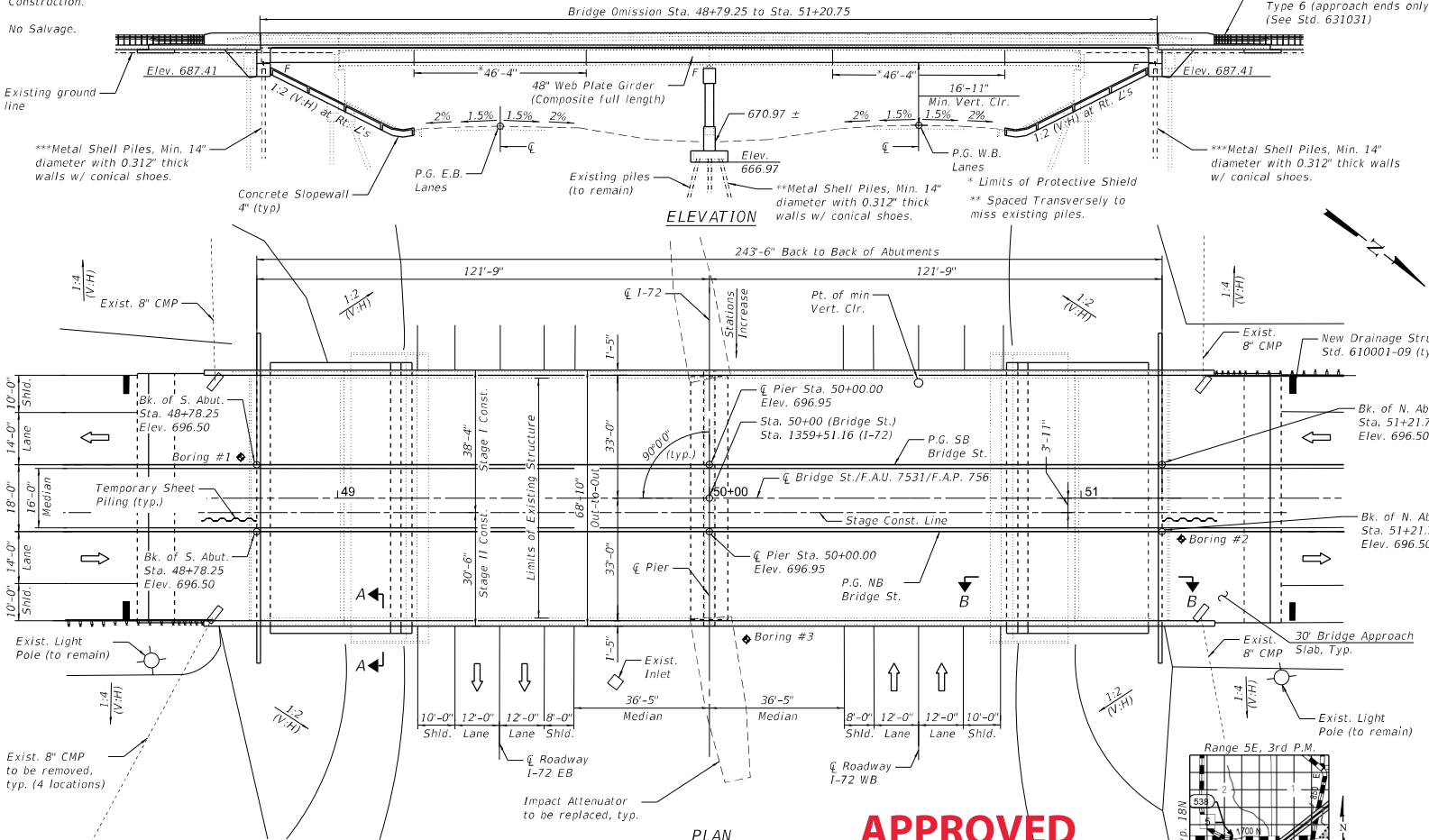
**LOADING HL-93**  
 Allow 50#/sq. ft. For future wearing surface.

**SEISMIC DATA**  
 Seismic Performance Zone (SPZ) = I  
 Design Spectral Acceleration at 1.0 sec. (SD1) = 0.142g  
 Design Spectral Acceleration at 0.2 sec. (SD5) = 0.250g  
 Soil Site Class = D

**DESIGN SPECIFICATIONS**  
 2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

**DESIGN STRESSES**  
 FIELD UNITS

f'c = 3,500 psi (Substructure)  
 f'c = 4,000 psi (Superstructure)  
 fy = 60,000 psi (Reinforcement)  
 fy = 50,000 psi (M270 Grade 50)



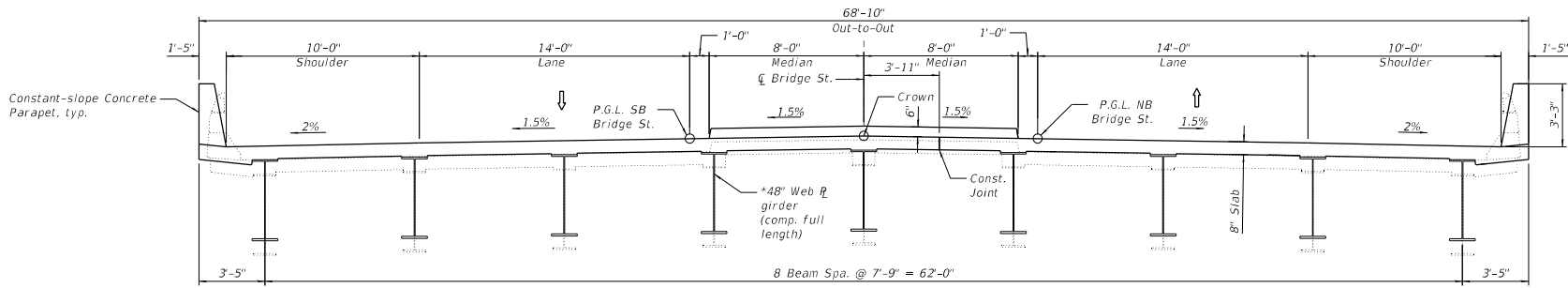
**APPROVED**  
**FEBRUARY 23, 2023**  
 AS A BASIS FOR  
 PREPARATION OF DETAILED PLANS

**GENERAL PLAN & ELEVATION**  
**BRIDGE STREET OVER I-72**  
 F.A.I.-72 - SEC 74-68BR  
 PIATT COUNTY  
 STA. 50+00.00  
 STRUCTURE NO. 074-0089

\*\*\* The Abutment piles shall be driven through minimum 24-inch diameter pre-cored holes, extending 10 ft below the bottom of the abutment cap elevation according to Art. 512.09(c) of the Standard Specifications expect that the void space outside the piles needs to be filled with bentonite according to the manufacturers recommendations to achieve a Qu of 1.5 tsf. Cost included in driving piles.

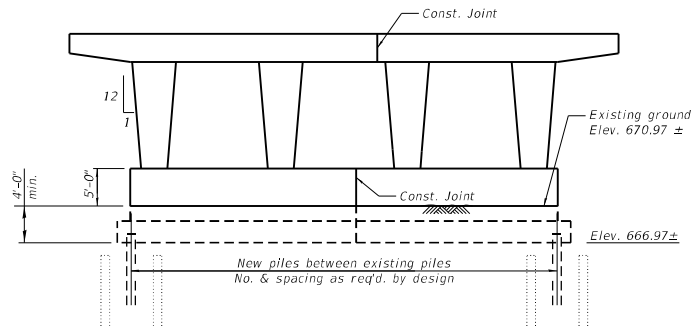
For Section A-A and B-B, see sheet 2 of 4

|  |  |  |   |  |
|--|--|--|---|--|
| <br>GREENE & BRADFORD, INC.<br>CIVIL ENGINEERS<br>1000 S. WASHINGTON ST.<br>PIATT COUNTY, ILLINOIS 62451<br>PHONE: 618-238-1111 FAX: 618-238-1112<br>WWW.GRENEBRADFORD.COM | USER NAME = kashfs<br>DESIGNED - KAS<br>CHECKED - MAC<br>DRAWN - PG<br>PLOT DATE = 2/23/2023 | REVISED -<br>REVISED -<br>REVISED -<br>REVISED - | STATE OF ILLINOIS<br>DEPARTMENT OF TRANSPORTATION | F.A.I. RTE. 72<br>SECTION (74-68BR)<br>COUNTY PIATT<br>SHEET 1 OF 4 SHEETS<br>CONTRACT NO. 70D61 |
|  | TOTAL SHEETS 4<br>SHEET NO. 1<br>ILLINOIS F&E JOB PROJECT                                    |  |   |  |

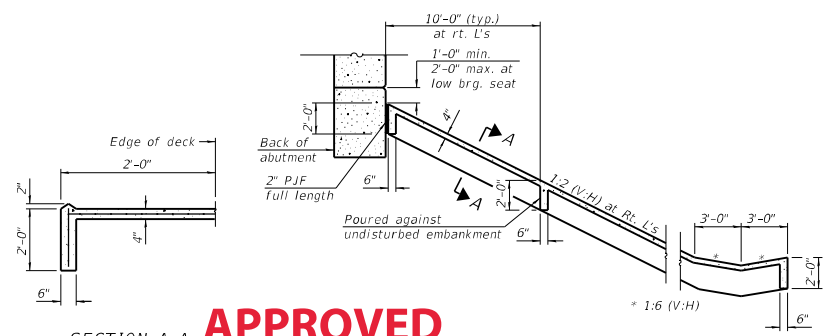


\* All structural steel girders, interior cross frames, bearing stiffeners and connection plates shall be metallized. The metallized areas shall be painted with system 1. See Special Provisions. End cross frames and the steel for the Elastomeric Bearings, Type I and Type II shall be hot dipped galvanized, in accordance with the requirements noted in the section "Hot Dip Galvanizing Option" of the Special Provisions.

**CROSS SECTION**  
(Looking North)



**PIER SKETCH**

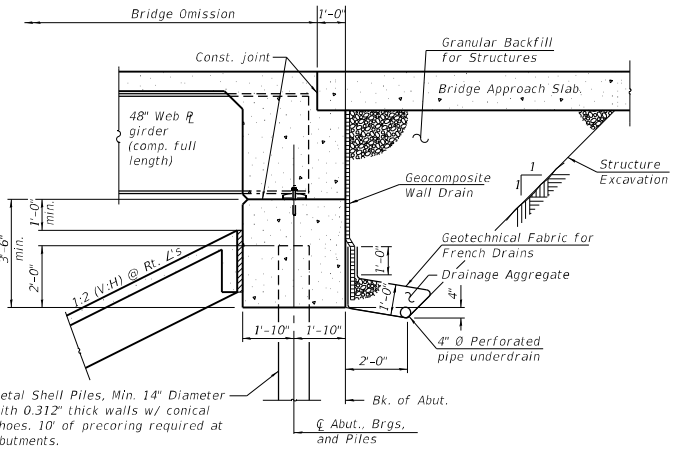


**APPROVED**  
FEBRUARY 23, 2023

AS A BASIS FOR  
PREPARATION OF DETAILED PLANS

**DETAILS**  
**BRIDGE STREET OVER I-72**  
**F.A.I. - 72 - SEC 74-68BR**  
**PIATT COUNTY**  
**STA. 50+00.00**  
**STRUCTURE NO. 074-0089**

**SECTION THRU INTEGRAL ABUTMENT**  
(Horiz. dim. @ Rt. L's)



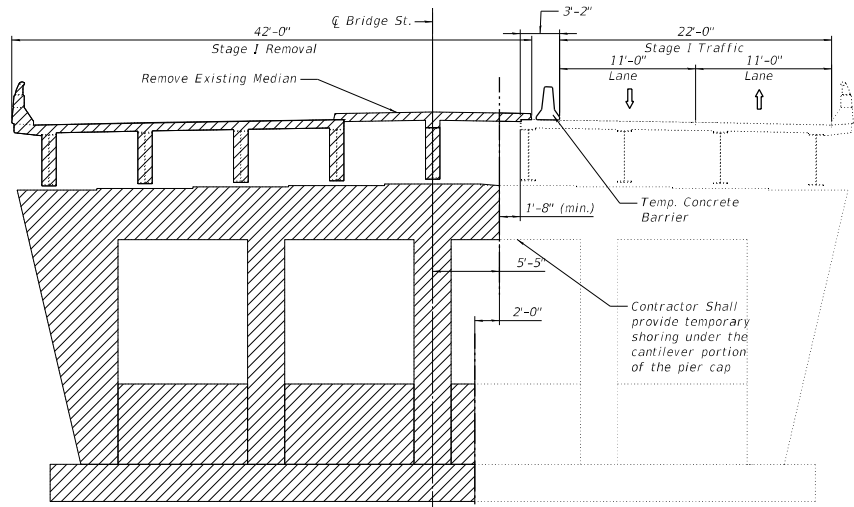
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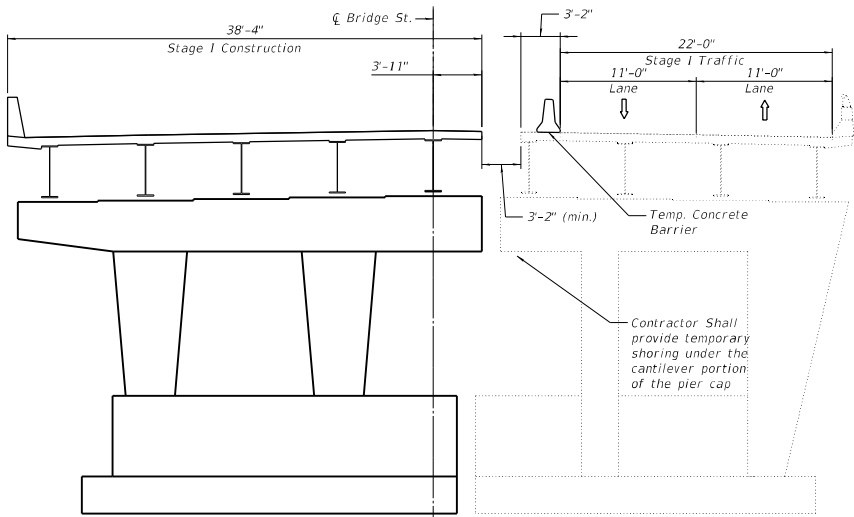
**STATE OF ILLINOIS**  
**DEPARTMENT OF TRANSPORTATION**

SHEET 2 OF 4 SHEETS

| F.A.I. RTE.        | SECTION   | COUNTY | TOTAL SHEETS | SHEET NO. |
|--------------------|-----------|--------|--------------|-----------|
| 72                 | (74-68)BR | PIATT  |              |           |
| CONTRACT NO. 70D61 |           |        |              |           |



STAGE I REMOVAL



STAGE I CONSTRUCTION

- Note:
- All sections are looking North
  - Hatching represents limits of removal.

**APPROVED**

**FEBRUARY 23, 2023**

AS A BASIS FOR  
PREPARATION OF DETAILED PLANS

STAGE I CONSTRUCTION DETAILS  
BRIDGE STREET OVER I-72  
F.A.I. - 72 - SEC 74-68BR  
PIATT COUNTY  
STA. 50+00.00  
STRUCTURE NO. 074-0089

STATE OF ILLINOIS  
DEPARTMENT OF TRANSPORTATION

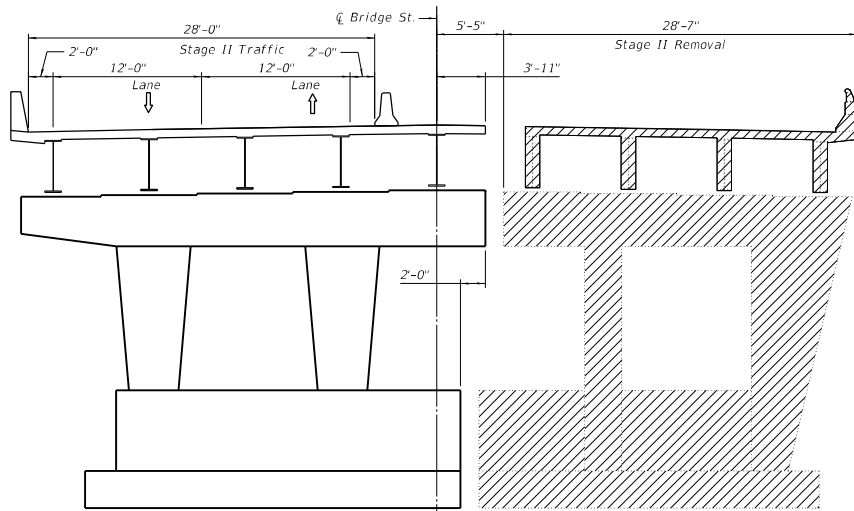
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|-------------|-----------|--------|--------------------|-----------|
| 72          | (74-68)BR | PIATT  |                    |           |
|             |           |        | CONTRACT NO. 70D61 |           |

SHEET 3 OF 4 SHEETS

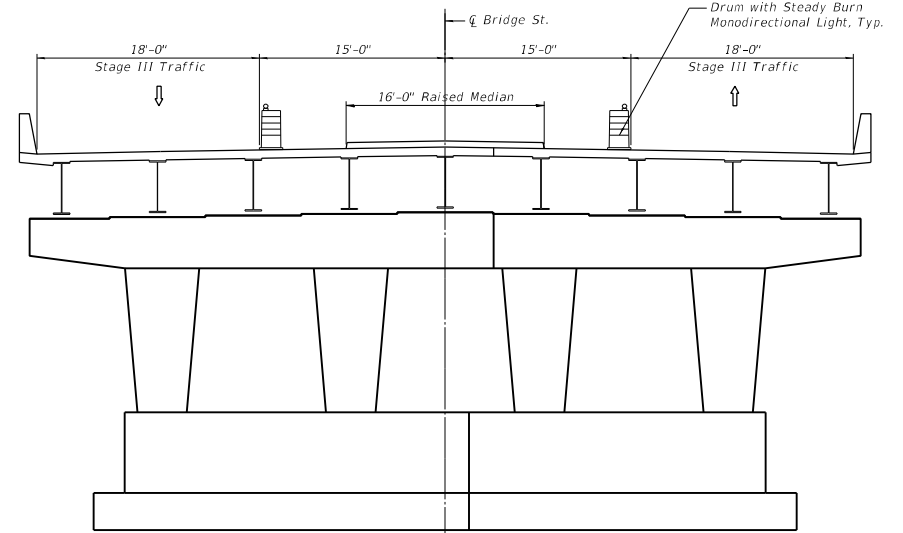
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GREENE & BRADFORD, INC.  
OF SPRINGFIELD  
REGISTERED PROFESSIONAL ENGINEERS  
REGISTERED PROFESSIONAL ARCHITECTS  
REGISTERED PROFESSIONAL LAND SURVEYORS  
REGISTERED PROFESSIONAL GEODETIC SURVEYORS  
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REGISTERED PROFESSIONAL MECHANICAL ENGINEERS  
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REGISTERED PROFESSIONAL METALLURGICAL ENGINEERS  
REGISTERED PROFESSIONAL NUCLEAR ENGINEERS  
REGISTERED PROFESSIONAL PETROLEUM ENGINEERS  
REGISTERED PROFESSIONAL AGRICULTURAL ENGINEERS  
REGISTERED PROFESSIONAL FORESTRY ENGINEERS  
REGISTERED PROFESSIONAL MINING ENGINEERS  
REGISTERED PROFESSIONAL METALS ENGINEERS  
REGISTERED PROFESSIONAL POLYMER ENGINEERS  
REGISTERED PROFESSIONAL RAILROAD ENGINEERS  
REGISTERED PROFESSIONAL TRANSPORTATION ENGINEERS  
REGISTERED PROFESSIONAL WATER RESOURCES ENGINEERS  
REGISTERED PROFESSIONAL WIND ENGINEERS  
REGISTERED PROFESSIONAL BIOMEDICAL ENGINEERS  
REGISTERED PROFESSIONAL ENVIRONMENTAL ENGINEERS  
REGISTERED PROFESSIONAL FOOD ENGINEERS  
REGISTERED PROFESSIONAL TEXTILE ENGINEERS  
REGISTERED PROFESSIONAL FIBER ENGINEERS  
REGISTERED PROFESSIONAL PAPER ENGINEERS  
REGISTERED PROFESSIONAL PLASTIC ENGINEERS  
REGISTERED PROFESSIONAL RUBBER ENGINEERS  
REGISTERED PROFESSIONAL GLASS ENGINEERS  
REGISTERED PROFESSIONAL CERAMIC ENGINEERS  
REGISTERED PROFESSIONAL COMPOSITE ENGINEERS  
REGISTERED PROFESSIONAL POLYMER ENGINEERS  
REGISTERED PROFESSIONAL FIBER ENGINEERS  
REGISTERED PROFESSIONAL PAPER ENGINEERS  
REGISTERED PROFESSIONAL PLASTIC ENGINEERS  
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REGISTERED PROFESSIONAL COMPOSITE ENGINEERS

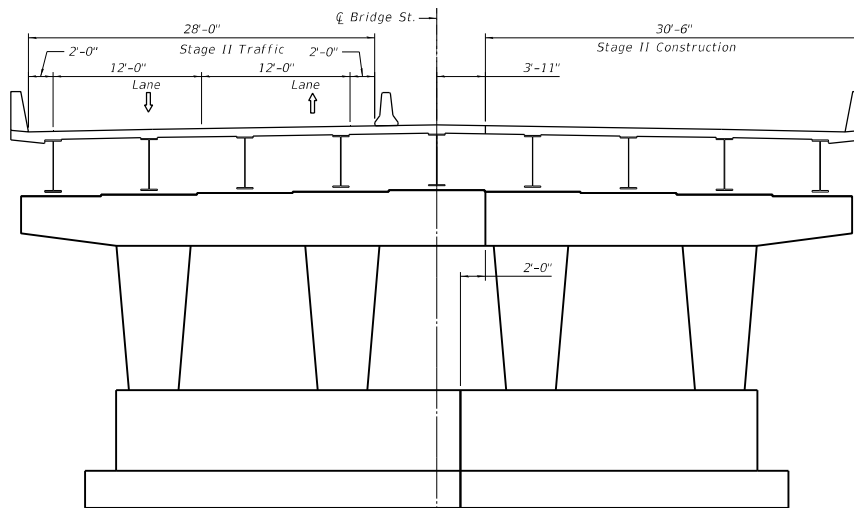
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| PLOT SCALE = |           | DRAWN -    | PG  | REVISED - |  |
| PLOT DATE =  | 2/23/2023 | CHECKED -  | MAC | REVISED - |  |



**STAGE II REMOVAL**



**STAGE III CONSTRUCTION**



**STAGE II CONSTRUCTION**

- Note:  
 1. All sections are looking North  
 2. Hatching represents limits of removal.

**APPROVED**

**FEBRUARY 23, 2023**

AS A BASIS FOR  
 PREPARATION OF DETAILED PLANS

**STAGE II & III CONSTRUCTION DETAILS**

**BRIDGE STREET OVER I-72**

**F.A.I. - 72 - SEC 74-68BR**

**PIATT COUNTY**

**STA. 50+00.00**

**STRUCTURE NO. 074-0089**

**STATE OF ILLINOIS  
 DEPARTMENT OF TRANSPORTATION**

SHEET 4 OF 4 SHEETS

| F.A.I. RTE.        | SECTION   | COUNTY | TOTAL SHEETS | SHEET NO. |
|--------------------|-----------|--------|--------------|-----------|
| 72                 | (74-68)BR | PIATT  |              |           |
| CONTRACT NO. 70D61 |           |        |              |           |

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**GREENE & BRADFORD, INC.**  
 OF SPRINGFIELD  
 400 NORTH BRIDGE STREET  
 SPRINGFIELD, ILLINOIS 62761  
 PHONE: (217) 223-1111  
 FAX: (217) 223-1112  
 WWW.GRENEANDBRADFORD.COM

|              |           |            |     |           |  |
|--------------|-----------|------------|-----|-----------|--|
| USER NAME =  | kashifs   | DESIGNED - | KAS | REVISED - |  |
|              |           | CHECKED -  | MAC | REVISED - |  |
| PLOT SCALE = |           | DRAWN -    | PG  | REVISED - |  |
| PLOT DATE =  | 2/23/2023 | CHECKED -  | MAC | REVISED - |  |

## Reported Estimated Factored Loads

| <b>TOTAL GIRDER REACTION TABLE - FACTORED</b> |     |          | Total Pier | Including |          |
|---|-----|----------|------------|-----------|----------|
|   |     | Abutment | Pier       | Dead Wt   | Pier Wt. |
| R <sub>DC1</sub>                              | (k) | 531.4    | 2,041.6    | 785.025   | 2,826.6  |
| R <sub>DC2</sub>                              | (k) | 129.4    | 469.6      |           |          |
| R <sub>DW</sub>                               | (k) | 223.2    | 809.8      |           |          |
| R <sub>LL+IM</sub>                            | (k) | 1,468.0  | 2,916.2    |           |          |
| R <sub>TOTAL</sub>                            | (k) | 2,352.1  | 6,237.2    |           |          |





# SOIL BORING LOG

ROUTE F.A.U. 7531/F.A.P. 756 DESCRIPTION Bridge Street over I-72 LOGGED BY KEG

SECTION (74-68)BR LOCATION 40°2'8.47" N, 88°35'46.21" W ; STA. 48+74, 11' LT (Near South Abutment)

COUNTY Piatt DRILLING METHOD HSA and MUD ROTARY HAMMER TYPE AUTO

STRUCT. NO. 074-0065  
Station 1359+51.04  
BORING NO. SB-1  
Station 48+74  
Offset 11' LT  
Ground Surface Elev. 694.83 ft

D E P T H (ft)  
B L O W S (/6")  
U C S (tsf)  
M O I S T (%)

Surface Water Elev. \_\_\_\_\_ ft  
Stream Bed Elev. \_\_\_\_\_ ft  
Groundwater Elev.:  
First Encounter \_\_\_\_\_ ft  
Upon Completion \_\_\_\_\_ ft  
After \_\_\_\_\_ Hrs. \_\_\_\_\_ ft

D E P T H (ft)  
B L O W S (/6")  
U C S (tsf)  
M O I S T (%)

|   |       |   |     |    |   |       |    |     |    |
|---|-------|---|-----|----|---|-------|----|-----|----|
| ASPHALT PAVEMENT - 10"  | 694.0 |   |     |    | SILTY CLAY LOAM TILL - Brown and gray, stiff <i>(continued)</i> |       |    |     |    |
| CLAY LOAM - Gray and brown, med-stiff, w/ some gravel                                       |       | 3 |     |    | becomes gray and brown, w/ med-coarse sand seams                |       | 5  |     |    |
|   |       | 3 | 1.3 | 15 |   |       | 8  | 2.6 | 18 |
|   |       | 5 | B   |    |   |       | 10 | B   |    |
|   | 691.3 |   |     |    |   |       |    |     |    |
| SILTY CLAY LOAM - Gray, med-stiff<br>Atterberg Limits - LL= 25, PI=10<br><br>w/ some gravel |       | 2 |     |    |   |       | 5  |     |    |
|   |       | 3 | 0.9 | 17 |   |       | 8  | 4.8 | 11 |
|   |       | 4 | B   |    |   |       | 10 | B   |    |
|   |       | 3 |     |    |   |       | 6  |     |    |
|   |       | 4 | 1.1 | 14 |   |       | 7  | 5.5 | 14 |
|   |       | 3 | B   |    |   |       | 11 | B   |    |
|   |       | 3 |     |    |   |       |    |     |    |
|   |       | 4 | 1.0 | 12 |   | 665.8 | 3  |     |    |
|   |       | 5 | B   |    | SILTY CLAY - Brown, med-stiff                                   |       | 5  | 3.3 | 24 |
|   |       | 1 |     |    | Change to Mud Wash at 30'                                       |       | 7  | S   |    |
|   |       | 2 | 0.9 | 16 |   |       |    |     |    |
|   |       | 5 | B   |    |   |       |    |     |    |
|   |       | 2 |     |    |   | 661.3 | 8  |     |    |
| becomes slightly moist  |       | 5 | 2.0 | 17 | SAND - Gray, well-graded, dense, wet                            |       | 8  | 3.8 | 15 |
|   |       | 5 | B   |    | SANDY CLAY LOAM TILL - Gray, stiff                              | 660.3 | 8  | P   |    |
|   |       | 3 |     |    |   |       |    |     |    |
|   |       | 4 | 2.2 | 11 |   |       |    |     |    |
|   | 677.8 | 6 | B   |    |   | 657.8 |    |     |    |
| SANDY CLAY TILL - Brown, stiff, w/ 1" fine sand seams at 19.5'                              |       | 4 |     |    | SILTY CLAY LOAM TILL - Brown and gray, stiff                    |       | 8  |     |    |
|   |       | 6 | 4.2 | 12 |   |       | 8  | 6.3 | 12 |
|   | 675.3 | 6 | B   |    |   |       | 12 | B   |    |
|   |       |   |     |    |   |       |    |     |    |

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)  
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)









# SOIL BORING LOG

ROUTE F.A.U. 7531/F.A.P. 756 DESCRIPTION Bridge Street over I-72 LOGGED BY KEG

SECTION (74-68)BR LOCATION 40°2'10.18" N, 88°35'46.69" W; STA. 50+10, 36' RT (Near Pier)

COUNTY Piatt DRILLING METHOD HSA and MUD ROTARY HAMMER TYPE AUTO

| STRUCT. NO.   | Station    | BORING NO. | Station | Offset | Ground Surface Elev. | D<br>E<br>P<br>T<br>H<br><br>ft | B<br>L<br>O<br>W<br>S<br><br>(/6") | U<br>C<br>S<br><br>(tsf) | M<br>O<br>I<br>S<br>T<br><br>(%) | Surface Water Elev. | Stream Bed Elev. | D<br>E<br>P<br>T<br>H<br><br>ft | B<br>L<br>O<br>W<br>S<br><br>(/6") | U<br>C<br>S<br><br>(tsf) | M<br>O<br>I<br>S<br>T<br><br>(%) |
|---|------------|------------|---------|--------|----------------------|---------------------------------|------------------------------------|--------------------------|----------------------------------|---------------------|------------------|---------------------------------|------------------------------------|--------------------------|----------------------------------|
| 074-0065  | 1359+51.04 | SB-3       | 50+10   | 36' RT | 671.33               |                                 |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
| CLAY LOAM - Brown, med-stiff  |            |            |         |        |                      |                                 |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 5                                  |                          |                                  |                     |                  |                                 | 7                                  |                          |                                  |
|   |            |            |         |        |                      | 669.3                           | 6                                  | 2.0                      | 13                               |                     |                  |                                 | 7                                  | 2.4                      | 25                               |
| SAND - Brown, well-graded, med-dense, w/ some clay                              |            |            |         |        |                      |                                 | 6                                  | P                        |                                  |                     |                  |                                 | 10                                 | S                        |                                  |
| no more clay  |            |            |         |        |                      |                                 | 3                                  |                          |                                  |                     |                  |                                 | 6                                  |                          |                                  |
|   |            |            |         |        |                      |                                 | 3                                  | -                        | 13                               |                     |                  |                                 | 10                                 | 6.1                      | 14                               |
|   |            |            |         |        |                      |                                 | 3                                  |                          |                                  |                     |                  |                                 | 13                                 | S                        |                                  |
|   |            |            |         |        |                      | -5                              |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
| w/ some clay and gravel   |            |            |         |        |                      |                                 | 1                                  |                          |                                  |                     |                  |                                 | 7                                  |                          |                                  |
|   |            |            |         |        |                      |                                 | 2                                  | -                        | 14                               |                     |                  |                                 | 7                                  | 4.6                      | 27                               |
|   |            |            |         |        |                      |                                 | 2                                  |                          |                                  |                     |                  |                                 | 11                                 | B                        |                                  |
| becomes brown and gray, no more clay  |            |            |         |        |                      |                                 | 6                                  |                          |                                  |                     |                  |                                 | 4                                  |                          |                                  |
|   |            |            |         |        |                      |                                 | 9                                  | -                        | 5                                |                     |                  |                                 | 8                                  | 5.2                      | 21                               |
|   |            |            |         |        |                      |                                 | 12                                 |                          |                                  |                     |                  |                                 | 9                                  | S                        |                                  |
|   |            |            |         |        |                      | -10                             |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
| w/ gravel traces  |            |            |         |        |                      |                                 | 12                                 |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 25                                 | -                        | 17                               |                     |                  |                                 |                                    |                          |                                  |
| FINE SAND - gray, dense, moist  |            |            |         |        |                      |                                 | 20                                 |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      | 659.3                           |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
| SILTY CLAY LOAM TILL - Gray and brown, stiff<br>Atterberg Limits - LL= 22, PI=8 |            |            |         |        |                      |                                 | 15                                 |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 16                                 | 5.7                      | 11                               |                     |                  |                                 | 8                                  | 6.6                      | 13                               |
|   |            |            |         |        |                      |                                 | 11                                 | B                        |                                  |                     |                  |                                 | 17                                 | B                        |                                  |
|   |            |            |         |        |                      | -15                             |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 7                                  |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 8                                  | 6.1                      | 11                               |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 9                                  | S                        |                                  |                     |                  |                                 |                                    |                          |                                  |
| w/ 3.5" of granite fragments  |            |            |         |        |                      |                                 |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |
|   |            |            |         |        |                      |                                 | 12                                 |                          |                                  |                     |                  |                                 | 8                                  |                          |                                  |
| SILTY CLAY LOAM - Brown and black, stiff<br>Poor Recovery                       |            |            |         |        |                      |                                 | 11                                 | -                        | 13                               |                     |                  |                                 | 11                                 | 6.1                      | 14                               |
|   |            |            |         |        |                      |                                 | 15                                 |                          |                                  |                     |                  |                                 | 16                                 | B                        |                                  |
|   |            |            |         |        |                      | -20                             |                                    |                          |                                  |                     |                  |                                 |                                    |                          |                                  |

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)  
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)





**Approximate Location**  
Latitude =  $40^{\circ} 2' 8.61''\text{N}$   
Longitude =  $88^{\circ} 35' 45.97''\text{W}$



**Approximate Location**

Latitude = 40°2'8.78"N

Longitude = 88°35'45.69"W





**Approximate Location**  
Latitude =  $40^{\circ} 2'10.93''\text{N}$   
Longitude =  $88^{\circ}35'48.31''\text{W}$



**Approximate Location**

Latitude = 40° 2'10.75"N

Longitude = 88°35'48.59"W



PROJECT S.N. 074-0089PROJECT NUMBER 20-0318SHEET NUMBER 1DATE 1/26/2023SUBJECT Bridge Street over I-72COMPUTED BY RSS

CHECKED BY \_\_\_\_\_

SEISMIC VALUES

$$S_s = 0.15g \quad (\text{Fig. 3.10.2.1-2})$$

$$S_1 = 0.06g \quad (\text{Fig. 3.10.2.1-3})$$

$$F_a = 1.6 \quad \text{Site Class 0} \quad (\text{Fig. 3.10.3.2-2})$$

$$F_v = 2.4 \quad \text{Site Class 0} \quad (\text{Fig. 3.10.3.2-3})$$

$$S_{DS} = F_a S_s = (1.6)(0.15) = 0.24g$$

$$S_{D1} = F_v S_1 = (2.4)(0.06) = 0.144g$$

$$S_{D1} \leq 0.15 \rightarrow \text{Seismic Zone 1}$$

**GENERAL DATA**

STRUCTURE NUMBER=====SN 074-0089  
 STRUCTURE TYPE =====MULTI-SPAN  
 STRUCTURE SKEW=====0 DEGREES  
 SUPER. DATA IN REFERENCE TO SUB. DATA =====ABUT 1

TOTAL STRUCTURE LENGTH=====243.50 FT  
 NUMBER OF SPANS =====2  
 END SPAN LENGTH =====119.92 FT  
 ADJACENT INTERIOR SPAN LENGTH =====0.01 FT

| SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN) |              |     |
|---|--------------|-----|
| BEAM TYPE =====   | PLATE GIRDER |     |
| TOP FLANGE WIDTH =====  | 14.00        | IN  |
| TOP FLANGE THICKNESS =====                                    | 2.00         | IN  |
| WEB DEPTH =====   | 48.00        | IN  |
| WEB THICKNESS =====   | 0.50         | IN  |
| BOTTOM FLANGE WIDTH =====                                     | 14.00        | IN  |
| BOTTOM FLANGE THICKNESS =====                                 | 2.00         | IN  |
| BEAM SPACING PERP. TO CL =====                                | 7.75         | FT  |
| SLAB THICKNESS =====  | 8.00         | IN  |
| SLAB F'C =====  | 4.00         | KSI |

| SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN) |       |     |
|--|-------|-----|
| TOP FLANGE WIDTH =====                                     | 14.00 | IN  |
| TOP FLANGE THICKNESS =====                                 | 2.00  | IN  |
| WEB DEPTH =====  | 48.00 | IN  |
| WEB THICKNESS =====  | 0.50  | IN  |
| BOTTOM FLANGE WIDTH =====                                  | 14.00 | IN  |
| BOTTOM FLANGE THICKNESS =====                              | 2.00  | IN  |
| BEAM SPACING PERP. TO CL =====                             | 7.75  | FT  |
| SLAB THICKNESS =====                                       | 8.00  | IN  |
| SLAB F'C =====   | 4.00  | KSI |

| ABUTMENT #1 DATA                         |        |    |
|--|--------|----|
| ABUTMENT NAME =====                      | South  |    |
| ABUTMENT REFERENCE BORING =====          | B-1    |    |
| BOTTOM OF ABUTMENT ELEVATION =====       | 687.41 | FT |
| ESTIMATED NUMBER OF PILES AT ABUT. ===== | 9      |    |
| PILE SPACING PERP. TO CL =====           | 7.75   | FT |

| ABUTMENT #2 DATA                         |        |    |
|--|--------|----|
| ABUTMENT NAME =====                      | North  |    |
| ABUTMENT REFERENCE BORING =====          | B-2    |    |
| BOTTOM OF ABUTMENT ELEVATION =====       | 687.41 | FT |
| ESTIMATED NUMBER OF PILES AT ABUT. ===== | 9      |    |
| PILE SPACING PERP. TO CL =====           | 7.75   | FT |

| SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1 |                      |                                       |                               |                             |
|---|----------------------|---------------------------------------|-------------------------------|-----------------------------|
| BOT. OF LAYER ELEV. (FT)                          | LAYER THICKNESS (FT) | UNCONFINED COMPRESSIVE STRENGTH (TSF) | N S.P.T. VALUE (BLOWS/12 IN.) | Qu EQUIV. FOR N VALUE (TSF) |
| 685.91  | 1.50                 | 1.1                                   |                               |                             |
| 683.41  | 2.50                 | 1.0                                   |                               |                             |
| 680.91  | 2.50                 | 0.9                                   |                               |                             |
| 678.41  | 2.50                 | 2.0                                   |                               |                             |
| 677.41  | 1.00                 | 2.2                                   |                               |                             |

| SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2 |                      |                                       |                               |                             |
|---|----------------------|---------------------------------------|-------------------------------|-----------------------------|
| BOT. OF LAYER ELEV. (FT)                          | LAYER THICKNESS (FT) | UNCONFINED COMPRESSIVE STRENGTH (TSF) | N S.P.T. VALUE (BLOWS/12 IN.) | Qu EQUIV. FOR N VALUE (TSF) |
| 686.91  | 0.50                 | 3.1                                   |                               |                             |
| 683.41  | 3.50                 | 3.1                                   |                               |                             |
| 680.91  | 2.50                 | 4.4                                   |                               |                             |
| 678.41  | 2.50                 | 1.90                                  |                               |                             |
| 677.41  | 1.00                 | 7.90                                  |                               |                             |

10.00 FT = TOTAL DEPTH ENTERED

10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1===== 1.36 TSF

WEIGHTED AVERAGE Qu FOR ABUTMENT #2===== 3.61 TSF

PILE STIFFNESS MODIFIER FOR ABUTMENT #1  
 = 1/(1.45-[0.3\*1.36])===== 0.96

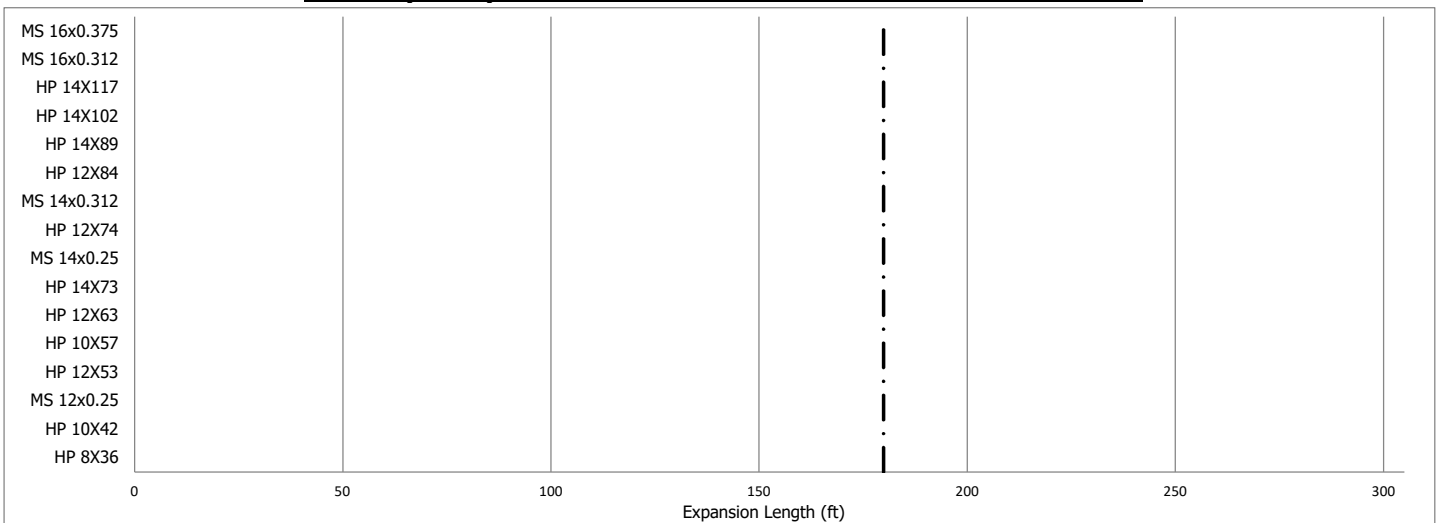
PILE STIFFNESS MODIFIER FOR ABUTMENT #2  
 = 1/(1.45-[0.3\*3.61])===== 2.71

**WEIGHTED AVG. Qu > 3.0 TSF WITH TRIB. LENGTH > 20%, INTEGRAL ABUTMENT STRUCTURE NOT ALLOWED**

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 = [0.96\*9\*0+2.71\*9\*243.5]/[0.96\*9+2.71\*9]===== 179.88 FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 = [2.71\*9\*0+0.96\*9\*243.5]/[2.71\*9+0.96\*9]===== 63.62 FT

**ABUT 1 (South) - EXPANSION LENGTH LIMIT CHART - 0 DEG. SKEW**



----- = Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration.  
 (Note: The same size pile should be used at both abutments.)

**GENERAL DATA**

STRUCTURE NUMBER===== **SN 074-0089**  
 STRUCTURE TYPE ===== **MULTI-SPAN**  
 STRUCTURE SKEW===== **0** DEGREES  
 SUPER. DATA IN REFERENCE TO SUB. DATA ===== **ABUT 1**

TOTAL STRUCTURE LENGTH===== **243.50** FT  
 NUMBER OF SPANS ===== **2**  
 END SPAN LENGTH ===== **119.92** FT  
 ADJACENT INTERIOR SPAN LENGTH ===== **0.01** FT

| SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (END OR MAIN SPAN) |                     |     |
|---|---------------------|-----|
| BEAM TYPE =====   | <b>PLATE GIRDER</b> |     |
| TOP FLANGE WIDTH =====  | <b>14.00</b>        | IN  |
| TOP FLANGE THICKNESS =====                                    | <b>2.00</b>         | IN  |
| WEB DEPTH =====   | <b>48.00</b>        | IN  |
| WEB THICKNESS =====   | <b>0.50</b>         | IN  |
| BOTTOM FLANGE WIDTH =====                                     | <b>14.00</b>        | IN  |
| BOTTOM FLANGE THICKNESS =====                                 | <b>2.00</b>         | IN  |
| BEAM SPACING PERP. TO CL =====                                | <b>7.75</b>         | FT  |
| SLAB THICKNESS =====  | <b>8.00</b>         | IN  |
| SLAB F'C =====  | <b>4.00</b>         | KSI |

| SUPERSTRUCTURE POSITIVE MOMENT REGION DATA (ADJACENT SPAN) |              |     |
|--|--------------|-----|
| TOP FLANGE WIDTH =====                                     | <b>14.00</b> | IN  |
| TOP FLANGE THICKNESS =====                                 | <b>2.00</b>  | IN  |
| WEB DEPTH =====  | <b>48.00</b> | IN  |
| WEB THICKNESS =====  | <b>0.50</b>  | IN  |
| BOTTOM FLANGE WIDTH =====                                  | <b>14.00</b> | IN  |
| BOTTOM FLANGE THICKNESS =====                              | <b>2.00</b>  | IN  |
| BEAM SPACING PERP. TO CL =====                             | <b>7.75</b>  | FT  |
| SLAB THICKNESS =====                                       | <b>8.00</b>  | IN  |
| SLAB F'C =====   | <b>4.00</b>  | KSI |

| ABUTMENT #1 DATA                         |               |    |
|--|---------------|----|
| ABUTMENT NAME =====                      | <b>South</b>  |    |
| ABUTMENT REFERENCE BORING =====          | <b>B-1</b>    | FT |
| BOTTOM OF ABUTMENT ELEVATION =====       | <b>687.41</b> | FT |
| ESTIMATED NUMBER OF PILES AT ABUT. ===== | <b>9</b>      | FT |
| PILE SPACING PERP. TO CL =====           | <b>7.75</b>   | FT |

| ABUTMENT #2 DATA                         |               |    |
|--|---------------|----|
| ABUTMENT NAME =====                      | <b>North</b>  |    |
| ABUTMENT REFERENCE BORING =====          | <b>B-2</b>    | FT |
| BOTTOM OF ABUTMENT ELEVATION =====       | <b>687.41</b> | FT |
| ESTIMATED NUMBER OF PILES AT ABUT. ===== | <b>9</b>      | FT |
| PILE SPACING PERP. TO CL =====           | <b>7.75</b>   | FT |

| SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #1 |                      |                                       |                               |                             |
|---|----------------------|---------------------------------------|-------------------------------|-----------------------------|
| BOT. OF LAYER ELEV. (FT)                          | LAYER THICKNESS (FT) | UNCONFINED COMPRESSIVE STRENGTH (TSF) | N S.P.T. VALUE (BLOWS/12 IN.) | Qu EQUIV. FOR N VALUE (TSF) |
| 685.91  | 1.50                 | 1.1                                   |                               |                             |
| 683.41  | 2.50                 | 1.0                                   |                               |                             |
| 680.91  | 2.50                 | 0.9                                   |                               |                             |
| 678.41  | 2.50                 | 2.0                                   |                               |                             |
| 677.41  | 1.00                 | 2.2                                   |                               |                             |

| SOIL DATA FOR 10 FT BENEATH BOTTOM OF ABUTMENT #2 |                      |                                       |                               |                             |
|---|----------------------|---------------------------------------|-------------------------------|-----------------------------|
| BOT. OF LAYER ELEV. (FT)                          | LAYER THICKNESS (FT) | UNCONFINED COMPRESSIVE STRENGTH (TSF) | N S.P.T. VALUE (BLOWS/12 IN.) | Qu EQUIV. FOR N VALUE (TSF) |
| 677.41  | 10.00                | 1.5                                   |                               |                             |

10.00 FT = TOTAL DEPTH ENTERED

10.00 FT = TOTAL DEPTH ENTERED

WEIGHTED AVERAGE Qu FOR ABUTMENT #1===== **1.36** TSF

WEIGHTED AVERAGE Qu FOR ABUTMENT #2===== **1.50** TSF

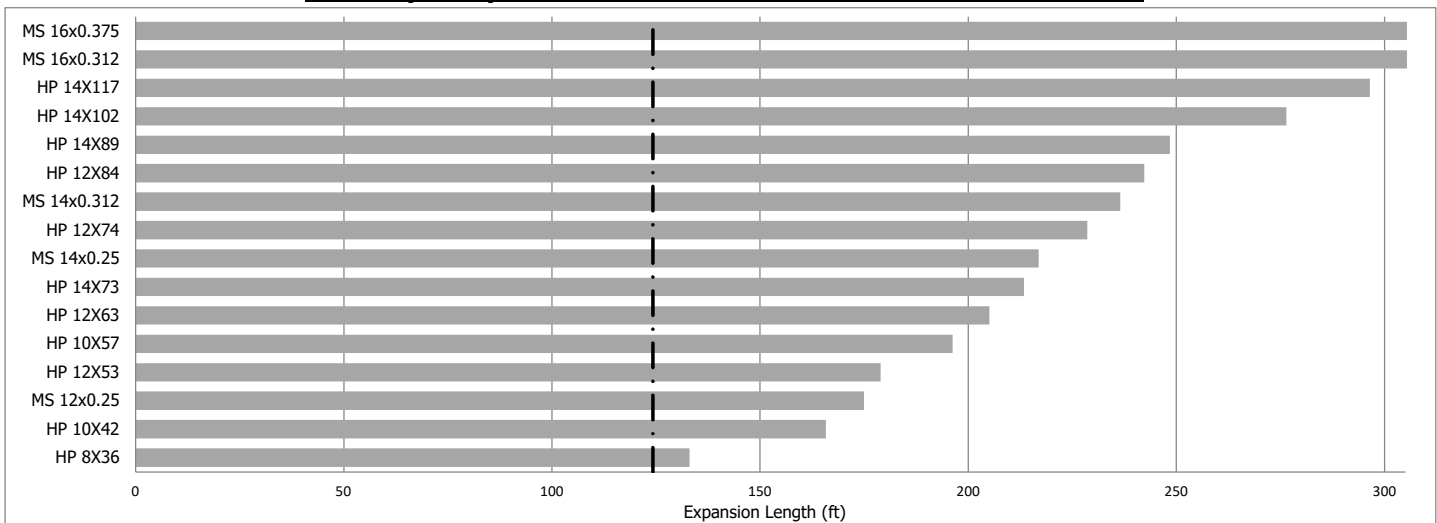
PILE STIFFNESS MODIFIER FOR ABUTMENT #1  
 = 1/(1.45-[0.3\*1.36])===== **0.96**

PILE STIFFNESS MODIFIER FOR ABUTMENT #2  
 = 1/(1.45-[0.3\*1.5])===== **1.00**

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #1 =  $[0.96*9*0+1*9*243.5]/[0.96*9+1*9]$ ===== **124.25** FT

DISTANCE TO CENTROID OF STIFFNESS FROM ABUTMENT #2 =  $[1*9*0+0.96*9*243.5]/[1*9+0.96*9]$ ===== **119.25** FT

**ABUT 1 (South) - EXPANSION LENGTH LIMIT CHART - 0 DEG. SKEW**



----- = Estimated expansion length for the indicated abutment. Piles with an expansion length greater than this are suitable for consideration.  
 (Note: The same size pile should be used at both abutments.)

SUBSTRUCTURE=====SE Abutment  
 REFERENCE BORING =====SB1  
 LRFD or ASD or SEISMIC =====LRFD  
 PILE CUTOFF ELEV. =====689.40 ft  
 GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 687.40 ft  
 GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) =====None  
 BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =====ft  
 TOP ELEV. OF LIQUEF. (so layers above apply DD) =====ft

TOTAL FACTORED SUBSTRUCTURE LOAD =====2352 kips  
 TOTAL LENGTH OF SUBSTRUCTURE (along skew)=====68.00 ft  
 NUMBER OF ROWS OF PILES PER SUBSTRUCTURE =====1

Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 276.71 KIPS  
 Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 103.76 KIPS

**MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses**

| Maximum Nominal<br>Req'd Bearing of Pile | Maximum Nominal<br>Req'd Bearing of Boring | Maximum Factored<br>Resistance Available in Boring | Maximum Pile<br>Driveable Length in Boring |
|--|--|--|--|
| <b>570</b> KIPS                          | <b>552</b> KIPS                            | <b>304</b> KIPS                                    | <b>53</b> FT.                              |

PILE TYPE AND SIZE =====Metal Shell 14"Φ w/.312" walls  
 Pile Perimeter=====3.665 FT.  
 Pile End Bearing Area=====1.069 SQFT.

| BOT.<br>OF<br>LAYER<br>ELEV.<br>(FT.) | LAYER<br>THICK.<br>(FT.) | UNCONF.<br>COMPR.<br>STRENGTH<br>(TSF) | S.P.T.<br>N<br>VALUE<br>(BLOWS) | GRANULAR<br>OR ROCK LAYER<br>DESCRIPTION | NOMINAL                   |                               |                            |  |  |  | NOMINAL<br>REQ'D<br>BEARING<br>(KIPS) | FACTORED<br>GEOTECH.<br>LOSS FROM<br>SCOUR or DD<br>(KIPS) | FACTORED<br>GEOTECH.<br>LOSS LOAD<br>FROM DD<br>(KIPS) | FACTORED<br>RESISTANCE<br>AVAILABLE<br>(KIPS) | ESTIMATED<br>PILE<br>LENGTH<br>(FT.) |
|---------------------------------------|--------------------------|--|---------------------------------|--|---------------------------|-------------------------------|----------------------------|--|--|--|---------------------------------------|--|--|---|--------------------------------------|
|                                       |                          |  |                                 |  | SIDE<br>RESIST.<br>(KIPS) | END BRG.<br>RESIST.<br>(KIPS) | TOTAL<br>RESIST.<br>(KIPS) |  |  |  |                                       |  |  |   |                                      |
| 685.90                                | 1.50                     | 1.10                                   | 7                               |  | 6.6                       |                               | 18.3                       |  |  |  | 18                                    | 0  | 0  | 10  | 4                                    |
| 683.40                                | 2.50                     | 1.00                                   | 9                               |  | 10.2                      | 11.7                          | 27.3                       |  |  |  | 27                                    | 0  | 0  | 15  | 6                                    |
| 680.90                                | 2.50                     | 0.90                                   | 7                               |  | 9.4                       | 10.6                          | 49.6                       |  |  |  | 50                                    | 0  | 0  | 27  | 9                                    |
| 678.40                                | 2.50                     | 2.00                                   | 10                              |  | 16.7                      | 23.5                          | 68.6                       |  |  |  | 69                                    | 0  | 0  | 38  | 11                                   |
| 675.90                                | 2.50                     | 2.20                                   | 10                              |  | 17.7                      | 25.8                          | 109.8                      |  |  |  | 110                                   | 0  | 0  | 60  | 14                                   |
| 673.40                                | 2.50                     | 4.20                                   | 12                              |  | 28.2                      | 49.2                          | 119.3                      |  |  |  | 119                                   | 0  | 0  | 66  | 16                                   |
| 670.90                                | 2.50                     | 2.60                                   | 18                              |  | 19.8                      | 30.5                          | 164.9                      |  |  |  | 165                                   | 0  | 0  | 91  | 19                                   |
| 668.40                                | 2.50                     | 4.80                                   | 18                              |  | 29.8                      | 56.3                          | 203.0                      |  |  |  | 203                                   | 0  | 0  | 112   | 21                                   |
| 665.90                                | 2.50                     | 5.50                                   | 18                              |  | 29.8                      | 64.5                          | 207.0                      |  |  |  | 207                                   | 0  | 0  | 114   | 24                                   |
| 660.90                                | 5.00                     | 3.30                                   | 12                              |  | 47.0                      | 38.7                          | 259.9                      |  |  |  | 260                                   | 0  | 0  | 143   | 29                                   |
| 655.90                                | 5.00                     | 3.80                                   | 16                              |  | 52.3                      | 44.6                          | 341.5                      |  |  |  | 341                                   | 0  | 0  | 188   | 34                                   |
| 650.90                                | 5.00                     | 6.30                                   | 20                              |  | 59.6                      | 73.9                          | 365.9                      |  |  |  | 366                                   | 0  | 0  | 201   | 39                                   |
| 645.90                                | 5.00                     | 3.30                                   | 17                              |  | 47.0                      | 38.7                          | 438.8                      |  |  |  | 439                                   | 0  | 0  | 241   | 44                                   |
| 636.40                                | 9.50                     | 5.50                                   | 21                              |  | 113.3                     | 64.5                          | 552.1                      |  |  |  | 552                                   | 0  | 0  | 304   | 53                                   |
| 635.90                                | 0.50                     | 5.50                                   | 21                              |  | 6.0                       | 64.5                          | 578.0                      |  |  |  | 578                                   | 0  | 0  | 348   | 54                                   |
| 625.90                                | 10.00                    | 7.20                                   | 25                              |  | 119.3                     | 84.4                          | 633.9                      |  |  |  | 634                                   | 0  | 0  | 349   | 64                                   |
| 615.90                                | 10.00                    | 1.80                                   | 19                              |  | 62.4                      | 21.1                          | 698.7                      |  |  |  | 699                                   | 0  | 0  | 384   | 74                                   |
| 614.90                                | 1.00                     | 2.00                                   | 26                              |  |                           | 23.5                          |                            |  |  |  |                                       |  |  |   |                                      |

**Pile Design Table for SE Abutment utilizing Boring #SB1**

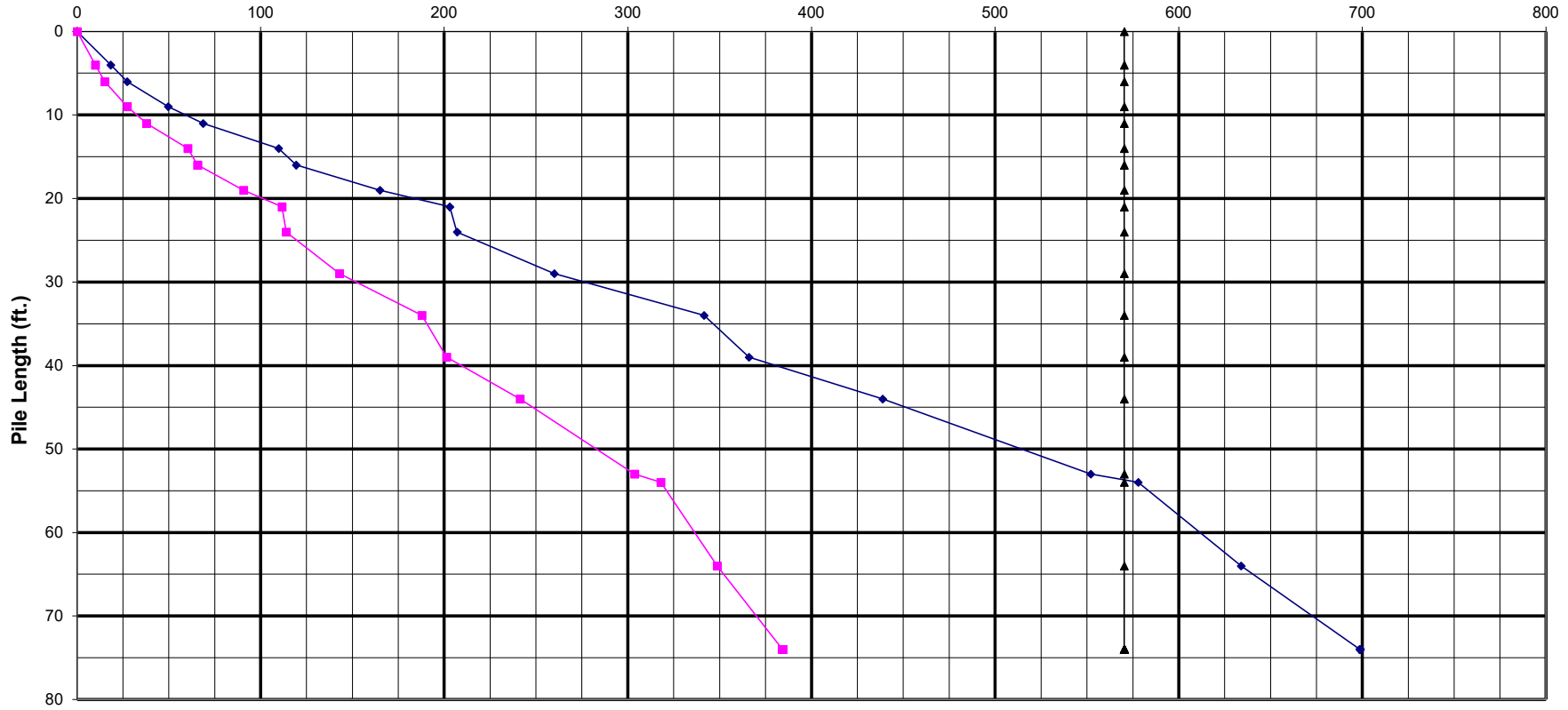
| Nominal Required Bearing (Kips)       | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) | Nominal Required Bearing (Kips) | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) | Nominal Required Bearing (Kips) | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) |
|---------------------------------------|--------------------------------------|-----------------------------|---------------------------------|--------------------------------------|-----------------------------|---------------------------------|--------------------------------------|-----------------------------|
| <b>Metal Shell 12"Φ w/.25" walls</b>  |                                      |                             | <b>Steel HP 10 X 42</b>         |                                      |                             | <b>Steel HP 12 X 84</b>         |                                      |                             |
| 173                                   | 95                                   | 24                          | 160                             | 88                                   | 29                          | 169                             | 93                                   | 24                          |
| 217                                   | 120                                  | 29                          | 214                             | 118                                  | 34                          | 210                             | 115                                  | 29                          |
| 284                                   | 156                                  | 34                          | 220                             | 121                                  | 39                          | 282                             | 155                                  | 39                          |
| 309                                   | 170                                  | 39                          | 268                             | 147                                  | 44                          | 348                             | 192                                  | 44                          |
| 368                                   | 203                                  | 44                          | 333                             | 183                                  | 53                          | 429                             | 236                                  | 53                          |
| <b>Metal Shell 14"Φ w/.25" walls</b>  |                                      |                             | <b>Steel HP 10 X 57</b>         |                                      |                             | <b>Steel HP 14 X 73</b>         |                                      |                             |
| 165                                   | 91                                   | 19                          | 164                             | 90                                   | 29                          | 459                             | 252                                  | 54                          |
| 203                                   | 112                                  | 21                          | 219                             | 121                                  | 34                          | 464                             | 255                                  | 64                          |
| 207                                   | 114                                  | 24                          | 225                             | 124                                  | 39                          | 512                             | 282                                  | 74                          |
| 260                                   | 143                                  | 29                          | 274                             | 151                                  | 44                          | <b>Steel HP 14 X 89</b>         |                                      |                             |
| 341                                   | 188                                  | 34                          | 341                             | 187                                  | 53                          | 184                             | 101                                  | 21                          |
| 366                                   | 201                                  | 39                          | 361                             | 198                                  | 54                          | 202                             | 111                                  | 24                          |
| 439                                   | 241                                  | 44                          | 377                             | 208                                  | 64                          | 250                             | 137                                  | 29                          |
| <b>Metal Shell 14"Φ w/.312" walls</b> |                                      |                             | <b>Steel HP 12 X 53</b>         |                                      |                             | <b>Steel HP 14 X 102</b>        |                                      |                             |
| 165                                   | 91                                   | 19                          | 416                             | 229                                  | 74                          | 180                             | 99                                   | 21                          |
| 203                                   | 112                                  | 21                          | <b>Steel HP 12 X 63</b>         |                                      |                             | 202                             | 111                                  | 24                          |
| 207                                   | 114                                  | 24                          | 162                             | 89                                   | 24                          | 250                             | 137                                  | 29                          |
| 260                                   | 143                                  | 29                          | 201                             | 111                                  | 29                          | 332                             | 183                                  | 39                          |
| 341                                   | 188                                  | 34                          | 272                             | 149                                  | 39                          | 413                             | 227                                  | 44                          |
| 366                                   | 201                                  | 39                          | 335                             | 184                                  | 44                          | 506                             | 278                                  | 53                          |
| 439                                   | 241                                  | 44                          | 413                             | 227                                  | 53                          | 537                             | 295                                  | 64                          |
| 552                                   | 304                                  | 53                          | <b>Steel HP 12 X 74</b>         |                                      |                             | <b>Steel HP 14 X 117</b>        |                                      |                             |
| <b>Metal Shell 16"Φ w/.312" walls</b> |                                      |                             | 164                             | 90                                   | 24                          | 186                             | 103                                  | 21                          |
| 141                                   | 78                                   | 16                          | 203                             | 112                                  | 29                          | 204                             | 112                                  | 24                          |
| 198                                   | 109                                  | 19                          | 274                             | 151                                  | 39                          | 253                             | 139                                  | 29                          |
| 242                                   | 133                                  | 21                          | 338                             | 186                                  | 44                          | 336                             | 185                                  | 39                          |
| 243                                   | 134                                  | 24                          | 417                             | 229                                  | 53                          | 418                             | 230                                  | 44                          |
| 304                                   | 167                                  | 29                          | 445                             | 245                                  | 54                          | 512                             | 282                                  | 53                          |
| 402                                   | 221                                  | 34                          | 452                             | 249                                  | 64                          | 543                             | 299                                  | 64                          |
| 425                                   | 233                                  | 39                          | <b>Steel HP 12 X 84</b>         |                                      |                             | 599                             | 329                                  | 74                          |
| 512                                   | 282                                  | 44                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 127</b>        |                                      |                             |
| 641                                   | 353                                  | 53                          | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| <b>Metal Shell 16"Φ w/.375" walls</b> |                                      |                             | 278                             | 153                                  | 39                          | 207                             | 114                                  | 24                          |
| 141                                   | 78                                   | 16                          | 343                             | 189                                  | 44                          | 257                             | 141                                  | 29                          |
| 198                                   | 109                                  | 19                          | 423                             | 233                                  | 53                          | 340                             | 187                                  | 39                          |
| 242                                   | 133                                  | 21                          | 452                             | 249                                  | 54                          | 424                             | 233                                  | 44                          |
| 243                                   | 134                                  | 24                          | 458                             | 252                                  | 64                          | 519                             | 285                                  | 53                          |
| 304                                   | 167                                  | 29                          | 505                             | 278                                  | 74                          | 549                             | 302                                  | 64                          |
| 402                                   | 221                                  | 34                          | <b>Steel HP 12 X 96</b>         |                                      |                             | 605                             | 333                                  | 74                          |
| 425                                   | 233                                  | 39                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 137</b>        |                                      |                             |
| 512                                   | 282                                  | 44                          | 207                             | 114                                  | 29                          | 151                             | 83                                   | 19                          |
| 641                                   | 353                                  | 53                          | 278                             | 153                                  | 39                          | 190                             | 105                                  | 21                          |
| 674                                   | 371                                  | 54                          | 343                             | 189                                  | 44                          | 210                             | 116                                  | 24                          |
| 728                                   | 400                                  | 64                          | 423                             | 233                                  | 53                          | 260                             | 143                                  | 29                          |
| <b>Steel HP 8 X 36</b>                |                                      |                             | 452                             | 249                                  | 54                          | 345                             | 190                                  | 39                          |
| 175                                   | 96                                   | 39                          | 458                             | 252                                  | 64                          | 430                             | 236                                  | 44                          |
| 211                                   | 116                                  | 44                          | 505                             | 278                                  | 74                          | 525                             | 289                                  | 53                          |
| 264                                   | 145                                  | 53                          | <b>Steel HP 12 X 108</b>        |                                      |                             | 555                             | 305                                  | 64                          |
| <b>Steel HP 8 X 42</b>                |                                      |                             | 166                             | 91                                   | 24                          | 612                             | 337                                  | 74                          |
| 175                                   | 96                                   | 39                          | 207                             | 114                                  | 29                          | <b>Precast 14"x 14"</b>         |                                      |                             |
| 211                                   | 116                                  | 44                          | 278                             | 153                                  | 39                          | 152                             | 84                                   | 16                          |
| 264                                   | 145                                  | 53                          | 343                             | 189                                  | 44                          | 210                             | 116                                  | 19                          |
| <b>Steel HP 8 X 48</b>                |                                      |                             | 423                             | 233                                  | 53                          | 258                             | 142                                  | 21                          |
| 175                                   | 96                                   | 39                          | 452                             | 249                                  | 54                          | <b>Steel HP 12 X 120</b>        |                                      |                             |
| 211                                   | 116                                  | 44                          | 458                             | 252                                  | 64                          | 169                             | 93                                   | 24                          |
| 264                                   | 145                                  | 53                          | 505                             | 278                                  | 74                          | 210                             | 115                                  | 29                          |
| <b>Steel HP 8 X 54</b>                |                                      |                             | <b>Steel HP 12 X 132</b>        |                                      |                             | 282                             | 155                                  | 39                          |
| 175                                   | 96                                   | 39                          | 166                             | 91                                   | 24                          | 348                             | 192                                  | 44                          |
| 211                                   | 116                                  | 44                          | 207                             | 114                                  | 29                          | 429                             | 236                                  | 53                          |
| 264                                   | 145                                  | 53                          | 278                             | 153                                  | 39                          | 459                             | 252                                  | 54                          |
| <b>Steel HP 8 X 60</b>                |                                      |                             | 343                             | 189                                  | 44                          | 464                             | 255                                  | 64                          |
| 175                                   | 96                                   | 39                          | 423                             | 233                                  | 53                          | 512                             | 282                                  | 74                          |
| 211                                   | 116                                  | 44                          | 452                             | 249                                  | 54                          | <b>Steel HP 14 X 143</b>        |                                      |                             |
| 264                                   | 145                                  | 53                          | 458                             | 252                                  | 64                          | 180                             | 99                                   | 21                          |
| <b>Steel HP 8 X 66</b>                |                                      |                             | 505                             | 278                                  | 74                          | 202                             | 111                                  | 24                          |
| 175                                   | 96                                   | 39                          | <b>Steel HP 12 X 144</b>        |                                      |                             | 250                             | 137                                  | 29                          |
| 211                                   | 116                                  | 44                          | 166                             | 91                                   | 24                          | 332                             | 183                                  | 39                          |
| 264                                   | 145                                  | 53                          | 207                             | 114                                  | 29                          | 413                             | 227                                  | 44                          |
| <b>Steel HP 8 X 72</b>                |                                      |                             | 278                             | 153                                  | 39                          | 506                             | 278                                  | 53                          |
| 175                                   | 96                                   | 39                          | 343                             | 189                                  | 44                          | 537                             | 295                                  | 64                          |
| 211                                   | 116                                  | 44                          | 423                             | 233                                  | 53                          | <b>Steel HP 14 X 159</b>        |                                      |                             |
| 264                                   | 145                                  | 53                          | 452                             | 249                                  | 54                          | 186                             | 103                                  | 21                          |
| <b>Steel HP 8 X 78</b>                |                                      |                             | 458                             | 252                                  | 64                          | 204                             | 112                                  | 24                          |
| 175                                   | 96                                   | 39                          | 505                             | 278                                  | 74                          | 253                             | 139                                  | 29                          |
| 211                                   | 116                                  | 44                          | <b>Steel HP 12 X 156</b>        |                                      |                             | 336                             | 185                                  | 39                          |
| 264                                   | 145                                  | 53                          | 166                             | 91                                   | 24                          | 418                             | 230                                  | 44                          |
| <b>Steel HP 8 X 84</b>                |                                      |                             | 207                             | 114                                  | 29                          | 512                             | 282                                  | 53                          |
| 175                                   | 96                                   | 39                          | 278                             | 153                                  | 39                          | 543                             | 299                                  | 64                          |
| 211                                   | 116                                  | 44                          | 343                             | 189                                  | 44                          | 599                             | 329                                  | 74                          |
| 264                                   | 145                                  | 53                          | 423                             | 233                                  | 53                          | <b>Steel HP 14 X 175</b>        |                                      |                             |
| <b>Steel HP 8 X 90</b>                |                                      |                             | 452                             | 249                                  | 54                          | 186                             | 103                                  | 21                          |
| 175                                   | 96                                   | 39                          | 458                             | 252                                  | 64                          | 207                             | 114                                  | 24                          |
| 211                                   | 116                                  | 44                          | 505                             | 278                                  | 74                          | 257                             | 141                                  | 29                          |
| 264                                   | 145                                  | 53                          | <b>Steel HP 12 X 168</b>        |                                      |                             | 340                             | 187                                  | 39                          |
| <b>Steel HP 8 X 96</b>                |                                      |                             | 166                             | 91                                   | 24                          | 424                             | 233                                  | 44                          |
| 175                                   | 96                                   | 39                          | 207                             | 114                                  | 29                          | 519                             | 285                                  | 53                          |
| 211                                   | 116                                  | 44                          | 278                             | 153                                  | 39                          | 549                             | 302                                  | 64                          |
| 264                                   | 145                                  | 53                          | 343                             | 189                                  | 44                          | 605                             | 333                                  | 74                          |
| <b>Steel HP 8 X 102</b>               |                                      |                             | 423                             | 233                                  | 53                          | <b>Steel HP 14 X 191</b>        |                                      |                             |
| 175                                   | 96                                   | 39                          | 452                             | 249                                  | 54                          | 151                             | 83                                   | 19                          |
| 211                                   | 116                                  | 44                          | 458                             | 252                                  | 64                          | 190                             | 105                                  | 21                          |
| 264                                   | 145                                  | 53                          | 505                             | 278                                  | 74                          | 210                             | 116                                  | 24                          |
| <b>Steel HP 8 X 108</b>               |                                      |                             | <b>Steel HP 12 X 180</b>        |                                      |                             | 260                             | 143                                  | 29                          |
| 175                                   | 96                                   | 39                          | 166                             | 91                                   | 24                          | 345                             | 190                                  | 39                          |
| 211                                   | 116                                  | 44                          | 207                             | 114                                  | 29                          | 430                             | 236                                  | 44                          |
| 264                                   | 145                                  | 53                          | 278                             | 153                                  | 39                          | 525                             | 289                                  | 53                          |
| <b>Steel HP 8 X 114</b>               |                                      |                             | 343                             | 189                                  | 44                          | 555                             | 305                                  | 64                          |
| 175                                   | 96                                   | 39                          | 423                             | 233                                  | 53                          | 612                             | 337                                  | 74                          |
| 211                                   | 116                                  | 44                          | 452                             | 249                                  | 54                          | <b>Steel HP 14 X 207</b>        |                                      |                             |
| 264                                   | 145                                  | 53                          | 458                             | 252                                  | 64                          | 152                             | 84                                   | 16                          |
| <b>Steel HP 8 X 120</b>               |                                      |                             | 505                             | 278                                  | 74                          | 210                             | 116                                  | 19                          |
| 175                                   | 96                                   | 39                          | <b>Steel HP 12 X 192</b>        |                                      |                             | 258                             | 142                                  | 21                          |
| 211                                   | 116                                  | 44                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 223</b>        |                                      |                             |
| 264                                   | 145                                  | 53                          | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| <b>Steel HP 8 X 126</b>               |                                      |                             | 278                             | 153                                  | 39                          | 204                             | 112                                  | 24                          |
| 175                                   | 96                                   | 39                          | 343                             | 189                                  | 44                          | 253                             | 139                                  | 29                          |
| 211                                   | 116                                  | 44                          | 423                             | 233                                  | 53                          | 336                             | 185                                  | 39                          |
| 264                                   | 145                                  | 53                          | 452                             | 249                                  | 54                          | 418                             | 230                                  | 44                          |
| <b>Steel HP 8 X 132</b>               |                                      |                             | 458                             | 252                                  | 64                          | 512                             | 282                                  | 53                          |
| 175                                   | 96                                   | 39                          | 505                             | 278                                  | 74                          | 543                             | 299                                  | 64                          |
| 211                                   | 116                                  | 44                          | <b>Steel HP 12 X 204</b>        |                                      |                             | 599                             | 329                                  | 74                          |
| 264                                   | 145                                  | 53                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 239</b>        |                                      |                             |
| <b>Steel HP 8 X 138</b>               |                                      |                             | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| 175                                   | 96                                   | 39                          | 278                             | 153                                  | 39                          | 204                             | 112                                  | 24                          |
| 211                                   | 116                                  | 44                          | 343                             | 189                                  | 44                          | 253                             | 139                                  | 29                          |
| 264                                   | 145                                  | 53                          | 423                             | 233                                  | 53                          | 336                             | 185                                  | 39                          |
| <b>Steel HP 8 X 144</b>               |                                      |                             | 452                             | 249                                  | 54                          | 418                             | 230                                  | 44                          |
| 175                                   | 96                                   | 39                          | 458                             | 252                                  | 64                          | 512                             | 282                                  | 53                          |
| 211                                   | 116                                  | 44                          | 505                             | 278                                  | 74                          | 543                             | 299                                  | 64                          |
| 264                                   | 145                                  | 53                          | <b>Steel HP 12 X 216</b>        |                                      |                             | 599                             | 329                                  | 74                          |
| <b>Steel HP 8 X 150</b>               |                                      |                             | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 255</b>        |                                      |                             |
| 175                                   | 96                                   | 39                          | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| 211                                   | 116                                  | 44                          | 278                             | 153                                  | 39                          | 204                             | 112                                  | 24                          |
| 264                                   | 145                                  | 53                          | 343                             | 189                                  | 44                          | 253                             | 139                                  | 29                          |
| <b>Steel HP 8 X 156</b>               |                                      |                             | 423                             | 233                                  | 53                          | 336                             | 185                                  | 39                          |
| 175                                   | 96                                   | 39                          | 452                             | 249                                  | 54                          | 418                             | 230                                  | 44                          |
| 211                                   | 116                                  | 44                          | 458                             | 252                                  | 64                          | 512                             | 282                                  | 53                          |
| 264                                   | 145                                  | 53                          | 505                             | 278                                  | 74                          | 543                             | 299                                  | 64                          |
| <b>Steel HP 8 X 162</b>               |                                      |                             | <b>Steel HP 12 X 228</b>        |                                      |                             | 599                             | 329                                  | 74                          |
| 175                                   | 96                                   | 39                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 271</b>        |                                      |                             |
| 211                                   | 116                                  | 44                          | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| 264                                   | 145                                  | 53                          | 278                             | 153                                  | 39                          | 204                             | 112                                  | 24                          |
| <b>Steel HP 8 X 168</b>               |                                      |                             | 343                             | 189                                  | 44                          | 253                             | 139                                  | 29                          |
| 175                                   | 96                                   | 39                          | 423                             | 233                                  | 53                          | 336                             | 185                                  | 39                          |
| 211                                   | 116                                  | 44                          | 452                             | 249                                  | 54                          | 418                             | 230                                  | 44                          |
| 264                                   | 145                                  | 53                          | 458                             | 252                                  | 64                          | 512                             | 282                                  | 53                          |
| <b>Steel HP 8 X 174</b>               |                                      |                             | 505                             | 278                                  | 74                          | 543                             | 299                                  | 64                          |
| 175                                   | 96                                   | 39                          | <b>Steel HP 12 X 240</b>        |                                      |                             | 599                             | 329                                  | 74                          |
| 211                                   | 116                                  | 44                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 287</b>        |                                      |                             |
| 264                                   | 145                                  | 53                          | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| <b>Steel HP 8 X 180</b>               |                                      |                             | 278                             | 153                                  | 39                          | 204                             | 112                                  | 24                          |
| 175                                   | 96                                   | 39                          | 343                             | 189                                  | 44                          | 253                             | 139                                  | 29                          |
| 211                                   | 116                                  | 44                          | 423                             | 233                                  | 53                          | 336                             | 185                                  | 39                          |
| 264                                   | 145                                  | 53                          | 452                             | 249                                  | 54                          | 418                             | 230                                  | 44                          |
| <b>Steel HP 8 X 186</b>               |                                      |                             | 458                             | 252                                  | 64                          | 512                             | 282                                  | 53                          |
| 175                                   | 96                                   | 39                          | 505                             | 278                                  | 74                          | 543                             | 299                                  | 64                          |
| 211                                   | 116                                  | 44                          | <b>Steel HP 12 X 252</b>        |                                      |                             | 599                             | 329                                  | 74                          |
| 264                                   | 145                                  | 53                          | 166                             | 91                                   | 24                          | <b>Steel HP 14 X 303</b>        |                                      |                             |
| <b>Steel HP 8 X 192</b>               |                                      |                             | 207                             | 114                                  | 29                          | 186                             | 103                                  | 21                          |
| 175                                   | 96                                   | 39                          | 278                             | 153                                  | 39                          | 204                             | 112                                  | 24                          |
| 211                                   | 116                                  | 44                          | 343                             | 189                                  | 44                          | 253                             | 139                                  | 29                          |
| 264                                   | 145                                  | 53                          | 423                             | 233                                  | 53                          | 336                             | 185                                  | 39                          |
| <b>Steel HP 8 X 198</b>               |                                      |                             | 452                             | 249                                  | 54                          | 418                             | 230                                  | 44                          |
| 175                                   | 96                                   | 39                          | 458                             | 252                                  | 64                          | 512                             | 282                                  | 53                          |
| 211                                   | 116                                  | 44                          | 505                             | 278                                  | 74                          | 543                             | 299                                  | 64                          |



# Pile Bearing vs. Estimated Length

Bearing Resistance (kips)

- NOMINAL REQ'D BEARING
- FACTORED RESISTANCE AVAILABLE
- ▲— Maximum Bearing For Metal Shell 14"Φ w/.312" walls Pile



SUBSTRUCTURE===== **NW Abutment**  
 REFERENCE BORING ===== **SB2**  
 LRFD or ASD or SEISMIC ===== **LRFD**  
 PILE CUTOFF ELEV. ===== **689.40** ft  
 GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = **677.40** ft  
 GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== **None**  
 BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ===== ft  
 TOP ELEV. OF LIQUEF. (so layers above apply DD) ===== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ===== **2352** kips  
 TOTAL LENGTH OF SUBSTRUCTURE (along skew)===== **68.00** ft  
 NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ===== **1**  
 Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 276.71 KIPS  
 Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 103.76 KIPS

**MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses**

| Maximum Nominal<br>Req'd Bearing of <u>Pile</u> | Maximum Nominal<br>Req'd Bearing of <u>Boring</u> | Maximum Factored<br>Resistance Available in <u>Boring</u> | Maximum Pile<br>Driveable Length in <u>Boring</u> |
|---|---|---|---|
| <b>570</b> KIPS                                 | <b>515</b> KIPS                                   | <b>284</b> KIPS   | <b>57</b> FT.                                     |

PILE TYPE AND SIZE ===== **Metal Shell 14"Φ w/.312" walls**  
 Pile Perimeter===== 3.665 FT.  
 Pile End Bearing Area===== 1.069 SQFT.

**Prebore to 10 ft.**

| BOT.<br>OF<br>LAYER<br>ELEV.<br>(FT.) | LAYER<br>THICK.<br>(FT.) | UNCONF.<br>COMPR.<br>STRENGTH<br>(TSF) | S.P.T.<br>N<br>VALUE<br>(BLOWS) | GRANULAR<br>OR ROCK LAYER<br>DESCRIPTION | NOMINAL                   |                               |                            | NOMINAL<br>REQ'D<br>BEARING<br>(KIPS) | FACTORED<br>GEOTECH.<br>LOSS FROM<br>SCOUR or DD<br>(KIPS) | FACTORED<br>GEOTECH.<br>LOSS LOAD<br>FROM DD<br>(KIPS) | FACTORED<br>RESISTANCE<br>AVAILABLE<br>(KIPS) | ESTIMATED<br>PILE<br>LENGTH<br>(FT.) |
|---------------------------------------|--------------------------|--|---------------------------------|--|---------------------------|-------------------------------|----------------------------|---------------------------------------|--|--|---|--------------------------------------|
|                                       |                          |  |                                 |  | SIDE<br>RESIST.<br>(KIPS) | END BRG.<br>RESIST.<br>(KIPS) | TOTAL<br>RESIST.<br>(KIPS) |                                       |  |  |   |                                      |
| 676.00                                | 1.40                     | 7.90                                   | 18                              |  | 16.7                      |                               | 49.5                       | 50                                    | 0  | 0  | 27  | 13                                   |
| 674.50                                | 1.50                     | 2.80                                   | 15                              |  | 12.5                      | 32.8                          | 42.1                       | 42                                    | 0  | 0  | 23  | 15                                   |
| 672.00                                | 2.50                     | 1.10                                   | 7                               |  | 11.0                      | 12.9                          | 76.2                       | 76                                    | 0  | 0  | 42  | 17                                   |
| 668.50                                | 3.50                     |  | 7                               | Clean Coarse Sand                        | 9.0                       | 35.9                          | 174.2                      | 174                                   | 0  | 0  | 96  | 21                                   |
| 666.00                                | 2.50                     |  | 19                              | Clean Coarse Sand                        | 17.5                      | 124.9                         | 194.7                      | 195                                   | 0  | 0  | 107   | 23                                   |
| 663.00                                | 3.00                     |  | 19                              | Clean Coarse Sand                        | 21.0                      | 127.9                         | 269.5                      | 270                                   | 0  | 0  | 148   | 26                                   |
| 656.00                                | 7.00                     |  | 27                              | Medium Sand                              | 64.5                      | 181.7                         | 448.4                      | 448                                   | 0  | 0  | 247   | 33                                   |
| 651.00                                | 5.00                     |  | 44                              | Medium Sand                              | 99.3                      | 296.1                         | 426.6                      | 427                                   | 0  | 0  | 235   | 38                                   |
| 648.00                                | 3.00                     |  | 26                              | Medium Sand                              | 26.4                      | 175.0                         | 321.4                      | 321                                   | 0  | 0  | 177   | 41                                   |
| 636.00                                | 12.00                    | 3.70                                   | 19                              |  | 123.0                     | 43.4                          | 467.8                      | 468                                   | 0  | 0  | 257   | 53                                   |
| 632.00                                | 4.00                     | 5.70                                   | 20                              |  | 47.7                      | 66.8                          | 515.5                      | 515                                   | 0  | 0  | 284   | 57                                   |
| 631.00                                | 1.00                     | 5.70                                   | 20                              |  | 11.9                      | 66.8                          | 632.2                      | 632                                   | 0  | 0  | 348   | 58                                   |
| 621.00                                | 10.00                    |  | 34                              | Hard Till                                | 69.2                      | 171.6                         | 1034.5                     | 4934                                  | 0  | 0  | 569   | 68                                   |
| 615.50                                | 5.50                     |  | 100                             | Hard Till                                |                           | 504.7                         |                            |                                       |  |  |   |                                      |

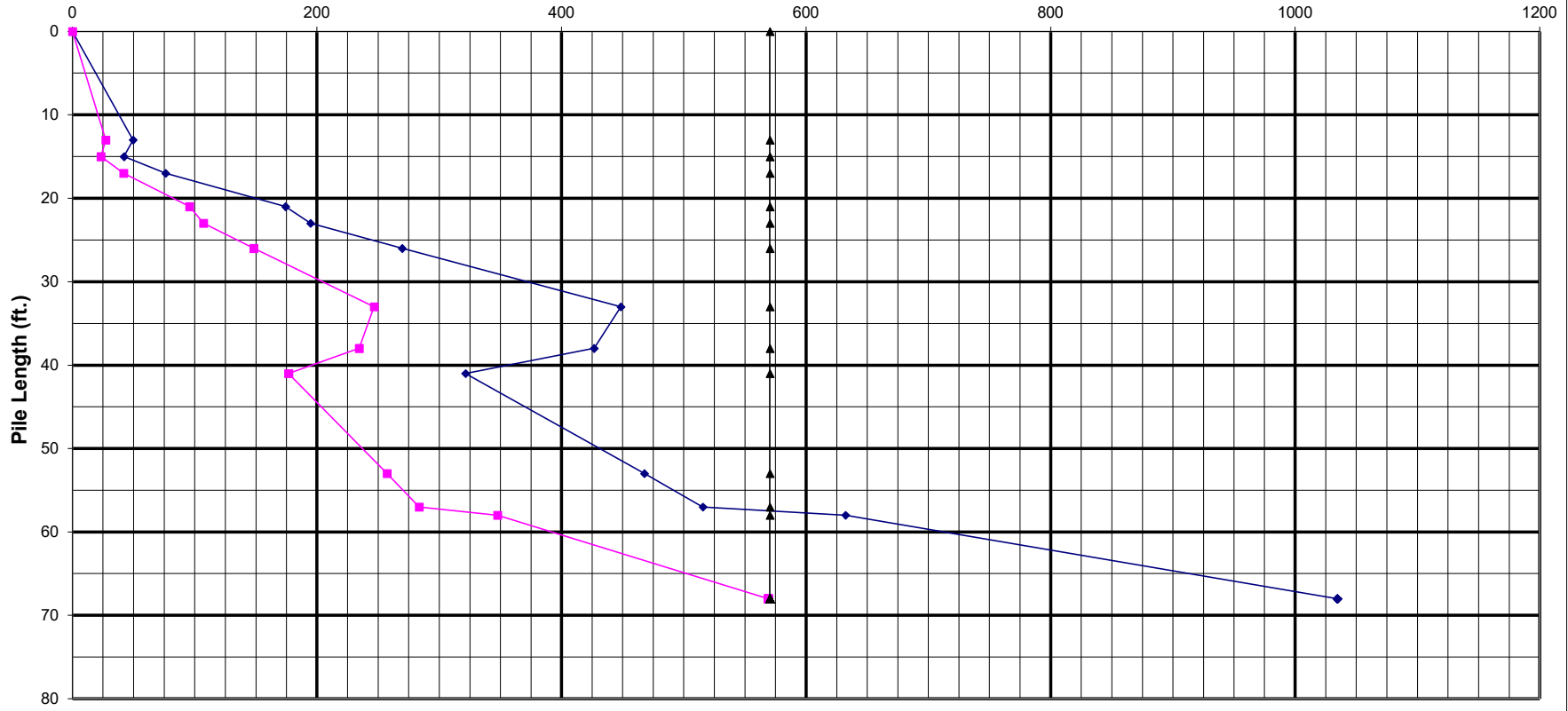
**Pile Design Table for NW Abutment utilizing Boring #SB2**

| Nominal Required Bearing (Kips)       | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) | Nominal Required Bearing (Kips) | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) | Nominal Required Bearing (Kips) | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) |
|---------------------------------------|--------------------------------------|-----------------------------|---------------------------------|--------------------------------------|-----------------------------|---------------------------------|--------------------------------------|-----------------------------|
| <b>Metal Shell 12"Φ w/.25" walls</b>  |                                      |                             | <b>Steel HP 10 X 42</b>         |                                      |                             | <b>Steel HP 12 X 84</b>         |                                      |                             |
| 151                                   | 83                                   | 23                          | 101                             | 55                                   | 41                          | 127                             | 70                                   | 41                          |
| 209                                   | 115                                  | 26                          | 191                             | 105                                  | 53                          | 253                             | 139                                  | 53                          |
| 270                                   | 149                                  | 41                          | 214                             | 118                                  | 58                          | 279                             | 153                                  | 58                          |
| <b>Metal Shell 14"Φ w/.25" walls</b>  |                                      |                             | 285                             | 157                                  | 68                          | 361                             | 199                                  | 68                          |
| 174                                   | 96                                   | 21                          | <b>Steel HP 10 X 57</b>         |                                      |                             | <b>Steel HP 14 X 73</b>         |                                      |                             |
| 195                                   | 107                                  | 23                          | 103                             | 57                                   | 41                          | 146                             | 80                                   | 41                          |
| 270                                   | 148                                  | 26                          | 195                             | 107                                  | 53                          | 300                             | 165                                  | 53                          |
| 321                                   | 177                                  | 41                          | 219                             | 120                                  | 58                          | 330                             | 182                                  | 58                          |
| <b>Metal Shell 14"Φ w/.312" walls</b> |                                      |                             | 292                             | 161                                  | 68                          | 414                             | 228                                  | 68                          |
| 174                                   | 96                                   | 21                          | <b>Steel HP 12 X 53</b>         |                                      |                             | <b>Steel HP 14 X 89</b>         |                                      |                             |
| 195                                   | 107                                  | 23                          | 121                             | 66                                   | 41                          | 149                             | 82                                   | 41                          |
| 270                                   | 148                                  | 26                          | 242                             | 133                                  | 53                          | 305                             | 168                                  | 53                          |
| 321                                   | 177                                  | 41                          | 267                             | 147                                  | 58                          | 335                             | 184                                  | 58                          |
| 468                                   | 257                                  | 53                          | 341                             | 188                                  | 68                          | 424                             | 233                                  | 68                          |
| 515                                   | 284                                  | 57                          | <b>Steel HP 12 X 63</b>         |                                      |                             | <b>Steel HP 14 X 102</b>        |                                      |                             |
| <b>Metal Shell 16"Φ w/.312" walls</b> |                                      |                             | 123                             | 68                                   | 41                          | 151                             | 83                                   | 41                          |
| 93                                    | 51                                   | 17                          | 245                             | 135                                  | 53                          | 308                             | 169                                  | 53                          |
| 219                                   | 121                                  | 21                          | 270                             | 149                                  | 58                          | 339                             | 187                                  | 58                          |
| 243                                   | 134                                  | 23                          | 350                             | 192                                  | 68                          | 430                             | 237                                  | 68                          |
| 338                                   | 186                                  | 26                          | <b>Steel HP 12 X 74</b>         |                                      |                             | <b>Steel HP 14 X 117</b>        |                                      |                             |
| 374                                   | 206                                  | 41                          | 125                             | 69                                   | 41                          | 154                             | 84                                   | 41                          |
| 546                                   | 300                                  | 53                          | 249                             | 137                                  | 53                          | 313                             | 172                                  | 53                          |
| 600                                   | 330                                  | 57                          | 274                             | 151                                  | 58                          | 344                             | 189                                  | 58                          |
| <b>Metal Shell 16"Φ w/.375" walls</b> |                                      |                             | 356                             | 196                                  | 68                          | 439                             | 241                                  | 68                          |
| 93                                    | 51                                   | 17                          | <b>Steel HP 8 X 36</b>          |                                      |                             | <b>Precast 14"x 14"</b>         |                                      |                             |
| 219                                   | 121                                  | 21                          | 168                             | 92                                   | 58                          | 97                              | 53                                   | 17                          |
| 243                                   | 134                                  | 23                          | 229                             | 126                                  | 68                          | 222                             | 122                                  | 21                          |
| 338                                   | 186                                  | 26                          |                                 |                                      |                             | 248                             | 136                                  | 23                          |
| 374                                   | 206                                  | 41                          |                                 |                                      |                             |                                 |                                      |                             |
| 546                                   | 300                                  | 53                          |                                 |                                      |                             |                                 |                                      |                             |
| 600                                   | 330                                  | 57                          |                                 |                                      |                             |                                 |                                      |                             |
| 750                                   | 413                                  | 58                          |                                 |                                      |                             |                                 |                                      |                             |

# Pile Bearing vs. Estimated Length

Bearing Resistance (kips)

- ◆ NOMINAL REQ'D BEARING
- FACTORED RESISTANCE AVAILABLE
- ▲ Maximum Bearing For Metal Shell 14"Φ w/.312" walls Pile



SUBSTRUCTURE===== Pier  
 REFERENCE BORING ===== SB3  
 LRFD or ASD or SEISMIC ===== LRFD  
 PILE CUTOFF ELEV. ===== 667.50 ft  
 GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 667.00 ft  
 GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ===== None  
 BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ===== ft  
 TOP ELEV. OF LIQUEF. (so layers above apply DD) ===== ft  
 TOTAL FACTORED SUBSTRUCTURE LOAD ===== 7022 kips  
 TOTAL LENGTH OF SUBSTRUCTURE (along skew)===== 56.50 ft  
 NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ===== 3  
 Approx. Factored Loading Applied per pile at 8 ft. Cts ===== 331.42 KIPS  
 Approx. Factored Loading Applied per pile at 3 ft. Cts ===== 124.28 KIPS

**MAX. REQUIRED BEARING & RESISTANCE for Selected Pile, Soil Profile, & Losses**

| Maximum Nominal<br>Req'd Bearing of <u>Pile</u> | Maximum Nominal<br>Req'd Bearing of <u>Boring</u> | Maximum Factored<br>Resistance Available in <u>Boring</u> | Maximum Pile<br>Driveable Length in <u>Boring</u> |
|---|---|---|---|
| <b>654 KIPS</b>                                 | <b>555 KIPS</b>                                   | <b>305 KIPS</b>   | <b>39 FT.</b>                                     |

PILE TYPE AND SIZE ===== Metal Shell 16"Φ w/.312" walls  
 Pile Perimeter===== 4.189 FT.  
 Pile End Bearing Area===== 1.396 SQFT.

| BOT.<br>OF<br>LAYER<br>ELEV.<br>(FT.) | LAYER<br>THICK.<br>(FT.) | UNCONF.<br>COMPR.<br>STRENGTH<br>(TSF) | S.P.T.<br>N<br>VALUE<br>(BLOWS) | GRANULAR<br>OR ROCK LAYER<br>DESCRIPTION | NOMINAL                   |                               |                            |  |  |  | NOMINAL<br>REQ'D<br>BEARING<br>(KIPS) | FACTORED<br>GEOTECH.<br>LOSS FROM<br>SCOUR or DD<br>(KIPS) | FACTORED<br>GEOTECH.<br>LOSS LOAD<br>FROM DD<br>(KIPS) | FACTORED<br>RESISTANCE<br>AVAILABLE<br>(KIPS) | ESTIMATED<br>PILE<br>LENGTH<br>(FT.) |
|---------------------------------------|--------------------------|--|---------------------------------|--|---------------------------|-------------------------------|----------------------------|--|--|--|---------------------------------------|--|--|---|--------------------------------------|
|                                       |                          |  |                                 |  | SIDE<br>RESIST.<br>(KIPS) | END BRG.<br>RESIST.<br>(KIPS) | TOTAL<br>RESIST.<br>(KIPS) |  |  |  |                                       |  |  |   |                                      |
| 665.00                                | 2.00                     |  | 6                               | Medium Sand                              | 4.6                       |                               | 18.2                       |  |  |  | 18                                    | 0  | 0  | 10  | 3                                    |
| 662.50                                | 2.50                     |  | 4                               | Medium Sand                              | 3.9                       | 13.6                          | 119.2                      |  |  |  | 119                                   | 0  | 0  | 66  | 5                                    |
| 660.00                                | 2.50                     |  | 21                              | Medium Sand                              | 20.2                      | 110.7                         | 350.8                      |  |  |  | 351                                   | 0  | 0  | 193   | 8                                    |
| 657.50                                | 2.50                     |  | 45                              | Fine Sand                                | 51.0                      | 322.1                         | 167.0                      |  |  |  | 167                                   | 0  | 0  | 92  | 10                                   |
| 655.00                                | 2.50                     | 5.70                                   | 27                              |  | 34.1                      | 87.3                          | 207.2                      |  |  |  | 207                                   | 0  | 0  | 114   | 13                                   |
| 652.50                                | 2.50                     | 6.10                                   | 17                              |  | 34.1                      | 93.4                          | 213.7                      |  |  |  | 214                                   | 0  | 0  | 118   | 15                                   |
| 650.00                                | 2.50                     | 4.30                                   | 26                              |  | 32.9                      | 65.9                          | 217.5                      |  |  |  | 217                                   | 0  | 0  | 120   | 18                                   |
| 647.50                                | 2.50                     | 2.40                                   | 17                              |  | 21.5                      | 36.8                          | 295.6                      |  |  |  | 296                                   | 0  | 0  | 163   | 20                                   |
| 645.00                                | 2.50                     | 6.10                                   | 23                              |  | 34.1                      | 93.4                          | 306.7                      |  |  |  | 307                                   | 0  | 0  | 169   | 23                                   |
| 642.50                                | 2.50                     | 4.60                                   | 18                              |  | 34.1                      | 70.4                          | 350.0                      |  |  |  | 350                                   | 0  | 0  | 193   | 25                                   |
| 637.50                                | 5.00                     | 5.20                                   | 17                              |  | 68.2                      | 79.6                          | 439.6                      |  |  |  | 440                                   | 0  | 0  | 242   | 30                                   |
| 632.50                                | 5.00                     | 6.60                                   | 30                              |  | 68.2                      | 101.1                         | 500.1                      |  |  |  | 500                                   | 0  | 0  | 275   | 35                                   |
| 628.50                                | 4.00                     | 6.10                                   | 27                              |  | 54.5                      | 93.4                          | 554.6                      |  |  |  | 555                                   | 0  | 0  | 305   | 39                                   |
| 627.50                                | 1.00                     | 6.10                                   | 27                              |  | 13.6                      | 93.4                          | 1142.8                     |  |  |  | 1143                                  | 0  | 0  | 629   | 40                                   |
| 622.50                                | 5.00                     |  | 76                              | Medium Sand                              | 295.9                     | 668.0                         | 1649.7                     |  |  |  | 1650                                  | 0  | 0  | 907   | 45                                   |
| 612.50                                | 10.00                    |  | 100                             | Fine Sand                                | 757.8                     | 878.9                         | 2047.1                     |  |  |  | 2047                                  | 0  | 0  | 1126  | 55                                   |
| 602.50                                | 10.00                    |  | 59                              | Medium Sand                              | 392.4                     | 518.6                         | 2298.8                     |  |  |  | 2299                                  | 0  | 0  | 1264  | 65                                   |
| 592.50                                | 10.00                    |  | 43                              | Medium Sand                              | 217.6                     | 377.9                         | 2454.9                     |  |  |  | 2455                                  | 0  | 0  | 1350  | 75                                   |
|                                       | 1.00                     |  | 36                              | Medium Sand                              |                           | 316.4                         |                            |  |  |  |                                       |  |  |   |                                      |

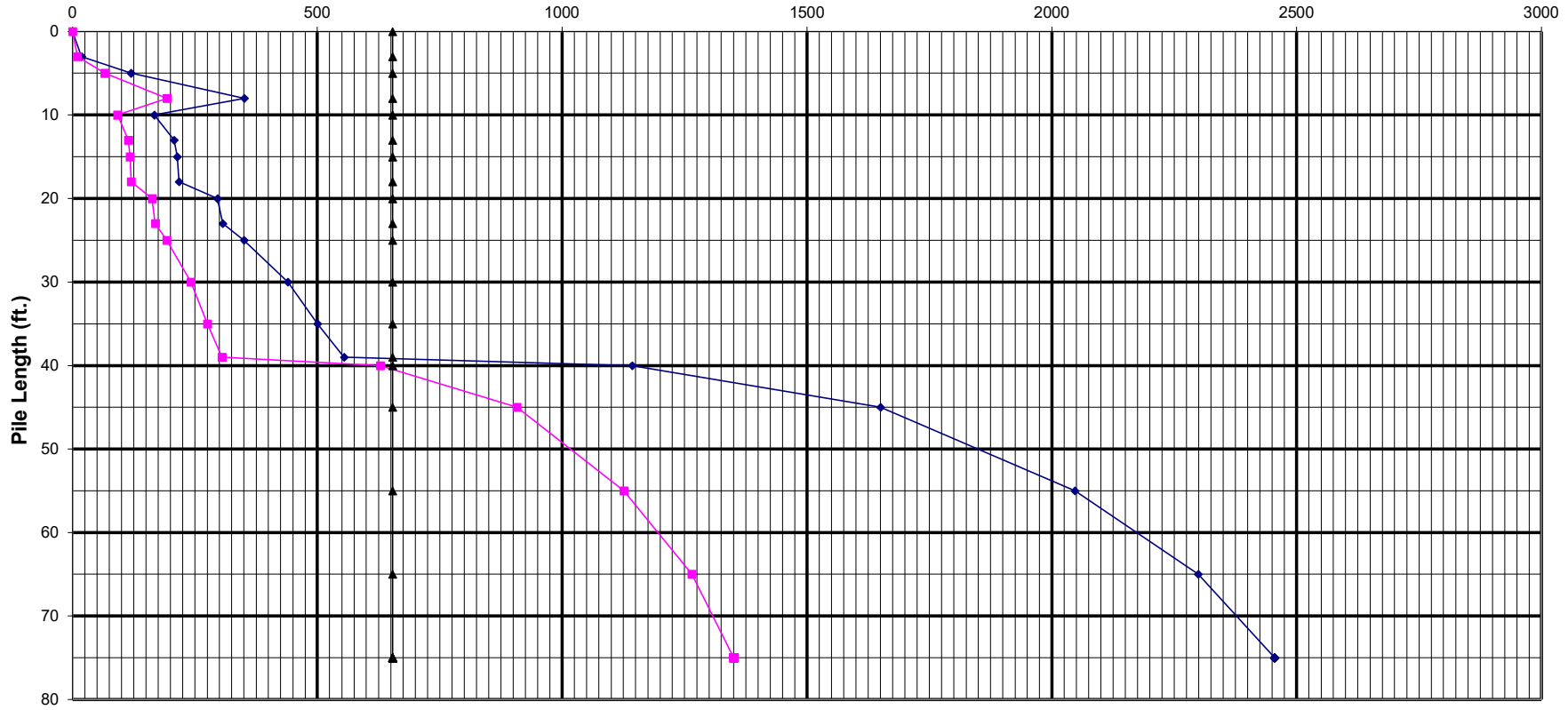
**Pile Design Table for Pier utilizing Boring #SB3**

| Nominal Required Bearing (Kips)       | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) | Nominal Required Bearing (Kips) | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) | Nominal Required Bearing (Kips) | Factored Resistance Available (Kips) | Estimated Pile Length (Ft.) |
|---------------------------------------|--------------------------------------|-----------------------------|---------------------------------|--------------------------------------|-----------------------------|---------------------------------|--------------------------------------|-----------------------------|
| <b>Metal Shell 12"Φ w/.25" walls</b>  |                                      |                             | <b>Steel HP 10 X 42</b>         |                                      |                             | <b>Steel HP 12 X 84</b>         |                                      |                             |
| 217                                   | 119                                  | 23                          | 206                             | 113                                  | 30                          | 208                             | 114                                  | 25                          |
| 248                                   | 136                                  | 25                          | 235                             | 129                                  | 35                          | 273                             | 150                                  | 30                          |
| 311                                   | 171                                  | 30                          | 263                             | 144                                  | 39                          | 310                             | 170                                  | 35                          |
| 358                                   | 197                                  | 35                          | 327                             | 180                                  | 40                          | 344                             | 189                                  | 39                          |
| <b>Metal Shell 14"Φ w/.25" walls</b>  |                                      |                             | <b>Steel HP 10 X 57</b>         |                                      |                             | <b>Steel HP 14 X 73</b>         |                                      |                             |
| 186                                   | 102                                  | 18                          | 211                             | 116                                  | 30                          | 413                             | 227                                  | 40                          |
| 248                                   | 137                                  | 20                          | 241                             | 133                                  | 35                          | 506                             | 278                                  | 45                          |
| 261                                   | 143                                  | 23                          | 269                             | 148                                  | 39                          | 621                             | 342                                  | 55                          |
| 298                                   | 164                                  | 25                          | 335                             | 184                                  | 40                          | 655                             | 360                                  | 65                          |
| 374                                   | 205                                  | 30                          | 410                             | 225                                  | 45                          | <b>Steel HP 14 X 89</b>         |                                      |                             |
| 427                                   | 235                                  | 35                          | <b>Steel HP 12 X 53</b>         |                                      |                             | 202                             | 111                                  | 23                          |
| <b>Metal Shell 14"Φ w/.312" walls</b> |                                      |                             | 198                             | 109                                  | 25                          | 240                             | 132                                  | 25                          |
| 186                                   | 102                                  | 18                          | 261                             | 143                                  | 30                          | 315                             | 173                                  | 30                          |
| 248                                   | 137                                  | 20                          | 297                             | 163                                  | 35                          | 370                             | 203                                  | 35                          |
| 261                                   | 143                                  | 23                          | 330                             | 181                                  | 39                          | 409                             | 225                                  | 39                          |
| 298                                   | 164                                  | 25                          | 392                             | 215                                  | 40                          | 475                             | 261                                  | 40                          |
| 374                                   | 205                                  | 30                          | <b>Steel HP 12 X 63</b>         |                                      |                             | <b>Steel HP 14 X 89</b>         |                                      |                             |
| 427                                   | 235                                  | 35                          | 203                             | 111                                  | 25                          | 206                             | 113                                  | 23                          |
| 475                                   | 261                                  | 39                          | 265                             | 146                                  | 30                          | 244                             | 134                                  | 25                          |
| <b>Metal Shell 16"Φ w/.312" walls</b> |                                      |                             | 300                             | 165                                  | 35                          | 321                             | 176                                  | 30                          |
| 217                                   | 120                                  | 18                          | 333                             | 183                                  | 39                          | 375                             | 206                                  | 35                          |
| 296                                   | 163                                  | 20                          | 401                             | 220                                  | 40                          | 415                             | 228                                  | 39                          |
| 307                                   | 169                                  | 23                          | 491                             | 270                                  | 45                          | 485                             | 267                                  | 40                          |
| 350                                   | 193                                  | 25                          | <b>Steel HP 12 X 74</b>         |                                      |                             | 594                             | 327                                  | 45                          |
| 440                                   | 242                                  | 30                          | 205                             | 113                                  | 25                          | <b>Steel HP 14 X 102</b>        |                                      |                             |
| 500                                   | 275                                  | 35                          | 269                             | 148                                  | 30                          | 209                             | 115                                  | 23                          |
| 555                                   | 305                                  | 39                          | 305                             | 168                                  | 35                          | 247                             | 136                                  | 25                          |
| <b>Metal Shell 16"Φ w/.375" walls</b> |                                      |                             | 339                             | 186                                  | 39                          | 324                             | 178                                  | 30                          |
| 217                                   | 120                                  | 18                          | 407                             | 224                                  | 40                          | 380                             | 209                                  | 35                          |
| 296                                   | 163                                  | 20                          | 499                             | 274                                  | 45                          | 415                             | 228                                  | 39                          |
| 307                                   | 169                                  | 23                          | <b>Steel HP 8 X 36</b>          |                                      |                             | 485                             | 267                                  | 40                          |
| 350                                   | 193                                  | 25                          | 206                             | 113                                  | 39                          | 594                             | 327                                  | 45                          |
| 440                                   | 242                                  | 30                          | 258                             | 142                                  | 40                          | <b>Steel HP 14 X 102</b>        |                                      |                             |
| 500                                   | 275                                  | 35                          |                                 |                                      |                             | 209                             | 115                                  | 23                          |
| 555                                   | 305                                  | 39                          |                                 |                                      |                             | 247                             | 136                                  | 25                          |
|                                       |                                      |                             |                                 |                                      |                             | 324                             | 178                                  | 30                          |
|                                       |                                      |                             |                                 |                                      |                             | 380                             | 209                                  | 35                          |
|                                       |                                      |                             |                                 |                                      |                             | 420                             | 231                                  | 39                          |
|                                       |                                      |                             |                                 |                                      |                             | 491                             | 270                                  | 40                          |
|                                       |                                      |                             |                                 |                                      |                             | 602                             | 331                                  | 45                          |
|                                       |                                      |                             |                                 |                                      |                             | 758                             | 417                                  | 55                          |
|                                       |                                      |                             |                                 |                                      |                             | 789                             | 434                                  | 65                          |
|                                       |                                      |                             |                                 |                                      |                             | <b>Steel HP 14 X 117</b>        |                                      |                             |
|                                       |                                      |                             |                                 |                                      |                             | 212                             | 117                                  | 23                          |
|                                       |                                      |                             |                                 |                                      |                             | 251                             | 138                                  | 25                          |
|                                       |                                      |                             |                                 |                                      |                             | 330                             | 181                                  | 30                          |
|                                       |                                      |                             |                                 |                                      |                             | 386                             | 212                                  | 35                          |
|                                       |                                      |                             |                                 |                                      |                             | 426                             | 234                                  | 39                          |
|                                       |                                      |                             |                                 |                                      |                             | 501                             | 275                                  | 40                          |
|                                       |                                      |                             |                                 |                                      |                             | 615                             | 338                                  | 45                          |
|                                       |                                      |                             |                                 |                                      |                             | 768                             | 422                                  | 55                          |
|                                       |                                      |                             |                                 |                                      |                             | 799                             | 440                                  | 65                          |
|                                       |                                      |                             |                                 |                                      |                             | 823                             | 453                                  | 75                          |
|                                       |                                      |                             |                                 |                                      |                             | <b>Precast 14"x 14"</b>         |                                      |                             |
|                                       |                                      |                             |                                 |                                      |                             | 117                             | 65                                   | 5                           |

# Pile Bearing vs. Estimated Length

Bearing Resistance (kips)

- NOMINAL REQ'D BEARING
- FACTORED RESISTANCE AVAILABLE
- ▲— Maximum Bearing For Metal Shell 16"Φ w/.312" walls Pile



SOIL PROPERTIES BELOW EXCAVATION LINE

STRUCTURE ===== SN 074-0089  
 SUBSTRUCTURE & REFERENCE BORING ===== SE Abutment Stage Construction Sheet Piling - Boring SB#1

| RETAINED HEIGHT (FT)     | LAYER THICKNESS (FT) | SPT N-VALUE (BPF) | UNCONFINED COMP. STRENGTH Qu (TSF) |
|--------------------------|----------------------|-------------------|------------------------------------|
| 7.5                      | 1.5                  |                   | 1.1                                |
| (ROUND TO NEAREST 0.25') | 2.5                  |                   | 1                                  |
|                          | 2.5                  |                   | 0.9                                |
|                          | 2.5                  |                   | 2                                  |
|                          | 2.5                  |                   | 2.2                                |
|                          | 2.5                  |                   | 4.2                                |
|                          | 2.5                  |                   | 2.6                                |

COHESIVE CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 5.63 FT  
 AND REQUIRES A SECTION MODULUS OF: 3.08 IN.<sup>3</sup>/FT

| DEPTH BELOW EXCAV. (FT) | SPLIT LAYER THICKNESS (FT) | SPLIT N AT DEPTH (BPF) | SPLIT Qu AT DEPTH (TSF) | AVG. N ABOVE DEPTH (BPF) | AVG. N IN UPPER 50% (BPF) | REQ'D CHART EMBED. DEPTH (FT) | AVG. N IN UPPER 33% (BPF) | REQ'D CHART W/ AMP. (IN. <sup>3</sup> /FT) | RATIO LOWER/UPPER 1/3 N | AVG. Qu ABOVE DEPTH (TSF) | AVG. Qu IN UPPER 50% (TSF) | REQ'D EMBED. DEPTH (FT) | AVG. Qu IN UPPER 33% (TSF) | REQ'D CHART W/ AMP. (IN. <sup>3</sup> /FT) | RATIO OF LOWER/UPPER 1/3 Qu |
|-------------------------|----------------------------|------------------------|-------------------------|--------------------------|---------------------------|-------------------------------|---------------------------|--|-------------------------|---------------------------|----------------------------|-------------------------|----------------------------|--|-----------------------------|
| 0.38                    | 0.375                      | 11                     | 1.1                     | 11.00                    |                           |                               |                           |  |                         | 1.10                      |                            |                         |                            |  |                             |
| 0.75                    | 0.375                      | 11                     | 1.1                     | 11.00                    |                           |                               |                           |  |                         | 1.10                      |                            |                         |                            |  |                             |
| 1.13                    | 0.375                      | 11                     | 1.1                     | 11.00                    | 11.00                     | 12-42                         | 11.00                     |  | 1.00                    | 1.10                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 1.50                    | 0.375                      | 11                     | 1.1                     | 11.00                    | 11.00                     | 12-42                         | 11.00                     |  | 1.00                    | 1.10                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 1.81                    | 0.3125                     | 10                     | 1                       | 10.83                    | 11.00                     | 12-42                         | 11.00                     |  | 1.00                    | 1.08                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 2.13                    | 0.3125                     | 10                     | 1                       | 10.71                    | 11.00                     | 12-48                         | 11.00                     |  | 1.00                    | 1.07                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 2.44                    | 0.3125                     | 10                     | 1                       | 10.62                    | 11.00                     | 12-23                         | 11.00                     |  | 1.00                    | 1.06                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 2.75                    | 0.3125                     | 10                     | 1                       | 10.55                    | 11.00                     | 12-26                         | 11.00                     |  | 1.00                    | 1.05                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 3.06                    | 0.3125                     | 10                     | 1                       | 10.49                    | 10.98                     | 12-29                         | 11.00                     |  | 1.00                    | 1.05                      | 1.10                       | 5-63                    | 1.10                       |  | 1.00                        |
| 3.38                    | 0.3125                     | 10                     | 1                       | 10.44                    | 10.89                     | 12-34                         | 11.00                     |  | 1.00                    | 1.04                      | 1.09                       | 5-63                    | 1.10                       |  | 1.00                        |
| 3.69                    | 0.3125                     | 10                     | 1                       | 10.41                    | 10.81                     | 12-33                         | 11.00                     |  | 1.00                    | 1.04                      | 1.08                       | 5-63                    | 1.10                       |  | 1.00                        |
| 4.00                    | 0.3125                     | 10                     | 1                       | 10.38                    | 10.75                     | 12-34                         | 11.00                     |  | 1.00                    | 1.04                      | 1.08                       | 5-63                    | 1.10                       |  | 1.00                        |
| 4.31                    | 0.3125                     | 9                      | 0.9                     | 10.28                    | 10.70                     | 12-35                         | 11.00                     |  | 1.00                    | 1.03                      | 1.07                       | 5-63                    | 1.10                       |  | 1.00                        |
| 4.63                    | 0.3125                     | 9                      | 0.9                     | 10.19                    | 10.65                     | 12-39                         | 10.97                     |  | 1.00                    | 1.02                      | 1.06                       | 5-63                    | 1.10                       |  | 1.00                        |
| 4.94                    | 0.3125                     | 9                      | 0.9                     | 10.11                    | 10.61                     | 12-42                         | 10.91                     |  | 0.98                    | 1.01                      | 1.06                       | 5-63                    | 1.09                       |  | 0.98                        |
| 5.25                    | 0.3125                     | 9                      | 0.9                     | 10.05                    | 10.57                     | 12-45                         | 10.86                     |  | 0.97                    | 1.00                      | 1.06                       | 5-63                    | 1.09                       |  | 0.97                        |
| 5.56                    | 0.3125                     | 9                      | 0.9                     | 9.99                     | 10.54                     | 12-47                         | 10.81                     |  | 0.97                    | 1.00                      | 1.05                       | 5-63                    | 1.08                       |  | 0.97                        |
| 5.88                    | 0.3125                     | 9                      | 0.9                     | 9.94                     | 10.51                     | 12-49                         | 10.77                     |  | 0.96                    | 0.99                      | 1.05                       | 5-63                    | 1.08                       | 3.08                                       | 0.96                        |
| 6.19                    | 0.3125                     | 9                      | 0.9                     | 9.89                     | 10.48                     | 12-52                         | 10.73                     |  | 0.95                    | 0.99                      | 1.05                       | 5-63                    | 1.07                       |  | 0.95                        |
| 6.50                    | 0.3125                     | 9                      | 0.9                     | 9.85                     | 10.46                     | 12-54                         | 10.69                     |  | 0.94                    | 0.98                      | 1.05                       | 5-63                    | 1.07                       |  | 0.94                        |
| 6.81                    | 0.3125                     | 20                     | 2                       | 10.31                    | 10.44                     | 12-55                         | 10.66                     |  | 0.94                    | 1.03                      | 1.04                       |                         | 1.07                       |  | 0.94                        |
| 7.13                    | 0.3125                     | 20                     | 2                       | 10.74                    | 10.42                     | 12-37                         | 10.63                     |  | 0.93                    | 1.07                      | 1.04                       |                         | 1.06                       |  | 0.93                        |
| 7.44                    | 0.3125                     | 20                     | 2                       | 11.13                    | 10.40                     | 12-33                         | 10.61                     |  | 0.93                    | 1.11                      | 1.04                       |                         | 1.06                       |  | 0.93                        |
| 7.75                    | 0.3125                     | 20                     | 2                       | 11.48                    | 10.39                     | 12-34                         | 10.58                     |  | 0.92                    | 1.15                      | 1.04                       |                         | 1.06                       |  | 0.92                        |
| 8.06                    | 0.3125                     | 20                     | 2                       | 11.81                    | 10.36                     | 12-35                         | 10.56                     |  | 0.92                    | 1.18                      | 1.04                       |                         | 1.06                       |  | 0.92                        |
| 8.38                    | 0.3125                     | 20                     | 2                       | 12.12                    | 10.31                     | 12-36                         | 10.54                     |  | 0.92                    | 1.21                      | 1.03                       |                         | 1.05                       |  | 0.92                        |
| 8.69                    | 0.3125                     | 20                     | 2                       | 12.40                    | 10.27                     | 12-37                         | 10.52                     |  | 0.91                    | 1.24                      | 1.03                       |                         | 1.05                       |  | 0.91                        |
| 9.00                    | 0.3125                     | 20                     | 2                       | 12.67                    | 10.22                     | 12-39                         | 10.50                     |  | 0.91                    | 1.27                      | 1.02                       |                         | 1.05                       |  | 0.91                        |
| 9.31                    | 0.3125                     | 22                     | 2.2                     | 12.98                    | 10.18                     | 12-41                         | 10.48                     |  | 0.91                    | 1.30                      | 1.02                       |                         | 1.05                       |  | 0.91                        |
| 9.63                    | 0.3125                     | 22                     | 2.2                     | 13.27                    | 10.14                     | 12-42                         | 10.47                     |  | 0.91                    | 1.33                      | 1.01                       |                         | 1.05                       |  | 0.91                        |
| 9.94                    | 0.3125                     | 22                     | 2.2                     | 13.55                    | 10.11                     | 12-44                         | 10.45                     |  | 0.92                    | 1.35                      | 1.01                       |                         | 1.05                       |  | 0.92                        |
| 10.25                   | 0.3125                     | 22                     | 2.2                     | 13.80                    | 10.07                     | 12-45                         | 10.44                     |  | 0.92                    | 1.38                      | 1.01                       |                         | 1.04                       |  | 0.92                        |
| 10.56                   | 0.3125                     | 22                     | 2.2                     | 14.05                    | 10.04                     | 12-46                         | 10.43                     |  | 0.92                    | 1.40                      | 1.00                       |                         | 1.04                       |  | 0.92                        |
| 10.88                   | 0.3125                     | 22                     | 2.2                     | 14.28                    | 10.01                     | 12-47                         | 10.41                     |  | 0.92                    | 1.43                      | 1.00                       |                         | 1.04                       |  | 0.92                        |
| 11.19                   | 0.3125                     | 22                     | 2.2                     | 14.49                    | 9.98                      | 12-48                         | 10.40                     |  | 0.93                    | 1.45                      | 1.00                       |                         | 1.04                       |  | 0.93                        |
| 11.50                   | 0.3125                     | 22                     | 2.2                     | 14.70                    | 9.96                      | 12-50                         | 10.39                     |  | 0.93                    | 1.47                      | 1.00                       |                         | 1.04                       |  | 0.93                        |
| 11.81                   | 0.3125                     | 42                     | 4.2                     | 15.42                    | 9.93                      | 12-54                         | 10.38                     |  | 0.93                    | 1.54                      | 0.99                       |                         | 1.04                       |  | 0.93                        |
| 12.13                   | 0.3125                     | 42                     | 4.2                     | 16.10                    | 9.91                      | 12-52                         | 10.36                     |  | 0.93                    | 1.61                      | 0.99                       |                         | 1.04                       |  | 0.93                        |
| 12.44                   | 0.3125                     | 42                     | 4.2                     | 16.75                    | 9.88                      | 12-53                         | 10.33                     |  | 0.93                    | 1.68                      | 0.99                       |                         | 1.03                       |  | 0.93                        |
| 12.75                   | 0.3125                     | 42                     | 4.2                     | 17.37                    | 9.86                      | 12-54                         | 10.29                     | 7.55                                       | 0.92                    | 1.74                      | 0.99                       |                         | 1.03                       |  | 0.92                        |
| 13.06                   | 0.3125                     | 42                     | 4.2                     | 17.96                    | 9.89                      |                               | 10.26                     |  | 0.92                    | 1.80                      | 0.99                       |                         | 1.03                       |  | 0.92                        |
| 13.38                   | 0.3125                     | 42                     | 4.2                     | 18.52                    | 10.13                     |                               | 10.23                     |  | 0.92                    | 1.85                      | 1.01                       |                         | 1.02                       |  | 0.92                        |
| 13.69                   | 0.3125                     | 42                     | 4.2                     | 19.06                    | 10.36                     |                               | 10.21                     |  | 0.92                    | 1.91                      | 1.04                       |                         | 1.02                       |  | 0.92                        |
| 14.00                   | 0.3125                     | 42                     | 4.2                     | 19.57                    | 10.57                     |                               | 10.18                     |  | 0.91                    | 1.96                      | 1.06                       |                         | 1.02                       |  | 0.91                        |
| 14.31                   | 0.3125                     | 26                     | 2.6                     | 19.71                    | 10.78                     |                               | 10.15                     |  | 0.91                    | 1.97                      | 1.08                       |                         | 1.02                       |  | 0.91                        |
| 14.63                   | 0.3125                     | 26                     | 2.6                     | 19.85                    | 10.97                     |                               | 10.13                     |  | 0.91                    | 1.98                      | 1.10                       |                         | 1.01                       |  | 0.91                        |
| 14.94                   | 0.3125                     | 26                     | 2.6                     | 19.97                    | 11.16                     |                               | 10.10                     |  | 0.91                    | 2.00                      | 1.12                       |                         | 1.01                       |  | 0.91                        |
| 15.25                   | 0.3125                     | 26                     | 2.6                     | 20.10                    | 11.34                     |                               | 10.08                     |  | 0.90                    | 2.01                      | 1.13                       |                         | 1.01                       |  | 0.90                        |
| 15.56                   | 0.3125                     | 26                     | 2.6                     | 20.22                    | 11.52                     |                               | 10.06                     |  | 0.90                    | 2.02                      | 1.15                       |                         | 1.01                       |  | 0.90                        |
| 15.88                   | 0.3125                     | 26                     | 2.6                     | 20.33                    | 11.69                     |                               | 10.04                     |  | 0.90                    | 2.03                      | 1.17                       |                         | 1.00                       |  | 0.90                        |
| 16.19                   | 0.3125                     | 26                     | 2.6                     | 20.44                    | 11.85                     |                               | 10.02                     |  | 0.90                    | 2.04                      | 1.18                       |                         | 1.00                       |  | 0.90                        |
| 16.50                   | 0.3125                     | 26                     | 2.6                     | 20.55                    | 12.00                     |                               | 10.00                     |  | 0.90                    | 2.05                      | 1.20                       |                         | 1.00                       |  | 0.90                        |



SOIL PROPERTIES BELOW EXCAVATION LINE

| RETAINED HEIGHT (FT)     | LAYER THICKNESS (FT) | SPT N-VALUE (BPF) | UNCONFINED COMP. STRENGTH Qu (TSF) |
|--------------------------|----------------------|-------------------|------------------------------------|
| 7.5                      | 4                    |                   | 3.1                                |
| (ROUND TO NEAREST 0.25') | 2.5                  |                   | 4.4                                |
|                          | 2.5                  |                   | 1.9                                |

STRUCTURE ===== SN 074-0089  
 SUBSTRUCTURE & REFERENCE BORING ===== NW Abutment Stage Construction Sheet Piling - Boring SB#2

COHESIVE CHARTS CONTROL USING AN EMBEDMENT DEPTH OF: 5.63 FT  
 AND REQUIRES A SECTION MODULUS OF: 2.65 IN.<sup>3</sup>/FT

| DEPTH BELOW EXCAV. (FT) | SPLIT LAYER THICKNESS (FT) | SPLIT N AT DEPTH (BPF) | SPLIT Qu AT DEPTH (TSF) | AVG. N ABOVE DEPTH (BPF) | AVG. N IN UPPER 50% (BPF) | REQ'D CHART EMBED. DEPTH (FT) | AVG. N IN UPPER 33% (BPF) | REQ'D CHART SECT. MOD. W/ AMP. (IN. <sup>3</sup> /FT) | RATIO LOWER/UPPER 1/3 N | AVG. Qu ABOVE DEPTH (TSF) | AVG. Qu IN UPPER 50% (TSF) | REQ'D CHART EMBED. DEPTH (FT) | AVG. Qu IN UPPER 33% (TSF) | REQ'D CHART SECT. MOD. W/ AMP. (IN. <sup>3</sup> /FT) | RATIO OF LOWER/UPPER 1/3 Qu |
|-------------------------|----------------------------|------------------------|-------------------------|--------------------------|---------------------------|-------------------------------|---------------------------|---|-------------------------|---------------------------|----------------------------|-------------------------------|----------------------------|---|-----------------------------|
| 1.00                    | 1                          | 31                     | 3.1                     | 31.00                    |                           |                               |                           |   |                         | 3.10                      |                            |                               |                            |   |                             |
| 2.00                    | 1                          | 31                     | 3.1                     | 31.00                    |                           |                               |                           |   |                         | 3.10                      |                            |                               |                            |   |                             |
| 3.00                    | 1                          | 31                     | 3.1                     | 31.00                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.10                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 4.00                    | 1                          | 31                     | 3.1                     | 31.00                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.10                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 4.31                    | 0.3125                     | 44                     | 4.4                     | 31.94                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.19                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 4.63                    | 0.3125                     | 44                     | 4.4                     | 32.76                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.28                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 4.94                    | 0.3125                     | 44                     | 4.4                     | 33.47                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.35                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 5.25                    | 0.3125                     | 44                     | 4.4                     | 34.10                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.41                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 5.56                    | 0.3125                     | 44                     | 4.4                     | 34.65                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.47                      | 3.10                       | 5.63                          | 3.10                       |   | 1.00                        |
| 5.88                    | 0.3125                     | 44                     | 4.4                     | 35.15                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.51                      | 3.10                       | 5.63                          | 3.10                       | 2.65  | 1.00                        |
| 6.19                    | 0.3125                     | 44                     | 4.4                     | 35.60                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.56                      | 3.10                       |                               | 3.10                       |   | 1.00                        |
| 6.50                    | 0.3125                     | 44                     | 4.4                     | 36.00                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.60                      | 3.10                       |                               | 3.10                       |   | 1.00                        |
| 6.81                    | 0.3125                     | 19                     | 1.9                     | 35.22                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.52                      | 3.10                       |                               | 3.10                       |   | 1.00                        |
| 7.13                    | 0.3125                     | 19                     | 1.9                     | 34.51                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.45                      | 3.10                       |                               | 3.10                       |   | 1.00                        |
| 7.44                    | 0.3125                     | 19                     | 1.9                     | 33.86                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.39                      | 3.10                       |                               | 3.10                       |   | 1.00                        |
| 7.75                    | 0.3125                     | 19                     | 1.9                     | 33.26                    | 31.00                     | 9.38                          | 31.00                     |   | 1.00                    | 3.33                      | 3.10                       |                               | 3.10                       |   | 1.00                        |
| 8.06                    | 0.3125                     | 19                     | 1.9                     | 32.71                    | 31.10                     | 9.38                          | 31.00                     |   | 1.00                    | 3.27                      | 3.11                       |                               | 3.10                       |   | 1.00                        |
| 8.38                    | 0.3125                     | 19                     | 1.9                     | 32.19                    | 31.58                     | 9.38                          | 31.00                     |   | 1.00                    | 3.22                      | 3.16                       |                               | 3.10                       |   | 1.00                        |
| 8.69                    | 0.3125                     | 19                     | 1.9                     | 31.72                    | 32.03                     | 9.38                          | 31.00                     |   | 1.00                    | 3.17                      | 3.20                       |                               | 3.10                       |   | 1.00                        |
| 9.00                    | 0.3125                     | 19                     | 1.9                     | 31.28                    | 32.44                     | 9.38                          | 31.00                     |   | 1.00                    | 3.13                      | 3.24                       |                               | 3.10                       |   | 1.00                        |

## SOIL PARAMETER AND L-PILE LATERAL PARAMETER RECOMMENDATIONS

The following soil parameters (L-Pile included), are based on the soils encountered from the locations of the structure borings. The following recommended estimated soil parameter values may be used:

### Averaged Lateral Parameter Soil Recommendations Summary – Boring SB-1 – Near South Abutment

| ± Elev.  | ± Depth from Pile Cap | Cohesion C (psf) | ∅ | Static Soil Modulus, k (pci) | Soil Strain E <sub>50</sub> | Total Unit Wt. (PCF) | Soil Type |
|----------|-----------------------|------------------|---|------------------------------|-----------------------------|----------------------|-----------|
| 687½-681 | 0-6½                  | 1,000            | - | 100                          | 0.01                        | 120                  | CL        |
| 681-676  | 6½-11½                | 2,000            | - | 500                          | 0.007                       | 120                  | CL        |
| 676-666  | 11½-21½               | 4,000            | - | 1,000                        | 0.005                       | 130                  | CL        |
| 666-656  | 21½-31½               | 3,500            | - | 1,000                        | 0.005                       | 135                  | CL        |
| 656-626  | 31½-61½               | 5,000            | - | 2,000                        | 0.004                       | 135                  | CL        |
| 626-615  | 61½-72½               | 2000             | - | 1,000                        | 0.005                       | 130                  | CL        |

### Averaged Lateral Parameter Soil Recommendations Summary - Boring SB-2 – Near North Abutment

| ± Elev.   | ± Depth from Pile Cap | Cohesion C (psf) | ∅  | Static Soil Modulus, k (pci) | Soil Strain E <sub>50</sub> | Total Unit Wt. (PCF) | Soil Type    |
|-----------|-----------------------|------------------|----|------------------------------|-----------------------------|----------------------|--------------|
| 687½-677½ | 0-10                  | 1,000            | -  | 100                          | 0.01                        | 115                  | Bentonite/CL |
| 677½-674½ | 10-13                 | 3,000            | -  | 1,000                        | 0.005                       | 130                  | CL           |
| 674½-672  | 13-15½                | -                | 26 | 25                           | -                           | 118                  | ML           |
| 672-669   | 15½-18½               | -                | 32 | 25                           | -                           | 120                  | SW           |
| 669-663   | 18½-24½               | -                | 35 | 90                           | -                           | 125                  | SW           |
| 663-648   | 24½-39½               | -                | 37 | 125                          | -                           | 130                  | SW           |
| 648-630½  | 39½-57                | 4,500            | -  | 2,000                        | 0.004                       | 130                  | CL           |
| 630½-615  | 57-72½                | 3,500            | -  | 1,000                        | 0.005                       | 130                  | CL           |

### Averaged Lateral Parameter Soil Recommendations Summary - Boring SB-3 – Near Pier

| ± Elev.   | ± Depth from Pile Cap | Cohesion C (psf) | ∅  | Static Soil Modulus, k (pci) | Soil Strain E <sub>50</sub> | Total Unit Wt. (PCF) | Soil Type |
|-----------|-----------------------|------------------|----|------------------------------|-----------------------------|----------------------|-----------|
| 667-663   | 0-4                   | -                | 30 | 20                           | -                           | 120                  | SW        |
| 663-658½  | 4-8½                  | -                | 35 | 125                          | -                           | 125                  | SP        |
| 658½-627½ | 8½-39½                | 5,000            | -  | 2,000                        | 0.004                       | 135                  | CL        |
| 627½-606½ | 39½-60½               | -                | 40 | 125                          | -                           | 135                  | SP        |
| 606½-591½ | 60½-75½               | -                | 39 | 125                          | -                           | 130                  | SW        |