S-203-2007
(Consultant)

MEMORANDUM

TO: Allan Frank, P.E.
Division of Structural Design

FROM: William Broyles, P.E.
Geotechnical Branch Manager

BY: Bart Asher, P.E., P.L.S.
Geotechnical Branch

DATE: March 30, 2007

SUBJECT: **Jefferson County**
1200 056
Mars # 6554101D
Ramp 21 I-64 EB to I-65 SB
(S0160, Bridge B64-2)
Ohio River Bridges Project
Kennedy Interchange Reconstruction – Section 1
Item No. 5-118.18 & .19

The geotechnical engineering report for this structure has been completed by Barr & Prevost, Inc. We have reviewed and concur with the recommendations as presented in this report.

A copy of the report is attached. If you have any questions, please contact this office at 502-564-2374.

Attachment:

cc: J. Callihan
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A. Calvin
B. Greene
B. Bryant

Glen Kelly	(KTA-QK4)	(w/o attachment)
Stuart Edwards	(Barr & Prevost)	(w/o attachment)
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FINAL REPORT
GEOTECHNICAL INVESTIGATION
KENNEDY INTERCHANGE RECONSTRUCTION
SECTION 1 –
RAMP 21 I-64 EB to I-65 SB
(S0160, BRIDGE B64-2)
JEFFERSON COUNTY, KENTUCKY

For:

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Submitted by:

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March 8, 2007

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(S0160, BRIDGE B64-2)
JEFFERSON COUNTY, KENTUCKY
FOR
KENTUCKY TRANSPORTATION ASSOCIATES

1. LOCATION AND DESCRIPTION

This report presents the results of our geotechnical investigation for part of the proposed new bridge system carrying traffic from Eastbound (EB) I-64 to Southbound (SB) I-65 north of downtown Louisville, Kentucky. This structure is part of the Kennedy Interchange Reconstruction, in turn a component of the Louisville-Southern Indiana Ohio River Bridges Project. The bridge begins on I-64 at the joint east of the 2nd Street Bridge (Clark Memorial Bridge) and ends at the beginning of B64-4A (structure S0165). A Site Location Map is presented as Exhibit 1.

Working documents and drawings germane to the Kennedy Interchange Reconstruction are stored on ProjectWise, an internet-based data management system, utilized by Kentucky Transportation Associates' (KTA) team members and subcontractors. Subsequent reference to this system will take the form "ProjectWise 061014" referencing a document available on October 14, 2006. The bridge is being designed using the Load and Resistance Factor Design (LRFD) method as set forth in the American Association of State Highway and Transportation Officials (AASHTO) Publication "LRFD Bridge Design Specifications 4th Edition, 2007". Where this document is referenced subsequently, the term ?LRFD BDS' will be used.

According to the structural plans prepared by WMB, (ProjectWise 061129), the five-span bridge has a total length of 831.41 feet. The bridge section consists of a 6'-0" to 9'-8" inside shoulder, 15'-0" lane width and an 8'0" outside shoulder. Two superstructure options are being considered, a preferred – steel, and an alternate – concrete section. Foundation requirements are similar for both options. The bridge links two elevated sections of the interchange and is supported on piers; no abutments are present.

The proposed start/finish substructure centerlines are shown in Table 1. The bridge plan is presented in Exhibit 2.

Table 1: Proposed Substructures Stationing[1]

Structure	Substructure	Centerline Station
B64-2	Pier 1	216+71.50
B64-2	Pier 2	218+17.00
B64-2	Pier 3	219+62.50
B64-2	Pier 4	221+48.50
B64-2	Pier 5	223+22.25
B64-2	Pier 6	225+02.92

(1) Preferred Layout, ProjectWise 061129.

The purpose of this investigation is to characterize the subsurface conditions of the site, perform geotechnical engineering analyses, and provide recommendations for the design and construction of the foundations of the bridge piers.

2. SITE TOPOGRAPHY AND GEOLOGIC CONDITIONS

2.1 General

The project area is north of the Louisville central business district in Jefferson County, Kentucky. The interchange system will be constructed in close proximity to the Ohio River, and generally within its left bank flood plain. Sub-surface conditions are, therefore, dominated by the morphology of the river valley and more recent depositional history.

In the Louisville area, the Ohio River flows through a broad, relatively flat valley, carved into bedrock during postglacial periods. Bedrock typically consists of Devonian and Silurian-age limestone, dolomite and shale; the valley sides southeast of the site area are composed of Sellersburg and Jeffersonville limestone. This unit is typically 10 – 50 feet in thickness and underlain by dolomite up to 75 feet thick. The dolomite is, in turn, underlain by the Louisville limestone, 30 – 95 feet in thickness. The elevation of bedrock in the floor of the buried valley is recorded as being between 334 feet and 337 feet at more than a dozen well sites in the 2-mile stretch of the aquifer upstream from the current I-71 / I-64 interchange (Unthank & Nelson, 2006). It is likely that the valley floor continues downstream, with some variation, at about that elevation into the area covered by this investigation.

Bedrock is masked in the broad flood plain by Quaternary sediments that are frequently in excess of 100 feet thick. These consist of glacial outwash and river alluvium. Locally, man-made fill is present. The alluvium is generally less than 35 feet in thickness and may consist of clay, sand or gravel. Outwash deposits typically comprise sand and gravel, coarsening with depth and generally extending to bedrock. A geologic map is presented as Exhibit 3.

The subsurface investigation results are consistent with this geologic setting. The typical observed

stratigraphy consists of man-made fill (~10 feet) overlying alluvial clay (~20 feet) followed by outwash deposits (sand and gravel mixtures) to the total depth explored (80 – 116 feet).

Groundwater conditions in the flood plain are influenced heavily by the stage of the Ohio River. In the extreme, flood levels up to elevation 450 feet (100-year flood) may be experienced, but lesser floods can be expected annually that are capable of inundating the project area. The river stage is regulated and for much of the year the normal stage for McAlpine Upper Pool is elevation 420 feet. Groundwater levels near the river may be expected at a similar or slightly higher elevation.

2.2 Seismicity

The seismic acceleration coefficient (A) for the site is derived from contour maps prepared by the U.S. Geological Survey (USGS) (LRFD BDS Figures 3.10.2-1-3) for the design earthquake. The Louisville area coefficient is 6 percent (%) [corresponding to an acceleration of 0.06 times gravitational acceleration]. This places the structure in Seismic Zone 1 ($A \leq 0.09$). There is a 90% probability that this acceleration will not be exceeded during a 50-year period. The return frequency for such an event is about 475 years.

Design specifications for seismic design are currently under review at AASHTO and are expected to undergo major changes, perhaps as soon as 2007 (Imbsen, 2006). The Designer should be aware of the status of these changes as the design moves forward and request ongoing assistance from a geotechnical engineer, as appropriate.

3. FIELD INVESTIGATION PROGRAM

Drilling and sampling were performed by Fuller, Mossbarger, Scott and May Engineers, Inc. (FMSM) of Lexington, Kentucky between May 22 and 31, 2006. The subsurface exploration consisted of four structure borings, designated as Borings 4B-247, 4B-248, 4B-249, and 4B-250. Boring 4W-270 was drilled for an adjacent structure and serves to increase the level of detail for both. Boring 4B-247 was drilled to refusal at a depth of 93.6 feet below ground surface (bgs). Borings 4B-248 and 249 were drilled to a depth of 80 feet, while Boring 4B-250 was terminated at a depth of 116.5 feet bgs. Boring 4W-270 was drilled to a depth of 80 feet. The borings were marked in the field by a Qk4 survey crew in accordance with an approved plan.

As-drilled boring locations are shown on Exhibit 2, and summaries of the drilling information are presented in Table 2. The Coordinate Data Submission Form, provided by the Kentucky Transportation Cabinet (KYTC) Geotechnical Branch, is completed and included in Appendix A. The logs of three borings drilled in 1962 for construction of the original interchange (Holes #D, #E, #EE) were consulted for general stratigraphic correlation.

Table 2: Boring Summary for the Recommended Structure

Sub-Structure	Boring Number	Boring Location[(1)] (Station, Offset)	Surface Elevation (NGDV-Feet)	Bottom of Hole Elevation (Feet)
Pier 1	4B-247	333+36, 99 RT	439.06	345.46
Pier 2	4W-270	335+17, 133 RT	445.05	365.05
Pier 3	4B-248	336+93, 136 RT	443.69	363.69
Piers 4 and 5	4B-249	338+75, 136 RT	440.58	360.58
Pier 6	4B-250	341+95, 101 RT	444.07	327.57

(1) Feet along I-64 Centerline.

The borings were drilled by FMSM using either an all-terrain-vehicle-mounted drill rig, Model CME 55, or a truck-mounted CME 85 equipped with 3.25-inch hollow stem augers. The first 6.5 feet of Boring 4W-270 was drilled by vacuum extraction to address concern for sensitive utilities in the area. Water was used to reduce the amount of "blow-back" of the granular materials once the borings advanced below the surficial clay.

Soil sampling was performed using an auto hammer according to the AASHTO T-206 "Standard Method for Penetration Test and Split Barrel Sampling of Soils." FMSM indicated that the auto hammer efficiency of this hammer system is 80 percent. Undisturbed samples were obtained from the cohesive soil layers according to AASHTO T-207 "Standard Method for Thin-Walled Tube Sampling of Soils." The soil samples were obtained at 5-foot intervals starting 2 feet below the existing ground surface. Upon completion, borings were backfilled with soil cuttings. Boring 4B-247 is located on a roadway shoulder, and the surface was patched with asphalt.

An engineer monitored the drilling activities and maintained field boring logs. The field logs included results of Standard Penetration Tests (SPT) recorded as blows per 6 inches. These data were used to determine the values shown on the Subsurface Data Sheet (Exhibit 4) as N values representing blows per 12 inches. In the field, the soils were classified according to American Society for Testing and Materials (ASTM) D-2488 "Description and Identification of Soils: Visual – Manual Procedure".

All split-spoon samples collected in the field were placed in sealed, glass jars and transported to Wang Engineering Inc. (WEI's) geotechnical laboratory in Lombard, Illinois. All field visual classifications were reviewed in the laboratory.

4.0 LABORATORY TESTING AND RESULTS

Selected soil specimens recovered from split-spoon and Shelby tube samples were tested for natural moisture content, particle size distribution, Atterberg limits, and unconfined compressive strength after the KYTC approved the laboratory test requests. One-dimensional consolidation, and consolidated-undrained triaxial resistance were measured using some of the Boring 4B-248 samples primarily to support analysis of the abutment at adjacent bridge S0180 (B3RD-1). However, they provide useful

information concerning the over consolidation ratio of the clay, and effective stress parameters for the cohesive soils. The laboratory tests were performed according to applicable AASHTO or Kentucky Methods.

The test results are shown on the Subsurface Data Sheet (Exhibit 4), and the results of consolidation and triaxial tests are presented in Appendix B. Soils were classified using indices based on ASTM D-2487 "Classification of Soils for Engineering Purposes (Unified Soil Classification System)" and AASHTO M-145 "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes." The test results were used to establish material properties, and in subsequent engineering analyses to evaluate foundation alternatives and each one's respective installation.

4.1 Undisturbed (Shelby) Tube Samples

Undisturbed (Shelby) tube samples of the clay layers were obtained from all borings. The samples were extruded from the tubes, visually described, and trimmed into 6-inch specimens. Unit weight (dry and moist) and natural moisture contents were determined for each specimen. Selected specimens were subjected to engineering classification, unconfined compressive strength, one-dimensional consolidation and consolidated-undrained triaxial tests.

4.1.1 Engineering Classification Testing

Classification testing was performed on selected Shelby tube samples. In most cases, one soil classification test was completed per Shelby tube. Soils from the Shelby tube samples were classified mostly as clay (CL), according to the Unified Soil Classification System, and as A-6(15) and A-6(16), based on the AASHTO classification system.

4.1.2 Unconfined Compressive Strength Tests

The results of unconfined compressive strength tests are presented on the Subsurface Data Sheet (Exhibit 4) and are summarized in Table 3.

Table 3: Unconfined Compressive Strength Test Results

Boring Number	Location	Sample Interval Depth (ft)	Dry Unit Weight (pcf)	Moist Unit Weight (pcf)	Moisture Content (%)	Unconfined Compressive Strength (tsf)
4B-247	333+36, 99 RT	15 – 17	95.88	123.3	28.6	0.61
		20 – 22	105.73	129.64	22.61	0.44
		25 – 27	100.59	126.52	25.78	0.32
4B-248	336+93, 136 RT	30 – 32	104.46	128.91	23.41	0.76
4B-249	338+75, 136 RT	20 – 22	103.05	126.64	22.89	1.29
		25 – 27	97.74	121.49	24.29	0.23
4B-250	341+95, 101 RT	15 – 17	96.82	123.92	27.99	0.81
		20 – 22	98.89	125.53	26.94	0.65
		25 – 27	101.49	125.53	23.69	1.84
		30 – 32	127.26	102.10	24.65	0.52

The undrained shear strength (commonly referred as “undrained cohesion”) is one-half of the unconfined compressive strength.

4.1.3 One-Dimensional Consolidation Tests

Two one-dimensional consolidation tests were performed on clay samples from 20 and 30 feet bgs. The results are summarized in Table 4, as follows:

Table 4: One-Dimensional Consolidation Test Results

Boring/Sample Number	Depth (bgs) (ft)	C_c[(1)]	OCR[(2)]	C_V[(3)] (ft^2/day)
4B-248 #4	20-22	0.189	1.0	0.15
4W-270 #7	30-32	0.298	1.0	0.10

(1) C_c-field corrected compression index
(2) OCR-overconsolidation ratio
(3) C_V-consolidation coefficient

Laboratory data are provided in Appendix B.

4.1.4 CU Triaxial Test

A consolidated-undrained triaxial test was performed on a sample of clay from Boring 4B-248 at 20-27

feet bgs. Results may be summarized as:

Effective cohesion	0.0 pounds per square foot (psf)
Effective friction angle	32.1 degrees

Laboratory data are provided in Appendix B.

4.2 Standard Penetration Test Samples

Standard Penetration Tests (SPT) and split-barrel (commonly known as split-spoon) sampling of soils were performed in granular materials or where drilling resulted in poor Shelby tube recovery. SPT N-values ranged from 0 (push) to high values typically in the mid-thirties [blows per foot (bpf)]. The SPT N-values and laboratory test results, which include natural moisture contents, fine (silt and clay) contents, and engineering classifications, are presented on the Subsurface Data Sheet (Exhibit 4). SPT values used for calculation of internal friction angles were adjusted in a two-step process. First the value was modified to account for the high efficiency (80%) hammer used in the test, since N-ϕ correlations are based on older 60% efficiency hammer systems. Then the values were normalized to a constant effective stress of 1 atmosphere creating a N1(60) equivalent. These results are shown in Appendix C.

5. SUBSURFACE CONDITIONS

Detailed information describing the soil conditions encountered during the subsurface investigation are presented on the Subsurface Data Sheet (Exhibit 4). In general, the borings encountered similar soil conditions. Specifically, below either asphalt pavement or a few inches of black silty clay topsoil, the borings encountered 8 to 16 feet of fill consisting of silty clay, silty sand and gravel. Non-cohesive fill soils tended to be loose to medium dense and the fine-grained soils soft to medium stiff. Below the fill is soft to hard, brown and gray, lean clay that extends to about 35 feet bgs. The clay is usually underlain by medium dense sand with gravel, followed by medium dense to dense, poorly graded, sand and gravel, which extend to the termination depth. The top of sand elevation was plotted at the current and 1962 boring locations. Contouring was used to estimate the clay/sand interface surface configuration as shown in Table 5:

Table 5: Clay/Sand Interface

Substructure	Top of Sand Surface Elevation
Pier 1	396.1
Pier 2	406.0
Piers 3, 4, and 5	409.5
Pier 6	408.5

The borings produced samples at discrete locations within the subsurface environment beneath the site, and test data whether insitu or exsitu are representative only of those locations. To evaluate the general characteristics of the subsurface units, the data collected during field and laboratory testing were examined by observation, supported by statistical methods.

5.1 Man-made Fill

Fill consists of a variety of cohesive and non-cohesive soils. The unconfined compressive strength of near surface clay fill tends to be relatively high (7,000 to 9,000 psf in a few cases) suggesting that the material has been subjected to some compactive effort. The properties of the fill will have only minor impact on the design of pier foundations which are usually placed 5 feet or so below existing grade. Fill properties below about 5 feet are characterized as loose silty sand for purpose of design, with an estimated internal friction angle of 31 degrees (°).

5.2 Flood Plain Deposits (Clay)

This stratum is a significant member of the overall soil profile, capping the deeper outwash sands with about 25 feet of near-normally consolidated clay. The material tends to be silty clay, and unconfined compression testing suggests a highly variable strength profile. However, it is possible that this variability is more a reflection of the silt content than the actual strength of the material; silty samples with low cohesion tend to yield low apparent unconfined compressive strength.

An analysis of the strength test results suggests that the data set as a whole (all borings) is normally distributed, but that there is only a weak correlation of strength with depth and between borings. The mean shear strength (based on 50% of the unconfined compressive strength) is calculated to be 732 psf, and the 95% confidence level mean (where the mean is in fact higher than this value 95% of the time) is 685 psf. On a boring-by-boring basis, the mean varies from 481 psf to 1,431 psf with a 95% confidence mean value of 467 psf.

As indicated above, the silt content of the soil is likely to play a large role in determining the unconfined compressive strength. This effect is minimized in the consolidated-undrained triaxial test and in fact, the siltier the sample the higher the ϕ' is likely to be. Results of such a test conducted on a sample from Boring 4B-248 show that ϕ' is 32.1° – almost in the realm of fine sand. Because of the cost and time required to conduct these tests, it is not feasible to replicate the frequency of the unconfined compressive strength testing. It is therefore useful to include, as appropriate, the cu triaxial test results from other bridge investigations to improve the representativeness of the results. One such test was conducted in shallow, clayey fill soils at structure S0550. The results were $\phi' = 28.9°$, $c' = 139.5$ psf.

5.3 Sands

Sands extend beneath the floodplain clays to the total depth investigated. They comprise a variety of gradations and silt content with silty sands at one end of the spectrum and gravel (less frequently) at the other.

Effective stress parameters were estimated using corrected SPT blow counts – N1(60) values as presented in Appendix B. The values of ϕ' (effective internal friction angle) ranges from a high of 49° to a low of 30°

throughout the area investigated. Since these values are all derived from N values, the variability must be examined in that context. For example, the highest ϕ' value is in a gravel (GP-GM) sample, as may be expected ($\phi' = 49°$). More surprisingly, the second to highest is a silty sand (SM) sample $\phi' = 45°$). This result suggests that the presence of occasional large gravel particles could be having a significant impact on the raw N values which is then reflected in the calculated friction angles. Conversely, variations in the water level in the borings change effective stress conditions and may lead to under-reporting of N.

An analysis of the friction angle data set for the five borings showed no significant correlation of ϕ' with depth and indicated that the results as a whole were near-normally distributed. The overall mean value of ϕ' is 34.4° although this is higher than the individual means in Borings 4B-247 and 4W-270 suggesting that it would be a non-conservative value to use in design. For this reason, soil properties were described separately for the Borings 4B-247/4W-270 portion of the site, as described below in Section 5.5.

The base of the outwash deposits was not determined with certainty, but Boring B-247 was terminated at refusal at a depth of 93.6 feet (elevation 345.46 feet) which may be the top of bedrock. Other borings in the area (e.g. 4B-250) were extended to elevations as low as 327.57 feet without encountering refusal. It should be noted that regional geological analysis suggests a valley floor at about elevation 335 feet. However, elevations could be substantially higher depending on proximity to the valley wall or, deeper where there are local irregularities.

5.4 Groundwater

FMSM installed groundwater observation wells in Borings 3B-177 and 3B-190 drilled for other bridges, and provided groundwater fluctuations during an established period. Groundwater levels fluctuated between elevations 420 to 423 feet. Groundwater was encountered in the borings at depths between 27 and 40 feet, corresponding to elevations of 413 and 405 feet. These elevations correspond roughly with the base of the lean clay layer, which serves as a confining layer. Stabilized readings were not taken after drilling. It should be noted that groundwater levels fluctuate significantly throughout the year with springtime increases that may be measured in tens of feet. The Federal Emergency Management Agency (FEMA) flood map for Louisville shows a 100-year flood elevation of 450 feet mean sea level (msl), which would inundate the bridge site to a depth of about 10 feet.

5.5 Selection of Design Parameters

Examination of the soil conditions along the bridge alignment suggests that the westerly end of the project (Borings 4B-247 and 4W-270) is underlain by somewhat weaker soils than are present elsewhere. Accordingly, for purposes of design, the piers have been divided into two groups: Piers 1 and 2, and Piers 3-6.

The soil strength profiles for these two design cases have been generalized in Table 6. Depths are below ground surfaces.

Table 6: Soil Strength Profiles

Profile	Depth (feet)	Soil	
Piers 1 and 2 (P1P2)	0-13	silty sand	$\bar{\phi}' = 31.0°$
	13-43	silty clay	$\bar{S}_u = 350$ psf
	43-116	fine-medium sand	$\bar{\phi}' = 32.8°$
Piers 3-6 (P3P6)	0-10	silty sand	$\bar{\phi}' = 31.0°$
	10-36	silty clay	$\bar{S}_u = 500$ psf
	36-116	fine-medium sand	$\bar{\phi}' = 34.0°$

Note that Boring 4B-247 was drilled to refusal and it is possible this represents a point on the underlying bedrock surface (elevation 345.5). Deep foundations may encounter bedrock at depths in excess of about 80 feet.

Design of foundations should consider that groundwater levels are likely to be at, or near, normal (elevation ~ 421feet) during construction, but that seasonal increases will occur such that the groundwater level should be assumed to be at the ground surface for extended periods. This provides the worst-case scenario for axial resistance analysis of deep foundations.

6. SETTLEMENT AND GLOBAL STABILITY EVALUATIONS

The planned bridge is supported entirely on piers and there is no significant fill to be placed or excavation to be made. Settlement induced by embankment placement is therefore not a consideration for this structure. Similarly, there is no potential for slope instability.

7. FOUNDATION ANALYSES AND RECOMMENDATIONS

7.1 General

Two alternate five-span structures are under consideration for the final design of Bridge B64-2. Both ends of the structure link to elevated components of the interchange system and so no abutments are required. The bridge plan for the recommended structure is presented in Exhibit 2.

Based on the geotechnical conditions encountered in this investigation, it appears that friction H-piles represent the best candidate for supporting the proposed bridge substructures. Three sizes of steel H-piles (12x53, 14x73, 14x89) were analyzed for static and dynamic axial-bearing capacity, for pullout axial capacity and for pile drivability. As an alternative, the use of drilled shafts is presented and geotechnical resistances of four diameters of shaft (30", 36", 42" and 48") were estimated.

The LRFD design method requires independent consideration of the reliability of loads and resistances, and the assessment of structure performance under various limit states (e.g. service, strength). For geotechnical resistance [or ?load bearing capacity' as it is known under the Allowable Stress Design

(ASD) system] this is accomplished through the use of resistance factors that are applied to the nominal (or ultimate) resistance estimates to yield ?factored resistance'. These should not be confused with ?allowable load bearing capacities'. They must only be used by the Designer in the context of an LRFD design and with appropriately factored loads.

The following sections provide the results of the geotechnical evaluations and analyses together with foundation recommendations. Foundation analyses were performed in accordance with the provisions of the LRFD BDS.

7.2 Pile Axial Capacity

7.2.1 H-Piles

Driven pile axial capacity evaluations were performed using the Tomlinson method for clays and Nordlund/Thurman method for sands to derive the nominal side resistance and nominal end bearing. Both methods are incorporated in the computer software APILE plus 4.0 (ENSOFT Inc., 2004) and DRIVEN 1.0 (FHWA, 1998). The total nominal geotechnical axial resistance at a particular depth is the sum of the nominal side resistance and nominal end bearing at that depth. The total factored geotechnical axial compressive resistance for static analysis was derived by multiplying the corresponding total nominal resistance by a resistance factor of 0.35 for clays and 0.45 for sands. The total factored geotechnical axial compressive resistance for dynamic analysis was derived by multiplying the corresponding nominal resistance by a unique resistance factor of 0.65 for both clays and sands. The total factored geotechnical axial uplift resistance was obtained from the nominal side resistance multiplied by a resistance factor of 0.25 for clays and 0.35 for sands. These factors are specified in LRFD BDS Table 10.5.5.2.3-1.

Axial capacity evaluations for three selected sizes of steel H-piles (12x53, 14x73, 14x89) were performed for the project based on the assessment of soil conditions along the bridge alignment. The results of pile evaluations for each foot of depth below the bottom of the pile cap are presented in the tables included in Appendix D. It is to be noted that axial compressive resistance values in Appendix D are based on the assumption that positive skin friction develops along the entire pile length. Pile capacities have been calculated for two groups of piers (Piers 1 and 2, and Piers 3-6).

According to KYTC policy (August 18, 2006), maximum factored geotechnical resistance is limited as follows for 50 kips per square inch (ksi) steel H-piles:

HP 12x53 - 200 kips (100 tons)
HP 14x73 - 280 kips (140 tons)
HP 14x89 - 340 kips (170 tons)

Table 7 summarizes the required pile lengths and pile tip elevations as estimated for the maximum factored geotechnical resistance indicated above for each of the three pile sizes. Should more (or less)

capacity be required, refer to the pile capacity tables in Appendix D. H-pile lengths at each substructure location should be adjusted accordingly, based on the actual pile driving conditions encountered in the field and the designed pile cap elevations.

Table 7: Estimated H-Pile Length for Maximum Factored Geotechnical Resistance, Based on Static Analysis Method

Substructure	Pile Size	Maximum Total Factored Geotechnical Axial Compressive Resistance		Estimated Pile Length[1]	Estimated Pile Tip Elevation	Total Factored Geotechnical Axial Uplift Resistance[2]	
		(kips)	(tons)	(feet)	(feet)	(kips)	(tons)
Piers 1 & 2	HP 12x53	200	100	92	347	149	74
	HP 14x73	280	140	103	336	210	105
	HP 14x89	340	170	116	323	250	125
Piers 3-6	HP 12x53	200	100	85	354	148	74
	HP 14x73	280	140	95	344	208	104
	HP 14x89	340	170	108	331	252	126

[1] Below the bottom of the pile cap.

[2] Estimated uplift resistance for the corresponding estimated pile length.

It should be noted that drilling encountered refusal at an elevation above some of the predicted pile tip elevations presented above (Elevation 345.46 feet) and that regional analysis of the bedrock conditions suggests that the valley floor may be encountered at about elevation 335 feet. Therefore the possibility of meeting refusal while driving piles to the stated depths can not be ruled out. Where this occurs, it may be assumed that the design geotechnical axial compressive resistance of the pile has been attained.

7.2.2 Drilled Shafts

As an alternate to H-pile foundation support, a drilled shaft option was analyzed. Drilled shaft axial capacity evaluations were performed using alpha-method for clays and beta-method for sands to derive the nominal side resistance. The method developed by O'Neill and Reese (FHWA, 1999) was used to derive the nominal end bearing capacity.

The following factors were applied to the nominal resistance in order to obtain the factored resistance: 0.45 for side resistance in clays, 0.40 for end bearing in clays, 0.55 for side resistance in sands, and 0.50 for end bearing in sands. The total factored geotechnical axial compressive resistance at a particular depth is the sum of the factored side resistance and factored end bearing at the corresponding depth. The total factored geotechnical axial uplift resistance was obtained from the nominal side resistance multiplied by a resistance factor of 0.35 for clays and 0.45 for sands (LRFD BDS Table 10.5.5.2.4-1). Where the upper 5 feet of a shaft was surrounded by cohesive soils, no frictional resistance was assumed to exist in this zone (FHWA, 1999).

Axial capacity evaluations for four drilled shaft diameters (30", 36", 42", and 48") were conducted for both soil profiles. The results are presented in the tables included in Appendix E. It is to be noted that axial compressive resistance values in Appendix E are based on the assumption that positive skin friction develops along the entire shaft length unless the upper 5 feet of the shaft is in cohesive soil.

7.3 Downdrag

No embankment-induced settlement is anticipated at the pier locations and so downdrag loads are not expected.

7.4 Pile Drivability

A drivability assessment was made to provide guidance on the size of hammer likely to be required for installation of H-piles to the specified resistances without over-stressing the pile on the one hand, or using excessive blow counts on the other.

For purposes of the analysis, it was assumed that the Contractor will be installing piles with maximum factored geotechnical resistance as shown in Table 7. The soil profile representing Piers 3-6 was selected for analysis because it contains slightly stronger soils that might offer higher driving resistance. The difference between the two soil profiles is small and the impact on driving resistance is not likely to be significant. The Delmag family of hammers was selected as representative of diesel hammer performance for the applicable energy levels.

Analyses were conducted using Wave Equation software (GRLWEAP) developed by Pile Dynamics, Inc. for 12x53, 14x73 and 14x89 steel H-Piles and using hammers with a range of driving energy from 20 feet-kips to 80 feet-kips.

The soils contributing to the driving resistance include the upper clay layer and the underlying sand layers. In order to account for soil remolding, pore water pressure increase and corresponding shear strength decrease, the following skin friction reduction percentages proposed by KYTC were used to calculate driving resistance: 50% for clay and 25% for sand. The driving resistances corresponding to the pile lengths in Table 7 can be found in Appendix D. For each pile section/hammer combination, the relationship between static soil resistance (kips) and dynamic driving resistance [blows per foot (bpf)] was developed and plotted graphically.

The hammer energy to adequately drive the piles without delivering excessive blow counts or overstressing the piles has been set based on criteria established by FHWA (Soil and Foundation Workshop Manual) as blow counts between 30 and 144 blows per foot and maximum stress in steel less than 0.9 times the yield (45 ksi for Grade 50 steel). The results are shown in Exhibit 5. It appears that the 20 feet-kip and 40 feet-kip hammers are probably not capable of driving these three sections to the maximum factored axial resistance without excessive blow counts and /or stress to the pile. The 60 feet-kip hammer appears to be

suitable for driving all three sections, but a larger hammer (say 80 feet-kip) should be considered if there are a significant number of 14x89 section piles.

The Designer may use the driving resistance table in Appendix D and Exhibit 5 to correlate the minimum driving resistance required to achieve a desired factored geotechnical axial resistance for other pile lengths, as needed.

It should be noted that the information presented in Exhibit 5 is general in nature, and is not intended to replace independent analyses by pile driving contractors using actual hammer and driving accessory combinations. Further, the results of wave equation analyses should be calibrated based on dynamic field testing conducted prior to production driving and reliance on the results for predictions of static axial load capacities.

7.5 Lateral Load Analysis Parameters

Deep foundation elements subjected to horizontal loads should be analyzed for maximum bending moments and lateral deflections. The required lateral load capacity can be obtained by increasing the diameter or the embedment depth of the foundation element. The Site Specific Idealized Soil Profile and corresponding recommended lateral soil modulus, and soil strain to be used to analyze the laterally loaded pile by the p-y curve method are shown in Appendix F. The p-y curve method for laterally loaded pile analyses is routinely performed using either the L-Pile Plus or Com 624 computer software.

7.6 Seismic Load Evaluation and Liquefaction Potential

The soil profile at the site corresponds most closely to Type 3 (LRFD BDS – Table 3.10.5.1-1) resulting in a Site Coefficient (S) of 1.5. (A profile with soft to medium stiff clays and sands characterized by 30 feet or more of soft to medium stiff clays with or without intervening layers of sand or other cohesionless soils.)

Liquefaction of saturated, loose cohesionless soil may occur in response to vibration such as occurs during earthquakes. The attempted movement of individual soil particles is constrained by interstitial water, the pressure of which rises for the duration of the shaking. This increase in pore pressure corresponds to a decrease in effective stress and a reduction of associated strength parameters critical to foundation stability. As saturated, cohesionless soils are present beneath the B64-2 bridge site and USGS has established seismic design parameters for the area, a preliminary assessment of liquefaction potential was made.

The soils below a depth of about 35 feet bgs are predominantly silty sands, sands and gravelly sand mixtures. At this depth the soils are permanently saturated. The shallow surficial fill in the area is not dominantly cohesionless, but pockets of silty sand are present (e.g. Borings 4B-247 and 4B-250). These soils are typically not saturated, but may become so during the annual increase in stage of the Ohio River.

Accordingly, an assessment was made considering the soils at a depth of 6 feet with a groundwater table at the surface, and at 35 feet, which is below the permanent water table.

The analysis was conducted in accordance with the methodology proposed by Idriss and Boulanger (2004). In this method the cyclic shear ratio (CSR) is calculated and compared with the cyclic resistance ratio (CRR) computed based on corrected SPT 'N' values. The process is simplified by the use of graphical solutions to the underlying equations.

Results of the assessment are presented in Exhibit 6, and show that the potential for liquefaction of the deep soils is remote. While that of the shallow fill material is higher, it too is very low.

As indicated in Section 2.2, seismic design guidelines are currently under review by AASHTO; this section should be updated accordingly, if these changes occur.

8. SUMMARY OF FOUNDATION RECOMMENDATIONS

8.1 General

1. Two structural options are under consideration for the proposed new bridge B64-2 (S0160): a steel (favored) and concrete alternative. Foundation support requirements are similar for both.

2. No embankments are planned in the vicinity of the piers and so settlement induced down drag is not a design consideration.

3. Based on the geotechnical information developed during this investigation, friction H-piles appear to represent the best candidate for supporting the proposed bridge substructures.

4. Foundation analyses were performed according with the provisions of LRFD BDS.

8.2 Steel H-piles

1. The selection of pile types, driving systems, and installation procedures should be in conformance with the current AASHTO Standard Specifications for Highway Bridges (17th Edition).

2. Three sizes of Grade 50 steel H-friction piles (12x53, 14x73, 14x89) were analyzed for static and dynamic axial bearing capacity, for pullout axial capacity and for pile drivability.

3. Pile capacities were developed for two soil profiles, each representative of conditions at one or more of the piers. Axial capacity estimates for single, steel H-piles are provided in Appendix D. Upon determination of the final H-pile locations, arrangement and loads, the designer should use the capacity estimates to determine the H-pile size and length. The factored geotechnical axial

resistance estimates provided in Appendix D are based on the LRFD BDS resistance factors.

4. If load testing and/or dynamic analysis of driven piles in soil is conducted, the LRFD resistance factors used to determine the factored axial capacity for design purposes may be revised as outlined in LRFD BDS Table 10.5.5.2.3-1 based on site variability and the number and type of tests performed. The Designer should note that lateral capacity requirements will need to be revisited if the shaft lengths are revised based on load testing and/or dynamic analysis.

5. All pile axial capacities presented in Appendix D are for single piles. In addition to applying appropriate resistance factors, individual capacities for piles in group configurations may be further reduced depending upon soil type, bearing condition of the pile cap, or center-to-center spacing as recommended in LRFD BDS. The following criteria should be observed:

Table 8: Group Efficiency Factors

CTC Spacing	Group Efficiency Factor		
	Cohesive Soils		Cohesionless Soils (Cap in or not in firm Contact with Ground)
	Cap not in firm Contact with Ground	Cap in firm Contact with Ground	
6B	1.00	1.00	1.00
2.5B	0.65	1.00	1.00

The notation "B" is the shaft diameter and the percent reduction can be linearly interpolated between the values and spacing provided.

6. LRFD BDS include a resistance factor for horizontal geotechnical resistance of a single pile or pile group of 1.0 for lateral capacity analyses. Appendix F provides the recommended soil parameters for use in lateral load pile analyses.

7. For the initial group of piles installed, the piles should be left for a minimum of one day so excessive pore pressure caused by driving operations can dissipate and the soils can set-up. After the one-day waiting period, the piles should be re-struck to see if the required bearing capacity was achieved. If the set-up effect is not significant, subsequent groups of piles will not require re-striking.

8. Hammer selection was based on the ultimate driving resistance that 12x53, 14x73 and 14x89 steel H-piles would experience during the installation process. The results of these calculations are presented in Exhibit 5.

9. Upon selecting the pile size and length required to support the applied loads, the Designer should select the appropriate hammer required to drive the piles to the specified depths from Exhibit 5. The Designer should place a note on the drawings that states: A hammer system capable of

delivering a minimum energy of ___ foot-kips will be necessary to drive the piles to the maximum total factored geotechnical axial resistance without encountering excessive blow counts and over-stressing the piles. The Contractor should submit appropriate pile driving systems to the Kentucky Transportation Cabinet for approval prior to the installation of the first pile. Approval of the pile driving system by the Engineer will be subject to satisfactory field performance of the pile driving procedures.

10. Drivability studies were performed assuming continuous driving. If interruptions in driving individual piles should occur, difficulties in continuing the installation process will likely occur due to the pile "set-up" characteristics.

11. LRFD BDS (Section 6.5.4.2) recommends the following resistance factors for determining the structural capacity of steel H-piles:

Table 9: Resistance Factors – H-Pile Structural Capacity

Loading Condition	Resistance	
	Piles Subjected to Damage From Severe Driving Conditions[(1)]	Good Driving Conditions
Axial Resistance In Compression	φ_c=0.50	φ_c=0.60
Combined Axial and Flexural Resistance	N/A	φ_c=0.70 φ_f=1.00

[(1)] Apply these values only to the section of the pile likely to be damaged during driving (LRFD BDS Section 6.15.2).

8.3 Drilled Shafts

1. This option has been evaluated for comparison with H-pile supported foundations.

2. Axial capacity estimates for drilled shafts are provided in Appendix E and were derived utilizing the LRFD resistance factors in LRFD BDS. The capacities presented are for single shafts and do not include group reduction factors. Upon determination of the final shaft locations and shaft loads, the Designer should use the capacity estimates to determine shaft size and length for each shaft.

3. If load testing of drilled shafts in soil is conducted, the LRFD resistance factors used to determine the factored axial capacity for design purposes may be revised as outlined in LRFD BDS Table 10.5.5.2.4-1.

4. All shaft capacities presented in Appendix E are for single shafts. In addition to applying appropriate resistance factors, individual capacities for shafts in group configurations should be

further reduced depending upon center-to-center (CTC) spacing as specified in the LRFD BDS. The following criteria should be observed:

Table 10: Drilled Shaft Group Efficiency Factors

CTC Spacing	Group Efficiency Factor for Cohesive Soils	Group Efficiency Factor for Non-Cohesive Soils
6B	1.00	N/A
4B	0.80	1.00
2.5B	0.65	0.65

The notation "B" is the shaft diameter and the percent reduction can be linearly interpolated between the values and spacing provided.

5. LRFD BDS calls for a resistance factor for horizontal geotechnical resistance of a single shaft or shaft group of 1.0 for lateral capacity analyses. Appendix F provides the recommended soil parameters for use in lateral load analyses.

6. The Contractor should embed the drilled shafts to the plan tip elevation or to an elevation as directed by the Engineer.

7. If a temporary casing for drilled shafts is used during construction, the Contractor should either wait until concrete has been placed for the entire length of the shaft before pulling the casing, or the level of the concrete being placed should be maintained several feet above the hydrostatic head as the casing is retrieved. These measures should be implemented by the Contractor to reduce the likelihood of soils collapsing into the shaft excavation and detrimentally affecting the structural integrity of the drilled shafts.

8. It is recommended that Class A Modified concrete, which is in accordance with the current KYTC Special Note for Drilled Shafts, be used in construction of the drilled shaft. The concrete should also exhibit good workability, i.e., high slump. Once an excavation is complete and the steel reinforcing cage has been placed, concrete should be tremmied to the bottom of the shaft and should replace/displace any water or slurry remaining after drilling operations.

9. If drilling slurry is to be used during shaft installations, the slurry should be capable of suspending the soil particles encountered and not leave a thick coating of slurry, or "mud", on the excavation sides or bottom. In accordance with the current "Special Note for Drilled Shafts", the Contractor shall submit a detailed plan for its use and disposal along with a drilled shaft installation plan to the Geotechnical Branch of the KYTC for approval prior to implementation. The Contractor shall supply all equipment and construction techniques involving slurry that are necessary to maintain environmental standards.

10. Drilled Shaft Integrity Testing will be required for each drilled shaft. An appropriate number of Crosshole Sonic Logging (CSL) access tubes (approximately 3), consisting of 2-inch nominal diameter schedule 40 steel pipes, will be required. These tubes should be shown on the drilled shaft details with the following note on the Drilled Shaft Detail Sheet:

    Perform non-destructive Drilled Shaft Integrity Testing on the Drilled Shafts using Crosshole Sonic Logging (CSL) in accordance with the "Special Note for Non-Destructive Testing of Drilled Shafts". The Department will pay for this testing and associated cost at the contract unit bid price for "CSL Testing". This includes CSL Testing Mobilization and CSL Testing. The access tubes are incidental to the shaft.

11. Unless otherwise specified, all construction methods and materials used for drilled shaft installations shall be in accordance with the current "Special Note for Drilled Shafts".

9. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of determining bridge foundation recommendations only. Verification of the subsurface conditions for purposes of determining contamination, difficulty of excavation, the effect of excavation on slope stability or existing structures, and trafficability is beyond the scope of this study. The analyses and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on Exhibit 2, and on the Subsurface Data Sheet (Exhibit 4). This report does not reflect any variations that may occur between the borings or elsewhere on the site, and variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes in the nature, design or location of the proposed bridges are made, the conclusions and recommendations contained in this report should not be considered valid until the changes are reviewed, and the conclusions and recommendations in this report have been modified or verified in writing by a qualified geotechnical engineer.

It has been a pleasure to be of service to Kentucky Transportation Associates in performing this geotechnical investigation for Structure 0160, Bridge B64-2.

Respectfully Submitted,

BARR & PREVOST

Stuart Edwards, P.E.
Senior Project Manager

Gary R. Simmons, P.E.
Principal

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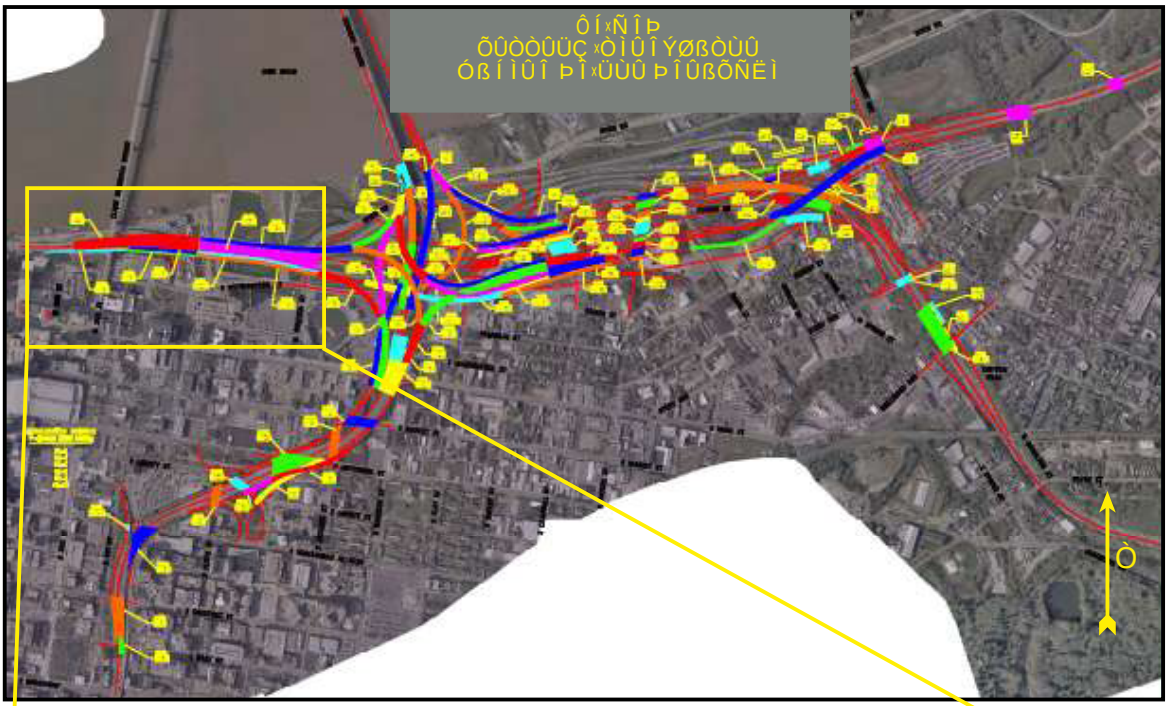
EXHIBITS



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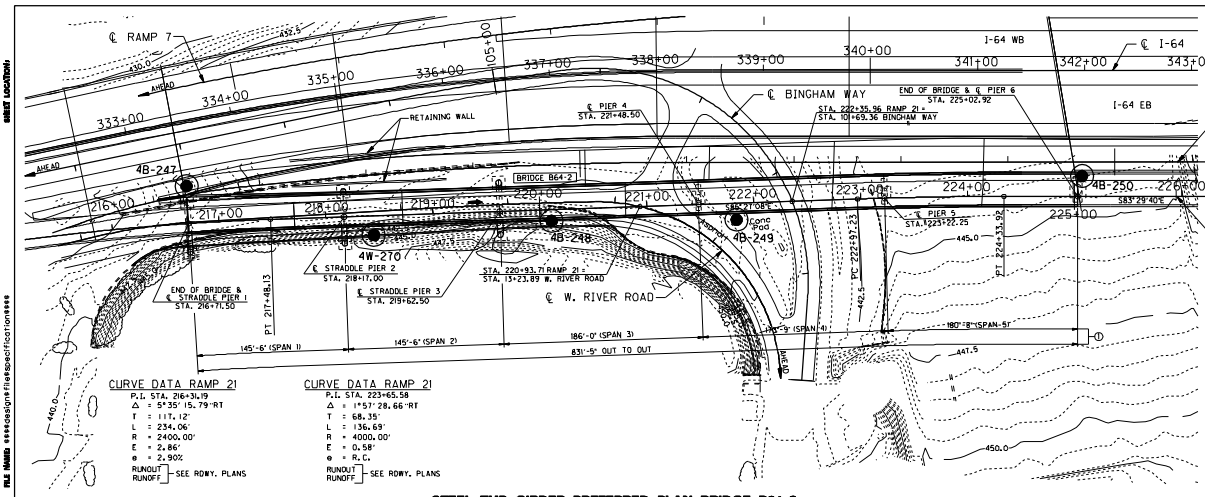


CURVE DATA RAMP 21

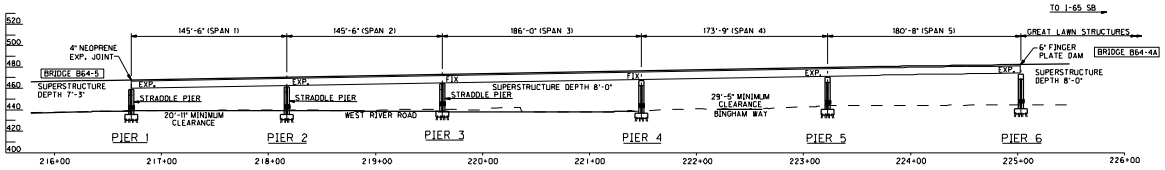
P.I. STA. 216+31.19
Δ = 5°35' 15.79" RT
T = 117.12'
L = 234.06'
R = 2400.00'
E = 2.86'
e = 2.90%
RUNOUT / RUNOFF — SEE RDWY. PLANS

CURVE DATA RAMP 21

P.I. STA. 223+65.58
Δ = 1°57' 28.66" RT
T = 68.35'
L = 136.69'
R = 4000.00'
E = 0.58'
e = R.C.
RUNOUT / RUNOFF — SEE RDWY. PLANS

STEEL TUB GIRDER PREFERRED PLAN BRIDGE B64-2

RAMP 21 ~ 5 SPANS 145'-6", 145'-6", 186'-0", 173'-9", & 180'-8", 81' STEEL TUB GIRDERS,
HS25 & ALTERNATE MILITARY LOADING, SKEW VARIES
ROADWAY WIDTH VARIES, SHOULDER WIDTH VARIES AT BRIDGE



SECTION ALONG PROFILE GRADE RAMP 21

① MEASURED ALONG ℄ RAMP 21

LEGEND

— — — - DENOTES EXISTING GROUND LINE

- BORING LOCATION

REVISION	DATE

DATE:
CHECKED BY
DESIGNED BY:
DETAILED BY:

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: JEFFERSON

ROUTE: I-64
CROSSING: RIVER ROAD

PREFERRED LAYOUT BRIDGE B64-2

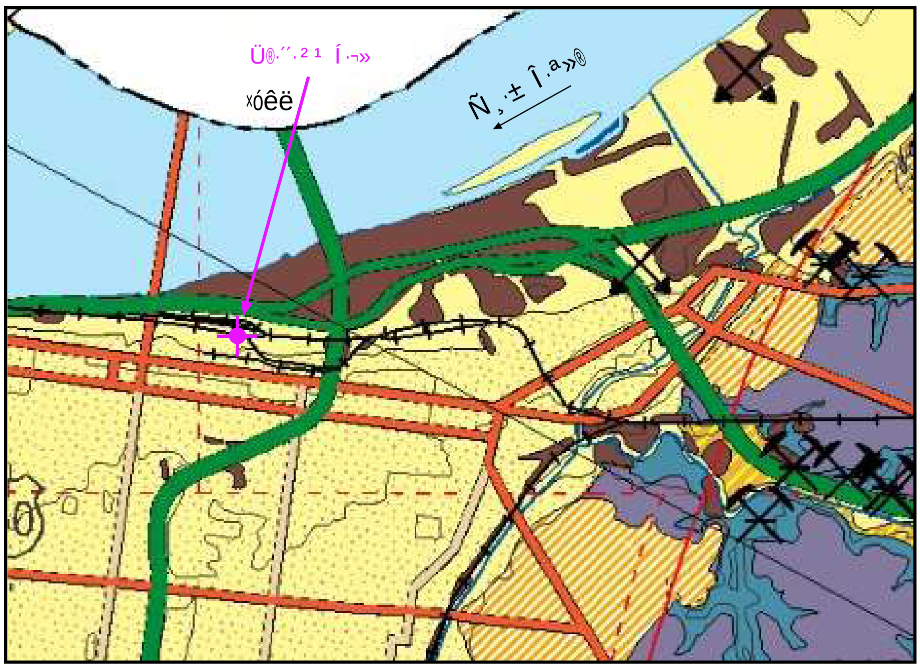
PREPARED BY: Kentucky Transportation Consultants

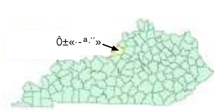
SHEET NO.

DRAWING NO.

EXHIBIT 2

ITEM NUMBER
5-118.18 & 5-118.19



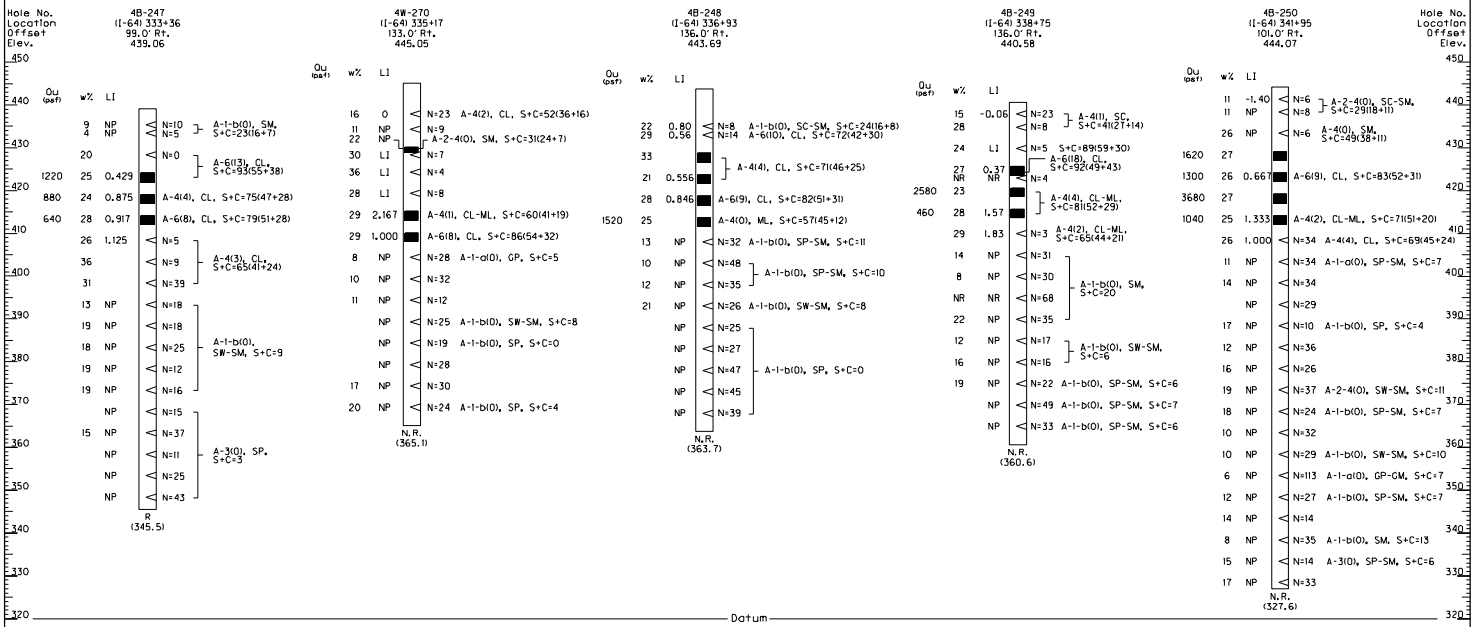


Commonwealth of Kentucky
Department of Highways

Kentucky Transportation Associates

BRIDGES

SUBSURFACE DATA



REVISION	DATE

DATE:	CHECKED BY
DESIGNED BY:	
DETAILED BY:	

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: **JEFFERSON**

ROUTE	CROSSING
I-64	RIVER ROAD

PREFERRED LAYOUT BRIDGE B64-2

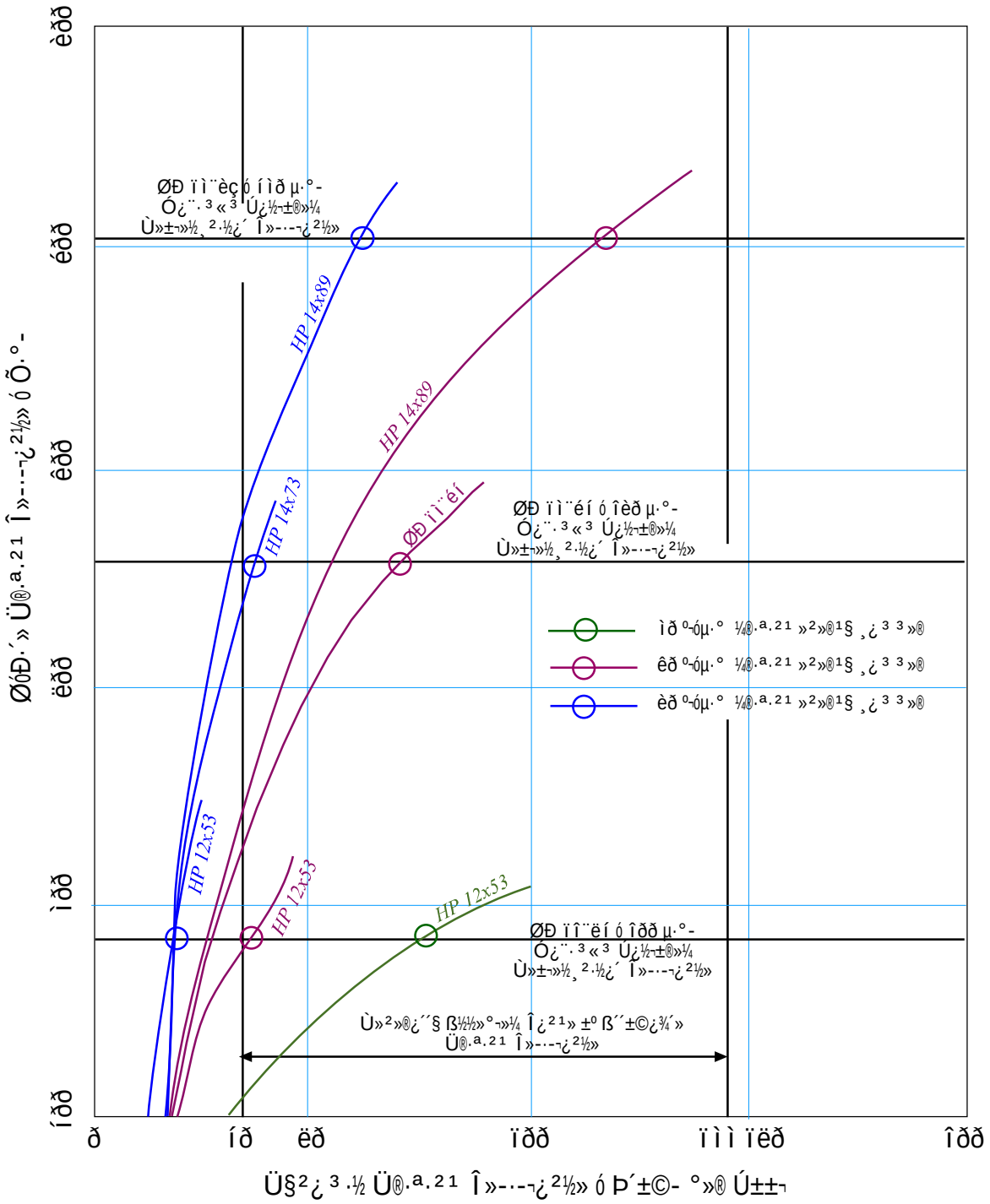
PREPARED BY: **Division of Structural Design**
GEOTECHNICAL BRANCH

SHEET NO.

DRAWING NO.

EXHIBIT 4

ITEM NUMBER
5-118.18 & 5-118.19



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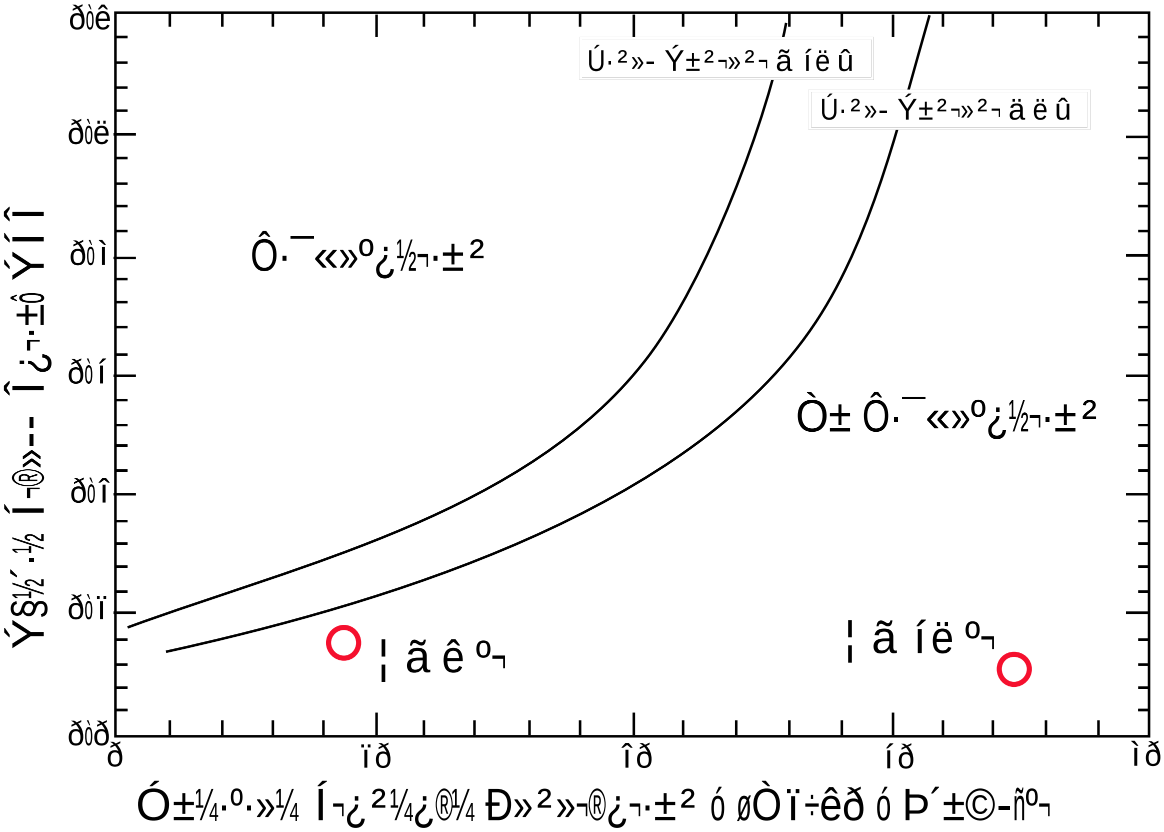

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APPENDIX A
COORDINATE DATA SUBMISSION FORM

COORDINATE DATA SUBMISSION FORM
KYTC DIVISION OF STRUCTURAL DESIGN -- GEOTECHNICAL BRANCH

County	**Jefferson**	**Date**	**11/15/2006**
Road Number	**I-64**		
Survey Crew / Consultant	**QK4 / Barr & Prevost Inc.**		**Notes:**
Contact Person	**Gary Simmons**		**All coordinates should be NAD-83 Latitude,**
Item #	**5-118.18 & 19**		**Longitude in Decimal Degrees**
MARS #	**C-04224166**		
Project #	**S0160 Bridge B 64-2**		

(Please Mark One)

Elevation Datum **Sea Level** (marked) **Assumed**

BORING NUMBER	STATION	OFFSET	ELEVATION (ft)	LATITUDE	LONGITUDE
4B-247	333+36	99' Rt	439.06	38.2587205690	85.7522083460
4B-248	336+93	136' Rt	443.69	38.2586517780	85.7510180750
4B-249	338+75	136' Rt	440.58	38.2586164020	85.7504175910
4B-250	341+95	101' Rt	444.07	38.2586266480	85.7492946120
4W-270	335+17	133' Rt	445.05	38.2586600810	85.7515985290
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APPENDIX B
CONSOLIDATION AND STRENGTH TESTING LABORATORY RESULTS

Wang Engineering, INC.
Geo-Environmental Engineers
1145 N Main Street
Lombard, IL 60148
Phone : 630 953-9928
Fax: 630 953-9938

Project Name: Kennedy Interchange - Phase 4 - S0160
Source: 4B-248 #4, 20'-22'
Cv computation Method: Cassagrande

Initial Void Ratio = 0.579
In-Situ Vertical Effective Stress = 2400 psf

Compression and Swelling Indices

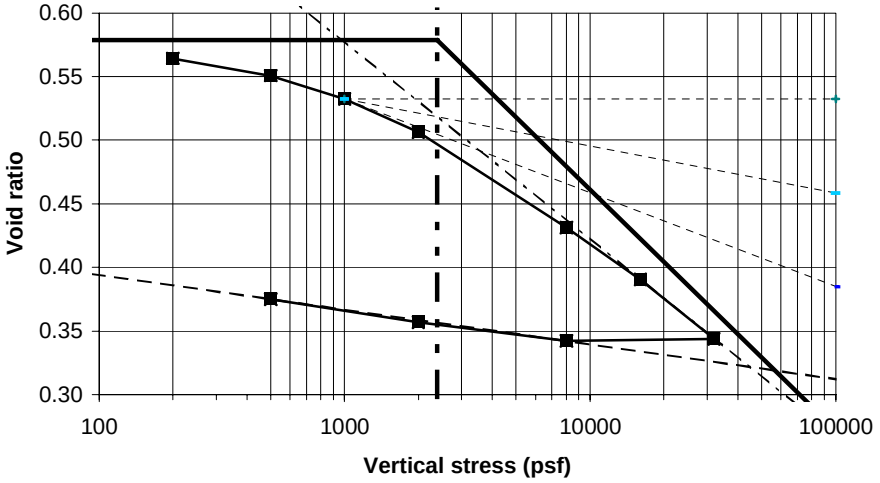
Compression index Cc = 0.155
Field corrected Cc = 0.189
Swelling index Cs = 0.027

Preconsolidation pressure,σ_c

Casagrande Method = 2382 psf
Over-Consolidation Ratio (OCR) = 1.0

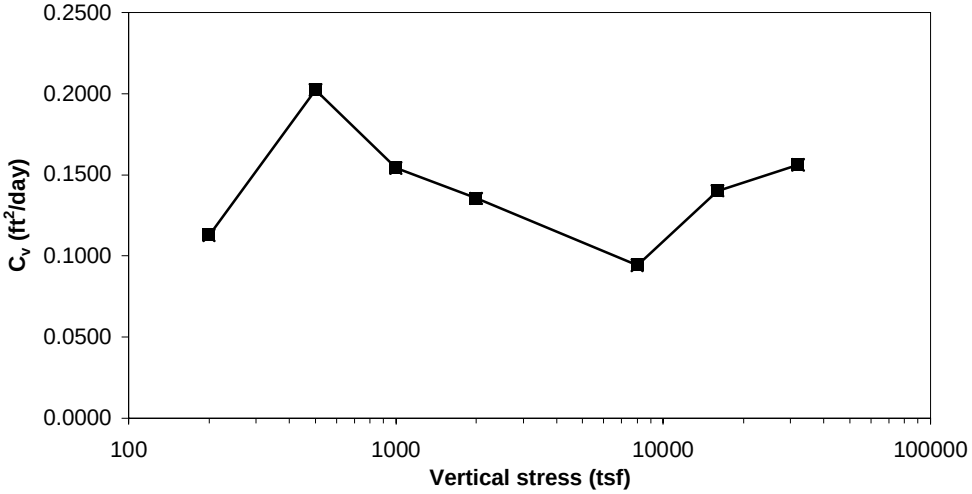
CONSOLIDATION CURVE

Sample 4B-248 #4, 20'-22'



CONSOLIDATION COEFFICIENT (C_v) vs. VERTICAL STRESS

Sample 4B-248 #4, 20'-22'



Wang Engineering, INC.
Geo-Environmental Engineers
1145 N Main Street
Lombard, IL 60148
Phone : 630 953-9928
Fax: 630 953-9938

Project Name: Kennedy Interchange - Phase 4 - S9070
Source: 4W-270 #7 (30'-32')
Cv computation Method: Cassagrande

Initial Void Ratio = 0.805
In-Situ Vertical Effective Stress = 2364 psf

Compression and Swelling Indices

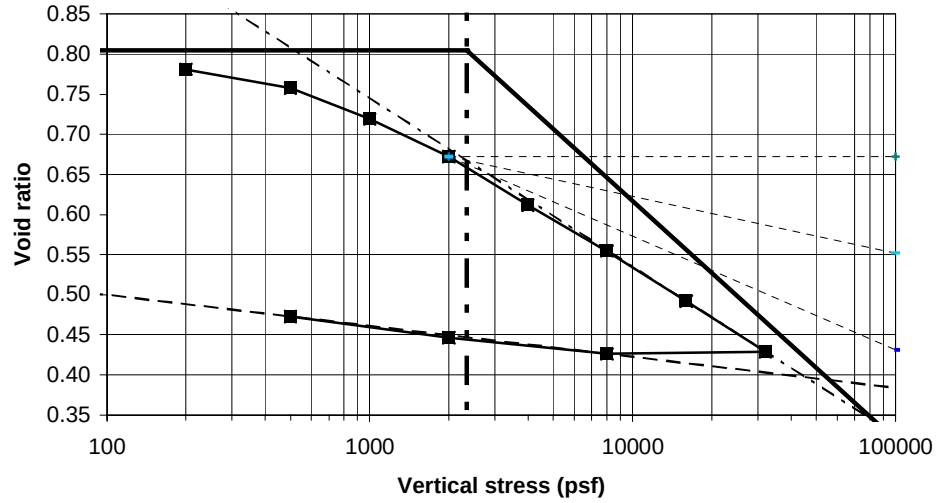
Compression index Cc = 0.210
Field corrected Cc = 0.298
Swelling index Cs = 0.039

Preconsolidation pressure,σ_C

Casagrande Method = 2340 psf
Over-Consolidation Ratio (OCR) = 1.0

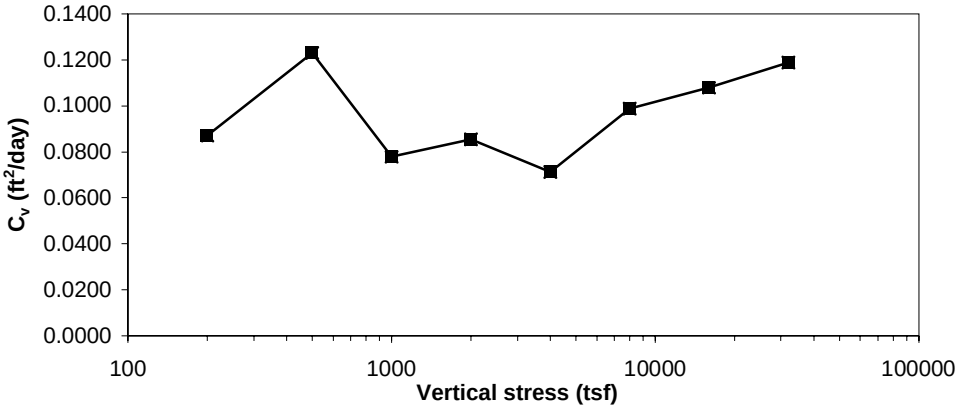
CONSOLIDATION CURVE

Sample 4W-270 #7, 30'-32'



CONSOLIDATION COEFFICIENT (C_v) vs. VERTICAL STRESS

Sample 4W-270 #7 (30'-32')

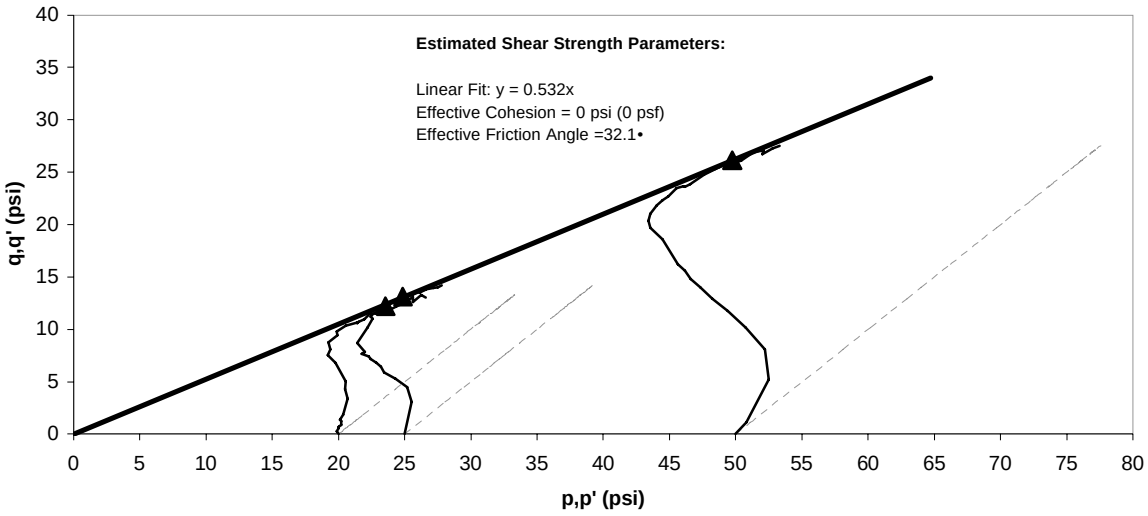


Wang Engineering, INC.
Geo-Environmental Engineers
1145 N Main Street
Lombard, IL 60148
Phone : 630 953-9928
Fax: 630 953-9938

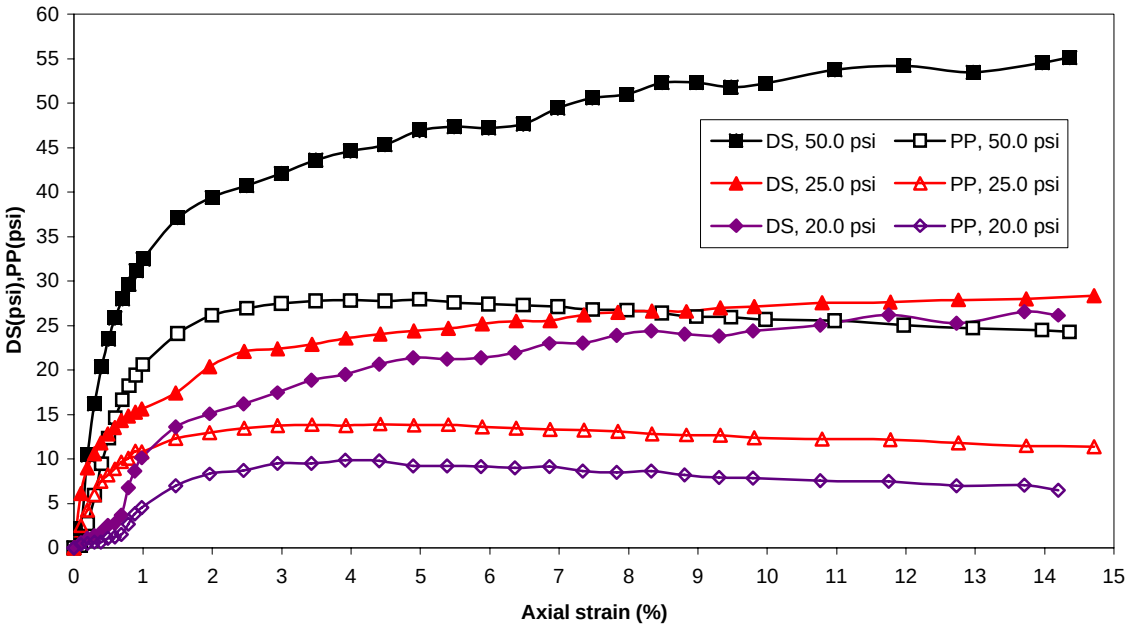
Project Kennedy Interchange - Phase 4 - S0160: Bridge 64-2
Sample ID 4B-24&7336+ 93,13& Rt., 20'to 27'

Failure Criterion : Maximum Effective Principal Stress Ratio

Total and Effective Stress Paths and Effective Stress Strength Envelope



Deviatoric Stress (DS) and Pore Water Pressure (PP) VS. Axial Strain



APPENDIX C
CORRECTED SPT N-VALUES AND SOIL PARAMETERS

Þ±®·²¹ ìÞóîìé
Õ»²²»¼§ ×²¬»®½¸¿²¹» Î»½±²-¬®«½¬·±² óÐ¸¿-» ì
Î¿³° îï ø×óêì ÛÞ ¬± ×óêë ÍÞ÷
ÙÉÔ ø»¨¬®»³»÷ ã ð ºº ¾¹- ø°´±±¼ -¬¿¹»÷
ÙÉÔ ø²±®³¿´÷ ã ïèòðê ºº ¾¹- øÛ´»ª¿¬·±² ìîï º¬÷ »-¬·³¿¬»¼ ¾¿-»¼ ±² Ñ¸·± Î·ª»® Ð±±´ »´»ª¿¬·±²

Í±·´ Ü»-½®·°¬·±²	Y´¿--·º·½¿¬·±² øËÍÝÍ÷	Ì±° Û´»ª¿¬·±² øº¬÷	Þ±¬¬±³ Û´»ª¿¬·±² øº¬÷	E²¼®¿·²»¼ I¸»¿® Í¬®»²¹¬¸ ø°-º÷	Î¿© Ú·»´¼ ÍÐÌ Òº·»´¼ øÞ´±© Y±«²¬÷	Ø¿³³»® Y±®®»½¬»¼ ÍÐÌ Òêð øÞ´±© Y±«²¬÷	U·²¿´ Y±®®»½¬»¼ ÍÐÌ Òïêð øÞ´±© Y±«²¬÷	×²¬»®²¿´ U®·½¬·±² ß²¹´» ø¼»¹®»»÷
Ô±±-» -·´¬§ -¿²¼	ÍÓ	ìíçòðê			ïð	ïí	îð	íí
	ÍÓ		ìííòðï		ë	é	ç	íð
Í±º¬ -·´¬§ ½´¿§	ÝÔ	ìííòðï		îëð				
	ÝÔ		ìîêòðï	êïð				
Ó»¼·«³ -·´¬§ ½´¿§	ÝÔ	ìîêòðï		ììð				
	ÝÔ			íîð				
	ÝÔ			îëð	ë	é	ê	
	ÝÔ			éëð	ç	ïî	ïð	
	ÝÔ		íçêòðï	éëð	íç	ëî	ìî	
Ó»¼·«³ ¼»²-» -·´¬§ -¿²¼	ÍÉóÍÓ	íçêòðï			ïè	îì	ïç	íí
	ÍÉóÍÓ				ïè	îì	ïè	íî
	ÍÉóÍÓ				îë	íí	îì	íì
	ÍÉóÍÓ				ïî	ïê	ïï	íð
	ÍÉóÍÓ		íéïòðï		ïê	îï	ïë	íï
Ó»¼·«³ ¼»²-» ¹®¿ª»´ -¿²¼	ÍÐ	íéïòðï			ïë	îð	ïí	íï
	ÍÐ				íé	ìç	íî	íê
	ÍÐ				ïï	ïë	ç	íð
	ÍÐ		íìçòðï		îë	íí	îð	íí
Ü»²-» ¹®¿ª»´	ÙÐ	íìçòðï	íìëòðë		ìí	ëé	íì	íé

Û¯«¿¬·±²-æ Òïã ÝÒ...

Î»º»®»²½»-æ

Þ±®·²¹ ìÞóî ìè

Õ»²²»¼§ ×²¬»®½¸¿²¹» Î»½±²-¬®«½¬·±² ó Ð¸¿-» ì

Î¿³° îï ø×óêì ÛÞ ¬± ×óêë ÍÞ÷

ÙÉÔ ø»¨·¬®» ³»÷ ã ð ⁰¬ ¾¹- ø⁰´±±¼ -¬¿¹»÷

ÙÉÔ ø²±®³¿´÷ ã îîòêç ⁰¬ ¾¹- øÛ´»ª¿¬·±² ìîï ⁰¬÷ »-¬·³¿¬»¼ ¾¿-»¼ ±² Ñ¸·± Î·ª»® Ð±±´ »´»ª¿¬·±²

Í±·´ Ü»-½®·°¬·±²	Y´¿--·⁰·½¿¬·±² øËÍÝÍ÷	Ì±° Û´»ª¿¬·±² ø⁰¬÷	Þ±¬¬±³ U´»ª¿¬·±² ø⁰¬÷	E²¼®¿·²»¼ I¸»¿® Í¬®»²¹¬¸ ø°-⁰÷	Î¿© Ú·»´¼ ÍÐÌ Ò₀·»´¼ øÞ´±© Y±«²¬÷	Ø¿³³»® Y±®®»½¬»¼ ÍÐÌ Òêð øÞ´±© Y±«²¬÷	U·²¿´ Y±®®»½¬»¼ ÍÐÌ Òïêð øÞ´±© Y±«²¬÷	ײ¬»®²¿´ U®·½¬·±² ß²¹´» ø¼»¹®»»÷
Ý´¿§»§ -¿²¼§ -·´¬	ÍÝóÍÓ	ììíòêç		ïîë	è	ïï	ïí	íï
Í±⁰¬ -·´¬§ ½´¿§	ÝÔ		ìíìòî	ëðð	ïì	ïç	îï	
	ÝÔ	ìíìòî		îëð				
	ÝÔ			ëðð				
	ÝÔ			ïððð				
	ÓÔ		ìïðòé	éêð				
Í·´¬§ -¿²¼ ©·¬¸ ¹®¿ª»´	ÍÐóÍÓ	ìïðòé			íî	ìí	íë	íé
	ÍÐóÍÓ				ìè	êì	ëð	ìï
	ÍÐóÍÓ				íë	ìé	íë	íé
	ÍÉóÍÓ		íçðòé		îê	íë	îë	íì
Ó»¼·«³ -¿²¼	ÍÐ	íçðòé			îë	íí	îì	íì
	ÍÐ				îé	íê	îë	íì
	ÍÐ				ìé	êí	ìî	íç
	ÍÐ				ìë	êð	íç	íè
	ÍÐ		íêíòé		íç	ëî	íí	íê

Û¯«¿¬·±²-æ ÒïãÝ₀Ò₀·»´¼å Ý₀ãÅðòéé´±¹ïðøìðñσᵥ÷Ãô ¿²¼ Ý₀äîòðå ï÷

Òêð ã øèðñêð÷Ò₀·»´¼ å Å½±®®»-°±²¼·²¹ ¬± èð û ¸¿³³»® »⁰⁰·½·»²½§Ã ï÷

ÒïêðãÝ₀Òêðå ï÷

φø¼»¹÷ãîéòïõðòíÒ½±®óðòððððëìÒ½±®² î÷

Î»º»®»²½»-æ ï÷ ßßÍØÌÑ ÔÎÚÜ Þ®·¼¹» Ü»-·¹² Í°»½·⁰·½¿¬·±²-ô ×²¬»®·³ îððêô Í»½¬·±² ïðòìòêòîòì

î÷ É±´⁰⁰ô Ìòô Úò øïçèç÷ þÐ·´» Ý¿°¿½·¬§ Ð®»¼·½¬·±² Ë-·²¹ Ð¿®¿³»¬»® Ú«²½¬·±²-ôþ ·² Ð®»¼·½¬»¼ ¿²¼ Ñ¾-»®ª»¼ ß¨·¿´ Þ»¸¿ª·±® ±⁰ Ð·´»-ô Î»-«´¬- ±⁰ ¿ Ð·´» Ð®»¼·½¬·±² Í§³°±-·«³ô -°±²-±®»¼ ¾§ ¬¸» Ù»±¬»½¸²·½¿´ Û²¹·²»»®·²¹ Ü·ª·-·±² ±⁰ ßÍÝÛô Ûª¿²-¬±²ô ×Ôô Ö«²» ïçèçô ßÍÝÛ Ù»±¬»½¸²·½¿´

Í°»½·¿´ Ð«¾´·½¿¬·±² Ò±ò îíô °°ò çêóïðêò

Þ±®·²¹ ìÞôîìç
Õ»²²»¼§ ײ¬»®½¸¿²¹» Î»½±²-¬®«½¬±² ó Ð¸¿-» ì
Î¿³° îï øײóêì ÛÞ ¬± ײóêë ÍÞ÷
ÙÉÔ ø»¨¬®»³»÷ ã ð ⁰¬ ¾¹- ø⁰´±±¼ -¬¿¹»÷
ÙÉÔ ø²±®³¿´÷ ã ïçòëè ⁰¬ ¾¹- øÛ´»ª¿¬·±² ìîï ⁰¬÷ »-¬·³¿¬»¼ ¾¿-»¼ ±² Ñ¸·± Î·ª»® Ð±±´ »´»ª¿¬·±²

Í±·´ Ü»-½®·°¬·±²	Y´¿--·º·½¿¬·±² øËÍÝÍ÷	Ì±° Û´»ª¿¬·±² ø⁰¬÷	Þ±¬¬±³ U´»ª¿¬·±² ø⁰¬÷	E²¼®¿·²»¼ I¸»¿® Í¬®»²¹¬¸ ø°-⁰÷	Î¿© Ú·»´¼ ÍÐÌ Ò₆₀ øÞ´±© Y±«²¬÷	Ø¿³³»® Y±®®»½¬»¼ ÍÐÌ Òêð øÞ´±© Y±«²¬÷	U·²¿´ Y±®®»½¬»¼ ÍÐÌ Òïêð øÞ´±© Y±«²¬÷	ײ¬»®²¿´ U®·½¬·±² ß²¹´» ø¼»¹®»»÷
Í¬·⁰⁰ -·´¬§ ½´¿§	ÍÝ	ììðòëè		ìëðð	îí	íï	ìè	
	ÝÔ		ìíîòï	ïððð	è	ïï	ïì	
	ÝÔ	ìíîòï		ïððð	ë	é	è	
	ÝÔ			éëð	ì	ë	ë	
	ÝÔóÓÔ			ïîçð				
	ÝÔóÓÔ			îíð				
	ÝÔóÓÔ		ìðéòê	ïîëð	í	ì	í	
Í·´¬§ -¿²¼ ©·¬¸ ¹®¿ª»´	ÍÓ	ìðéòê			íï	ìï	íì	íé
	ÍÓ				íð	ìð	íî	íê
	ÍÓ				êè	çï	éð	ìë
	ÍÓ		íèéòê		íë	ìé	íë	íé
Ó»¼·«³ -·´¬§ -¿²¼	ÍÉóÍÓ	íèéòê			ïé	îí	ïê	íî
	ÍÉóÍÓ				ïê	îï	ïë	íï
	ÍÐóÍÓ				îî	îç	îð	íí
	ÍÐóÍÓ				ìç	êë	ìí	íç
	ÍÐóÍÓ		íêðòê		íí	ìì	îè	íë

Û¯«¿¬·±²-æ Òïã Ý₀Ò₆₀å Ý₀ãÅðòéé´±¹ïðøìðñσ₀÷Àô ¿²¼ Ý₀äîòðå ïï÷
Òêð ã øèðñêð÷Ò₆₀ å Å½±®®»-°±²¼·²¹ ¬± èðû ¸¿³³»® »ºº·½·»²½§Ã ïî÷
Òïêð ãÝ₀Òêðå ïí÷
φø¼»¹÷ãîéòï õ ðòíÒ₁₆₀ óðòððððëìÒ₁₆₀² îì÷

Î»º»®»²½»-æ ïï÷ ßßÍØÌÑ ÔÎÚÜ Þ®·¼¹» Ü»-·¹² Í°»½·º·½¿¬·±²-ô ײ¬»®·³ îððêô Í»½¬·±² ïðòìòêòî
îï÷ É±´ºº ô Ìò Úò øïçèç÷ þÐ·´» Ý¿°¿½·¬§ Ð®»¼·½¬·±² Ë-·²¹ Ð¿®¿³»¬»® Ú«²½¬·±²-ô·þ ·² Ð®»¼·½¬»¼ ¿²¼ Ñ¾-»®ª»¼ ß¨·¿´ Þ»¸¿ª·±® ±º Ð·´»-ô Î»-«´¬- ±º
¿ Ð·´» Ð®»¼·½¬·±² Í§³°±-·«³ô -°±²-±®»¼ ¾§ ¬¸» Ù»±¬»½¸²·½¿´ Û²¹·²»»®·²¹ Ü·ª·-·±²ô ßÍÝÛô Ûª¿²-¬±²ô ×Ôô Ö«²» ïçèçô ßÍÝÛ Ù»±¬»½¸²·½¿´
Í°»½·¿´ Ð«¾´·½¿¬·±² Ò±ò îíô °°ò çêóïðè

Þ±®·²¹ ìÞóîëð

Õ»²²»¼§ ײ¬»®½¸¿²¹» Î»½±²-¬®«½¬·±² óÐ¸¿-» ì

Î¿³° îï øײóêì ÛÞ ¬± ײóêë ÍÞ÷

ÙÉÔ ø»¨¬®» ³»÷ ã ð ⁰¬ ¾¹ - ø⁰´±±¼ -¬¿¹»÷

ÙÉÔ ø²±® ³¿´÷ ã îíòðé ⁰¬ ¾¹ - øÛ´»ª¿¬·±² ìîï ⁰¬÷ »-¬· ³ ¿¬»¼ ¾¿-»¼ ±² Ѹ·± Î·ª»® Ю±´ »´»ª¿¬·±²

ͱ·´ Ü»-½®·°¬·±²	Ý´¿--·⁰·½¿¬·±² øËÍÝÍ÷	Ì±° Û´»ª¿¬·±² ø⁰¬÷	Þ±¬¬±³ Û´»ª¿¬·±² ø⁰¬÷	Ë²¼®¿·²»¼ Í ¸»¿® ͬ®»²¹¬¸ ø°-⁰÷	Ì¿© Ú·»´¼ ÍÐÌ Òºò»´¼ øÞ´±© Ý±«²¬÷	Ø¿³ ³»® Ý±®®»½¬»¼ ÍÐÌ Òêð øÞ´±© Ý±«²¬÷	Ú·²¿´ Ý±®®»½¬»¼ ÍÐÌ Òï êð øÞ´±© Ý±«²¬÷	ײ¬»®²¿´ Ú®·½¬·±² ß²¹´» ø¼»¹®»»÷
Í·´¬§ -¿²¼ ©·¬¸ ½´¿§	ÍÝóÍÓ	ììììòï			ê	è	ïî	íï
	ÍÝóÍÓ				è	ïï	ïì	íï
	ÍÓ		ìííòê		ê	è	ç	íð
Í·´¬§ ½´¿§	ÝÔ	ìííòê		èïð				
	ÝÔ			êëð				
	ÝÔ			ïèìð				
	ÝÔóÓÔ			ëîð				
	ÝÔ		ìðèòï	îëð	íì	ìë	íé	
Í·´¬§ -¿²¼ ©·¬¸ ¹®¿ª»´	ÍÐóÍÓ	ìðèòï			íì	ìë	íë	íé
	ÍÐóÍÓ				íì	ìë	íì	íé
	ÍÐóÍÓ		íçïòï		îç	íç	îè	íë
Ó»¼·«³ -¿²¼	ÍÐ	íçïòï			ïð	ïí	ç	íð
	ÍÐ				íê	ìè	íí	íê
	ÍÐ		íéêòï		îê	íë	îí	íì
Í·´¬§ -¿²¼ ©·¬¸ -¿²¼§	ÍÉóÍÓ	íéêòï			íé	ìç	íî	íê
¹®¿ª»´ ´»²-»-	ÍÐóÍÓ		-»» -¸»»¬ î ±⁰ î		îì	íî	îð	íí

Û¯«¿¬·±²-æ Òïã ÝÒ Òº ß ÝÛ ÝÞ ÝÎ ÝÍ ¿²¼ Ý Ò Ý Í ï÷

Òêð ã øèðñêð÷Òº ß ½±®®»½¬·±² ⁰±® ¸¿³³»® »⁰⁰·½·»²½§ ï÷

Òï êðã ÝÒ Òêð ï÷

φ ø¼»¹÷ã îé ï õ ðòí Òï êð ó ðòððððëì Òï êð î ï÷

λ⁰»®»²½»-æ ï÷ ßßÍØÌÑ ÔÎÚÜ Þ®·¼¹» Ü»-·¹² Í°»½·⁰·½¿¬·±²- ç¬¸ ؼ·¬·±²ô îðïè

î÷ Ê±´´³ »® ÓÉ Ð®±½»»¼·²¹- ±⁰ ¬¸» ͱ«¬¸»®² ˲·ª»®-·¬§ ÍÓ Ë Í±·´ Ó»½¸¿²·½- ¿²¼ Ú±«²¼¿¬·±² Û²¹·²»»®·²¹ Ý±²⁰»®»²½» Ý¸¿°¬»® íô ͱ«²¼·²¹- ¿²¼ Ѭ¸»® Ú·»´¼ Ì»-¬-ô ÍÓ Ë Ð®»-- ¿²¼ ßÍÝÛô Ö«²» ïçêì ßÍÝÛ Ð®»-- ¿²¼ ßÍÝÛ

Í°»½·¿´ Ы¾´·½¿¬·±² Ò±ò ï ïó ° ò çêóïðê

Þ±®·²¹ ìÞó îëð

Õ»²²»¼§ ײ¬»®½¸¿²¹» λ½±²-¬®«½¬·±² óÐ¸¿-» ì

Ϊ³° îï øׯóêì ÛÞ ¬± ׯóêë ÍÞ÷

ÙÉÔ ø»¨·-¬·²¹÷ ã ð ⁰¬ ¾¹- ø⁰´±±¼ -¬¿¹»÷

ÙÉÔ ø²±®³¿´÷ ã îðòðé ⁰¬ ¾¹- øÛ´»ª¿¬·±² ìîï ⁰¬÷ »-¬·³¿¬»¼ ¾¿-»¼ ±² Ñ¸·± Ϊª»® Ð±±´ »´»ª¿¬·±²

Í±·´ Ü»-½®·°¬·±²	Ý´¿--·⁰·½¿¬·±² øËÍÝÍ÷	̱° Û´»ª¿¬·±² ø⁰¬÷	Þ±¬¬±³ Û´»ª¿¬·±² ø⁰¬÷	Ê²¼®¿·²»¼ ͸»¿® ͬ®»²¹¬¸ ø°-º÷	Ì¿© Ú·»´¼ ÍÐÌ Òº»´¼ øÞ´±© Ý±«²¬÷	Ø¿³³»® Ý±®®»½¬»¼ ÍÐÌ Òêð øÞ´±© Ý±«²¬÷	Ù·²¿´ Ý±®®»½¬»¼ ÍÐÌ Òïêð øÞ´±© Ý±«²¬÷	ײ¬»®²¿´ Ú®·½¬·±² ß²¹´» ø¼»¹®»»÷
Í·´¬§ -¿²¼ ©·¬¸ -¿²¼§	ÍÐóÍÓ				íî	ìí	îê	íë
¹®¿ª»´ ´»²-»-	ÍÉóÍÓ				îç	íç	îí	íì
	ÙÐóÙÓ				ïïí	ïëï	èè	ìç
	ÍÐóÍÓ				îé	íê	îð	íí
	ÍÐóÍÓ				ïì	ïç	ïð	íð
	ÍÓ				íë	ìé	îë	íì
	ÍÐóÍÓ				ïì	ïç	ïð	íð
	ÍÐóÍÓ		íîéòê		íí	ìì	îí	íì

Û¯«¿¬·±²-æ ÒïãÝ₀Òₒ»å Ý₀ãÅðòéé´±¹ïðøîðñσ₀ß÷Ãô ¿²¼ Ý₀äîòðå ï÷

Òêð ã øèðñêð÷Òₒ»¼ å ß½±®®»-°±²¼·²¹ ¬± èð û ¸¿³³»® »⁰⁰·½·»²½§Ã ï÷

Òïêð ãÝ₀Òêðå ï÷

φ ø¼»¹÷ã îéò ïõðòí ÒïêðóðòððëëìÒïêð î î÷

λº»®»²½»-æ ï÷ ßß ÍØÌÑ ÔÎÚÜ Þ®·¼¹» Ü»-·¹² Í°»½·⁰·½¿¬·±²-ô ײ¬»®·³ îððêô Í»½¬·±² ïðòìòêòîòì

î÷ É±´⁰⁰ô Ìò Úòô øïçèç÷ò þÐ·´» Ý¿°¿½·¬§ Ð®»¼·½¬·±² ⁄±® ß¨·¿´ Ô±¿¼·²¹ò ´² Ð®»¼·½¬»¼ ¿²¼ Ñ¾-»®ª»¼ ߨ·¿´ Þ»¸¿ª·±® ±⁰ Ð·´»-ô Î»-«´¬- ±⁰ ¿ Ð®»¼·½¬·±² ͧ³°±-·«³ Ͱⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻⲻ

Þ±®·²¹ ì É₀îéð
O»²²»¼§ ×²¬»®½¸¿²¹» ׻½±²¬®«½¬·±²
Î¿³° îï ø×₀êì ÛÞ ¬± ×₀êë ÍÞ÷
ÙÉÔ ø»¨¬®»³»÷ ã ð ⁰¬ ¾¹ ø⁰´±±¼ ¬¿¹»÷
ÙÉÔ ø²±®³¿´÷ ã îì₀ðë ⁰¬ ¾¹ øÛ´»ª¿¬·±² ìîï ⁰¬÷ »¬·³¿¬»¼ ¾¿»¼ ±² Ѹ·± Î·ª»® Ð±±´ »´»ª¿¬·±²

Í±·´ Ü»½®·°¬·±²	Y´¿·º·½¿¬·±² øËÍÝÍ÷	̱° Û´»ª¿¬·±² ø⁰¬÷	Þ±¬¬±³ U´»ª¿¬·±² ø⁰¬÷	E²¼®¿·²»¼ ͸»¿® ͬ®»²¹¬¸ ø° ⁰÷	Î¿© Ú·»´¼ ÍÐÌ Ò₀·»´¼ øÞ´±© Y±«²¬÷	Ø¿³³»® Y±®®»½¬»¼ ÍÐÌ Ò₀ êð øÞ´±© Y±«²¬÷	U·²¿´ Y±®®»½¬»¼ ÍÐÌ Òï₀êð øÞ´±© Ý±«²¬÷	ײ¬»®²¿´ U®·½¬·±² ß²¹´» ø¼»¹®»»÷
Í·´¬§ ½´¿§	ÝÔ	ììë₀ðë	ìíê₀ï	íëðð	îí	íï	ìï	
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APPENDIX D
SINGLE STEEL H-PILE CAPACITY EVALUATIONS

Resistance Factors for LRFD – Driven Piles

Axial Capacity

Skin Friction and End Bearing in Clays – Alpha Method	0.35
Skin Friction and End Bearing in Sands – Nordlund/Thurman Method	0.45

Uplift Resistance

Clays	Alpha Method	0.25
Sands	Nordlund Method	0.35

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.20	0.20	0.10	**0.09**	**0.05**	**0.13**	**0.07**	**0.00**	**0.00**
	1.00	0.00	0.30	0.30	0.15	**0.14**	**0.07**	**0.20**	**0.10**	**0.00**	**0.00**
	2.00	0.00	0.50	0.50	0.25	**0.23**	**0.11**	**0.33**	**0.16**	**0.00**	**0.00**
	3.00	0.00	0.60	0.60	0.30	**0.27**	**0.14**	**0.39**	**0.20**	**0.00**	**0.00**
	4.00	0.00	0.70	0.70	0.35	**0.32**	**0.16**	**0.46**	**0.23**	**0.00**	**0.00**
	0.00	0.00	0.90	0.90	0.45	**0.41**	**0.20**	**0.59**	**0.29**	**0.00**	**0.00**
	1.00	2.20	1.00	3.20	1.60	**1.44**	**0.72**	**2.08**	**1.04**	**0.77**	**0.39**
	2.00	3.00	1.20	4.20	2.10	**1.89**	**0.95**	**2.73**	**1.37**	**1.05**	**0.53**
	3.00	3.90	1.30	5.20	2.60	**2.34**	**1.17**	**3.38**	**1.69**	**1.37**	**0.68**
Sand	**4.00**	4.90	1.40	6.30	3.15	**2.84**	**1.42**	**4.10**	**2.05**	**1.72**	**0.86**
	5.00	6.10	1.60	7.70	3.85	**3.47**	**1.73**	**5.01**	**2.50**	**2.14**	**1.07**
	6.00	7.30	1.40	8.70	4.35	**3.92**	**1.96**	**5.66**	**2.83**	**2.56**	**1.28**
	7.00	8.70	0.90	9.60	4.80	**4.32**	**2.16**	**6.24**	**3.12**	**3.05**	**1.52**
	8.00	10.30	0.30	10.60	5.30	**4.77**	**2.39**	**6.89**	**3.45**	**3.61**	**1.80**
	9.00	11.60	0.30	11.90	5.95	**5.20**	**2.60**	**7.74**	**3.87**	**3.93**	**1.97**
	10.00	12.70	0.30	13.00	6.50	**5.58**	**2.79**	**8.45**	**4.23**	**4.21**	**2.10**
	11.00	13.90	0.30	14.20	7.10	**6.00**	**3.00**	**9.23**	**4.62**	**4.51**	**2.25**
	12.00	15.10	0.30	15.40	7.70	**6.42**	**3.21**	**10.01**	**5.01**	**4.81**	**2.40**
	13.00	16.30	0.30	16.60	8.30	**6.84**	**3.42**	**10.79**	**5.40**	**5.11**	**2.55**
	14.00	17.60	0.30	17.90	8.95	**7.30**	**3.65**	**11.64**	**5.82**	**5.43**	**2.72**
	15.00	18.90	0.30	19.20	9.60	**7.75**	**3.88**	**12.48**	**6.24**	**5.76**	**2.88**
	16.00	20.20	0.30	20.50	10.25	**8.21**	**4.10**	**13.33**	**6.66**	**6.08**	**3.04**
	17.00	21.60	0.30	21.90	10.95	**8.70**	**4.35**	**14.24**	**7.12**	**6.43**	**3.22**
	18.00	22.90	0.30	23.20	11.60	**9.15**	**4.58**	**15.08**	**7.54**	**6.76**	**3.38**
	19.00	24.30	0.30	24.60	12.30	**9.64**	**4.82**	**15.99**	**8.00**	**7.11**	**3.55**
	20.00	25.70	0.30	26.00	13.00	**10.13**	**5.07**	**16.90**	**8.45**	**7.46**	**3.73**
	21.00	27.10	0.30	27.40	13.70	**10.62**	**5.31**	**17.81**	**8.91**	**7.81**	**3.90**
	22.00	28.50	0.30	28.80	14.40	**11.11**	**5.56**	**18.72**	**9.36**	**8.16**	**4.08**
Clay	**23.00**	29.90	0.30	30.20	15.10	**11.60**	**5.80**	**19.63**	**9.82**	**8.51**	**4.25**
	24.00	31.30	0.30	31.60	15.80	**12.09**	**6.05**	**20.54**	**10.27**	**8.86**	**4.43**
	25.00	32.70	0.30	33.00	16.50	**12.58**	**6.29**	**21.45**	**10.73**	**9.21**	**4.60**
	26.00	34.10	0.30	34.40	17.20	**13.07**	**6.54**	**22.36**	**11.18**	**9.56**	**4.78**
	27.00	35.50	0.30	35.80	17.90	**13.56**	**6.78**	**23.27**	**11.64**	**9.91**	**4.95**
	28.00	36.80	0.30	37.10	18.55	**14.02**	**7.01**	**24.12**	**12.06**	**10.23**	**5.12**
	29.00	38.20	0.30	38.50	19.25	**14.51**	**7.25**	**25.03**	**12.51**	**10.58**	**5.29**
	30.00	39.60	0.30	39.90	19.95	**15.00**	**7.50**	**25.94**	**12.97**	**10.93**	**5.47**
	31.00	41.00	0.30	41.30	20.65	**15.49**	**7.74**	**26.85**	**13.42**	**11.28**	**5.64**
	32.00	42.40	0.30	42.70	21.35	**15.98**	**7.99**	**27.76**	**13.88**	**11.63**	**5.82**
	33.00	43.80	0.30	44.10	22.05	**16.47**	**8.23**	**28.67**	**14.33**	**11.98**	**5.99**
	34.00	45.20	0.30	45.50	22.75	**16.96**	**8.48**	**29.58**	**14.79**	**12.33**	**6.17**
	35.00	46.60	0.30	46.90	23.45	**17.45**	**8.72**	**30.49**	**15.24**	**12.68**	**6.34**
	36.00	48.00	1.90	49.90	24.95	**18.50**	**9.25**	**32.44**	**16.22**	**13.03**	**6.52**
	37.00	49.40	4.80	54.20	27.10	**20.00**	**10.00**	**35.23**	**17.62**	**13.38**	**6.69**
	38.00	50.70	7.80	58.50	29.25	**21.51**	**10.75**	**38.03**	**19.01**	**13.71**	**6.85**
Sand	**39.00**	54.30	8.00	62.30	31.15	**24.00**	**12.00**	**40.50**	**20.25**	**14.97**	**7.48**
	40.00	60.20	8.10	68.30	34.15	**26.70**	**13.35**	**44.40**	**22.20**	**17.03**	**8.52**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand	**41.00**	66.10	8.30	74.40	37.20	**29.44**	**14.72**	**48.36**	**24.18**	**19.10**	**9.55**
	42.00	72.20	8.50	80.70	40.35	**32.28**	**16.14**	**52.46**	**26.23**	**21.23**	**10.62**
	43.00	78.50	8.70	87.20	43.60	**35.20**	**17.60**	**56.68**	**28.34**	**23.44**	**11.72**
	44.00	84.80	8.90	93.70	46.85	**38.13**	**19.06**	**60.91**	**30.45**	**25.64**	**12.82**
	45.00	91.30	9.00	100.30	50.15	**41.10**	**20.55**	**65.20**	**32.60**	**27.92**	**13.96**
	46.00	98.00	9.20	107.20	53.60	**44.20**	**22.10**	**69.68**	**34.84**	**30.26**	**15.13**
	47.00	104.70	9.40	114.10	57.05	**47.31**	**23.65**	**74.17**	**37.08**	**32.61**	**16.30**
	48.00	111.60	9.60	121.20	60.60	**50.50**	**25.25**	**78.78**	**39.39**	**35.02**	**17.51**
	49.00	118.60	9.70	128.30	64.15	**53.70**	**26.85**	**83.40**	**41.70**	**37.47**	**18.74**
	50.00	125.80	9.90	135.70	67.85	**57.03**	**28.51**	**88.21**	**44.10**	**39.99**	**20.00**
	51.00	133.10	10.10	143.20	71.60	**60.40**	**30.20**	**93.08**	**46.54**	**42.55**	**21.27**
	52.00	140.50	10.30	150.80	75.40	**63.82**	**31.91**	**98.02**	**49.01**	**45.14**	**22.57**
	53.00	147.90	10.40	158.30	79.15	**67.20**	**33.60**	**102.90**	**51.45**	**47.73**	**23.86**
	54.00	155.30	10.60	165.90	82.95	**70.62**	**35.31**	**107.84**	**53.92**	**50.32**	**25.16**
	55.00	162.80	10.80	173.60	86.80	**74.08**	**37.04**	**112.84**	**56.42**	**52.94**	**26.47**
	56.00	170.20	11.00	181.20	90.60	**77.50**	**38.75**	**117.78**	**58.89**	**55.53**	**27.77**
	57.00	177.60	11.10	188.70	94.35	**80.88**	**40.44**	**122.66**	**61.33**	**58.12**	**29.06**
	58.00	185.00	11.30	196.30	98.15	**84.30**	**42.15**	**127.60**	**63.80**	**60.71**	**30.36**
	59.00	192.40	11.50	203.90	101.95	**87.72**	**43.86**	**132.54**	**66.27**	**63.30**	**31.65**
	60.00	199.80	11.70	211.50	105.75	**91.14**	**45.57**	**137.48**	**68.74**	**65.89**	**32.95**
	61.00	207.30	11.80	219.10	109.55	**94.56**	**47.28**	**142.42**	**71.21**	**68.52**	**34.26**
	62.00	214.70	12.00	226.70	113.35	**97.98**	**48.99**	**147.36**	**73.68**	**71.11**	**35.55**
	63.00	222.10	12.20	234.30	117.15	**101.40**	**50.70**	**152.30**	**76.15**	**73.70**	**36.85**
	64.00	229.50	12.40	241.90	120.95	**104.82**	**52.41**	**157.24**	**78.62**	**76.29**	**38.14**
	65.00	236.90	12.50	249.40	124.70	**108.19**	**54.10**	**162.11**	**81.06**	**78.88**	**39.44**
	66.00	244.30	12.70	257.00	128.50	**111.61**	**55.81**	**167.05**	**83.53**	**81.47**	**40.73**
	67.00	251.80	12.90	264.70	132.35	**115.08**	**57.54**	**172.06**	**86.03**	**84.09**	**42.05**
	68.00	259.20	13.10	272.30	136.15	**118.50**	**59.25**	**177.00**	**88.50**	**86.68**	**43.34**
	69.00	266.60	13.30	279.90	139.95	**121.92**	**60.96**	**181.94**	**90.97**	**89.27**	**44.64**
	70.00	274.00	13.40	287.40	143.70	**125.29**	**62.65**	**186.81**	**93.41**	**91.86**	**45.93**
	71.00	281.40	13.60	295.00	147.50	**128.71**	**64.36**	**191.75**	**95.88**	**94.45**	**47.23**
	72.00	288.90	13.80	302.70	151.35	**132.18**	**66.09**	**196.76**	**98.38**	**97.08**	**48.54**
	73.00	296.30	14.00	310.30	155.15	**135.60**	**67.80**	**201.70**	**100.85**	**99.67**	**49.83**
	74.00	303.70	14.10	317.80	158.90	**138.97**	**69.49**	**206.57**	**103.29**	**102.26**	**51.13**
	75.00	311.10	14.30	325.40	162.70	**142.39**	**71.20**	**211.51**	**105.76**	**104.85**	**52.42**
	76.00	318.50	14.50	333.00	166.50	**145.81**	**72.91**	**216.45**	**108.23**	**107.44**	**53.72**
	77.00	325.90	14.70	340.60	170.30	**149.23**	**74.62**	**221.39**	**110.70**	**110.03**	**55.01**
	78.00	333.40	14.80	348.20	174.10	**152.65**	**76.32**	**226.33**	**113.17**	**112.65**	**56.33**
	79.00	340.80	15.00	355.80	177.90	**156.07**	**78.04**	**231.27**	**115.64**	**115.24**	**57.62**
	80.00	348.20	15.20	363.40	181.70	**159.49**	**79.74**	**236.21**	**118.11**	**117.83**	**58.92**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand	**81.00**	355.60	15.40	371.00	185.50	**162.91**	**81.46**	**241.15**	**120.58**	**120.42**	**60.21**
	82.00	363.00	15.50	378.50	189.25	**166.29**	**83.14**	**246.03**	**123.01**	**123.01**	**61.51**
	83.00	370.40	15.70	386.10	193.05	**169.71**	**84.85**	**250.97**	**125.48**	**125.60**	**62.80**
	84.00	377.90	15.90	393.80	196.90	**173.17**	**86.58**	**255.97**	**127.99**	**128.23**	**64.11**
	85.00	385.30	16.10	401.40	200.70	**176.59**	**88.29**	**260.91**	**130.46**	**130.82**	**65.41**
	86.00	392.70	16.20	408.90	204.45	**179.97**	**89.98**	**265.79**	**132.89**	**133.41**	**66.70**
	87.00	400.10	16.40	416.50	208.25	**183.39**	**91.69**	**270.73**	**135.36**	**136.00**	**68.00**
	88.00	407.50	16.60	424.10	212.05	**186.81**	**93.40**	**275.67**	**137.83**	**138.59**	**69.29**
	89.00	414.90	16.70	431.60	215.80	**190.18**	**95.09**	**280.54**	**140.27**	**141.18**	**70.59**
	90.00	422.40	16.80	439.20	219.60	**193.60**	**96.80**	**285.48**	**142.74**	**143.80**	**71.90**
	91.00	429.80	16.80	446.60	223.30	**196.93**	**98.46**	**290.29**	**145.15**	**146.39**	**73.20**
	92.00	437.20	16.80	454.00	227.00	**200.26**	**100.13**	**295.10**	**147.55**	**148.98**	**74.49**
	93.00	444.60	16.80	461.40	230.70	**203.59**	**101.80**	**299.91**	**149.96**	**151.57**	**75.79**
	94.00	452.00	16.80	468.80	234.40	**206.92**	**103.46**	**304.72**	**152.36**	**154.16**	**77.08**
	95.00	459.50	16.80	476.30	238.15	**210.30**	**105.15**	**309.60**	**154.80**	**156.79**	**78.39**
	96.00	466.90	16.80	483.70	241.85	**213.63**	**106.81**	**314.41**	**157.20**	**159.38**	**79.69**
	97.00	474.30	16.80	491.10	245.55	**216.96**	**108.48**	**319.22**	**159.61**	**161.97**	**80.98**
	98.00	481.70	16.80	498.50	249.25	**220.29**	**110.14**	**324.03**	**162.01**	**164.56**	**82.28**
	99.00	489.10	16.80	505.90	252.95	**223.62**	**111.81**	**328.84**	**164.42**	**167.15**	**83.57**
	100.00	496.50	16.80	513.30	256.65	**226.95**	**113.47**	**333.65**	**166.82**	**169.74**	**84.87**
	101.00	504.00	16.80	520.80	260.40	**230.32**	**115.16**	**338.52**	**169.26**	**172.36**	**86.18**
	102.00	511.40	16.80	528.20	264.10	**233.65**	**116.83**	**343.33**	**171.67**	**174.95**	**87.48**
	103.00	518.80	16.80	535.60	267.80	**236.98**	**118.49**	**348.14**	**174.07**	**177.54**	**88.77**
	104.00	526.20	16.80	543.00	271.50	**240.31**	**120.16**	**352.95**	**176.48**	**180.13**	**90.07**
	105.00	533.60	16.80	550.40	275.20	**243.64**	**121.82**	**357.76**	**178.88**	**182.72**	**91.36**
	106.00	541.00	16.80	557.80	278.90	**246.97**	**123.49**	**362.57**	**181.29**	**185.31**	**92.66**
	107.00	548.50	16.80	565.30	282.65	**250.35**	**125.17**	**367.45**	**183.72**	**187.94**	**93.97**
	108.00	555.90	16.80	572.70	286.35	**253.68**	**126.84**	**372.26**	**186.13**	**190.53**	**95.26**
	109.00	563.30	16.80	580.10	290.05	**257.01**	**128.50**	**377.07**	**188.53**	**193.12**	**96.56**
	110.00	570.70	16.80	587.50	293.75	**260.34**	**130.17**	**381.88**	**190.94**	**195.71**	**97.85**
	111.00	578.10	16.80	594.90	297.45	**263.67**	**131.83**	**386.69**	**193.34**	**198.30**	**99.15**
	112.00	585.60	16.80	602.40	301.20	**267.04**	**133.52**	**391.56**	**195.78**	**200.92**	**100.46**
	113.00	593.00	16.80	609.80	304.90	**270.37**	**135.19**	**396.37**	**198.19**	**203.51**	**101.76**
	114.00	600.40	16.80	617.20	308.60	**273.70**	**136.85**	**401.18**	**200.59**	**206.10**	**103.05**
	115.00	607.80	16.80	624.60	312.30	**277.03**	**138.52**	**405.99**	**203.00**	**208.69**	**104.35**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.30	0.30	0.15	**0.14**	**0.07**	**0.20**	**0.10**	**0.00**	**0.00**
	1.00	0.00	0.50	0.50	0.25	**0.23**	**0.11**	**0.33**	**0.16**	**0.00**	**0.00**
	2.00	0.00	0.70	0.70	0.35	**0.32**	**0.16**	**0.46**	**0.23**	**0.00**	**0.00**
	3.00	0.00	0.90	0.90	0.45	**0.41**	**0.20**	**0.59**	**0.29**	**0.00**	**0.00**
	4.00	0.00	1.10	1.10	0.55	**0.50**	**0.25**	**0.72**	**0.36**	**0.00**	**0.00**
	0.00	0.00	1.20	1.20	0.60	**0.54**	**0.27**	**0.78**	**0.39**	**0.00**	**0.00**
	1.00	2.60	1.40	4.00	2.00	**1.80**	**0.90**	**2.60**	**1.30**	**0.91**	**0.46**
	2.00	3.50	1.60	5.10	2.55	**2.30**	**1.15**	**3.32**	**1.66**	**1.23**	**0.61**
	3.00	4.60	1.80	6.40	3.20	**2.88**	**1.44**	**4.16**	**2.08**	**1.61**	**0.81**
Sand	**4.00**	5.80	2.00	7.80	3.90	**3.51**	**1.76**	**5.07**	**2.54**	**2.03**	**1.02**
	5.00	7.20	2.20	9.40	4.70	**4.23**	**2.12**	**6.11**	**3.06**	**2.52**	**1.26**
	6.00	8.70	1.70	10.40	5.20	**4.68**	**2.34**	**6.76**	**3.38**	**3.05**	**1.52**
	7.00	10.30	1.10	11.40	5.70	**5.13**	**2.57**	**7.41**	**3.71**	**3.61**	**1.80**
	8.00	12.10	0.50	12.60	6.30	**5.67**	**2.84**	**8.19**	**4.10**	**4.24**	**2.12**
	9.00	13.70	0.50	14.20	7.10	**6.18**	**3.09**	**9.23**	**4.62**	**4.64**	**2.32**
	10.00	15.10	0.50	15.60	7.80	**6.67**	**3.34**	**10.14**	**5.07**	**4.99**	**2.49**
	11.00	16.40	0.50	16.90	8.45	**7.13**	**3.56**	**10.99**	**5.49**	**5.31**	**2.66**
	12.00	17.80	0.50	18.30	9.15	**7.62**	**3.81**	**11.90**	**5.95**	**5.66**	**2.83**
	13.00	19.30	0.50	19.80	9.90	**8.14**	**4.07**	**12.87**	**6.44**	**6.04**	**3.02**
	14.00	20.80	0.50	21.30	10.65	**8.67**	**4.33**	**13.85**	**6.92**	**6.41**	**3.21**
	15.00	22.30	0.50	22.80	11.40	**9.19**	**4.60**	**14.82**	**7.41**	**6.79**	**3.39**
	16.00	23.90	0.50	24.40	12.20	**9.75**	**4.88**	**15.86**	**7.93**	**7.19**	**3.59**
	17.00	25.50	0.50	26.00	13.00	**10.31**	**5.16**	**16.90**	**8.45**	**7.59**	**3.79**
	18.00	27.20	0.50	27.70	13.85	**10.91**	**5.45**	**18.01**	**9.00**	**8.01**	**4.01**
	19.00	28.80	0.50	29.30	14.65	**11.47**	**5.73**	**19.05**	**9.52**	**8.41**	**4.21**
	20.00	30.40	0.50	30.90	15.45	**12.03**	**6.01**	**20.09**	**10.04**	**8.81**	**4.41**
	21.00	32.10	0.50	32.60	16.30	**12.62**	**6.31**	**21.19**	**10.60**	**9.24**	**4.62**
	22.00	33.70	0.50	34.20	17.10	**13.18**	**6.59**	**22.23**	**11.12**	**9.64**	**4.82**
Clay	**23.00**	35.40	0.50	35.90	17.95	**13.78**	**6.89**	**23.34**	**11.67**	**10.06**	**5.03**
	24.00	37.00	0.50	37.50	18.75	**14.34**	**7.17**	**24.38**	**12.19**	**10.46**	**5.23**
	25.00	38.70	0.50	39.20	19.60	**14.93**	**7.47**	**25.48**	**12.74**	**10.89**	**5.44**
	26.00	40.30	0.50	40.80	20.40	**15.49**	**7.75**	**26.52**	**13.26**	**11.29**	**5.64**
	27.00	42.00	0.50	42.50	21.25	**16.09**	**8.04**	**27.63**	**13.81**	**11.71**	**5.86**
	28.00	43.60	0.50	44.10	22.05	**16.65**	**8.32**	**28.67**	**14.33**	**12.11**	**6.06**
	29.00	45.20	0.50	45.70	22.85	**17.21**	**8.60**	**29.71**	**14.85**	**12.51**	**6.26**
	30.00	46.90	0.50	47.40	23.70	**17.80**	**8.90**	**30.81**	**15.41**	**12.94**	**6.47**
	31.00	48.50	0.50	49.00	24.50	**18.36**	**9.18**	**31.85**	**15.93**	**13.34**	**6.67**
	32.00	50.20	0.50	50.70	25.35	**18.96**	**9.48**	**32.96**	**16.48**	**13.76**	**6.88**
	33.00	51.80	0.50	52.30	26.15	**19.52**	**9.76**	**34.00**	**17.00**	**14.16**	**7.08**
	34.00	53.50	0.50	54.00	27.00	**20.11**	**10.06**	**35.10**	**17.55**	**14.59**	**7.29**
	35.00	55.10	0.50	55.60	27.80	**20.67**	**10.34**	**36.14**	**18.07**	**14.99**	**7.49**
	36.00	56.80	3.80	60.60	30.30	**22.42**	**11.21**	**39.39**	**19.70**	**15.41**	**7.71**
	37.00	58.40	7.30	65.70	32.85	**24.21**	**12.10**	**42.71**	**21.35**	**15.81**	**7.91**
	38.00	60.00	10.80	70.80	35.40	**25.99**	**13.00**	**46.02**	**23.01**	**16.21**	**8.11**
Sand	**39.00**	64.30	11.10	75.40	37.70	**29.14**	**14.57**	**49.01**	**24.51**	**17.72**	**8.86**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	71.20	11.30	82.50	41.25	**32.34**	**16.17**	**53.63**	**26.81**	**20.13**	**10.07**
	41.00	78.30	11.50	89.80	44.90	**35.62**	**17.81**	**58.37**	**29.19**	**22.62**	**11.31**
	42.00	85.50	11.80	97.30	48.65	**39.00**	**19.50**	**63.25**	**31.62**	**25.14**	**12.57**
	43.00	92.90	12.00	104.90	52.45	**42.42**	**21.21**	**68.19**	**34.09**	**27.73**	**13.86**
	44.00	100.40	12.30	112.70	56.35	**45.93**	**22.96**	**73.26**	**36.63**	**30.35**	**15.18**
	45.00	108.10	12.50	120.60	60.30	**49.48**	**24.74**	**78.39**	**39.20**	**33.05**	**16.52**
	46.00	115.90	12.80	128.70	64.35	**53.13**	**26.56**	**83.66**	**41.83**	**35.78**	**17.89**
	47.00	123.90	13.00	136.90	68.45	**56.82**	**28.41**	**88.99**	**44.49**	**38.58**	**19.29**
	48.00	132.10	13.20	145.30	72.65	**60.60**	**30.30**	**94.45**	**47.22**	**41.45**	**20.72**
	49.00	140.40	13.50	153.90	76.95	**64.47**	**32.23**	**100.04**	**50.02**	**44.35**	**22.18**
	50.00	148.90	13.70	162.60	81.30	**68.38**	**34.19**	**105.69**	**52.85**	**47.33**	**23.66**
	51.00	157.50	14.00	171.50	85.75	**72.39**	**36.19**	**111.48**	**55.74**	**50.34**	**25.17**
	52.00	166.30	14.20	180.50	90.25	**76.44**	**38.22**	**117.33**	**58.66**	**53.42**	**26.71**
	53.00	175.10	14.50	189.60	94.80	**80.53**	**40.27**	**123.24**	**61.62**	**56.50**	**28.25**
	54.00	183.80	14.70	198.50	99.25	**84.54**	**42.27**	**129.03**	**64.51**	**59.54**	**29.77**
	55.00	192.60	14.90	207.50	103.75	**88.59**	**44.29**	**134.88**	**67.44**	**62.62**	**31.31**
	56.00	201.40	15.20	216.60	108.30	**92.68**	**46.34**	**140.79**	**70.40**	**65.70**	**32.85**
	57.00	210.20	15.40	225.60	112.80	**96.73**	**48.37**	**146.64**	**73.32**	**68.78**	**34.39**
Sand	**58.00**	218.90	15.70	234.60	117.30	**100.78**	**50.39**	**152.49**	**76.25**	**71.83**	**35.91**
	59.00	227.70	15.90	243.60	121.80	**104.83**	**52.42**	**158.34**	**79.17**	**74.91**	**37.45**
	60.00	236.50	16.20	252.70	126.35	**108.93**	**54.46**	**164.26**	**82.13**	**77.99**	**38.99**
	61.00	245.30	16.40	261.70	130.85	**112.98**	**56.49**	**170.11**	**85.05**	**81.07**	**40.53**
	62.00	254.10	16.70	270.80	135.40	**117.07**	**58.54**	**176.02**	**88.01**	**84.15**	**42.07**
	63.00	262.80	16.90	279.70	139.85	**121.08**	**60.54**	**181.81**	**90.90**	**87.19**	**43.60**
	64.00	271.60	17.10	288.70	144.35	**125.13**	**62.56**	**187.66**	**93.83**	**90.27**	**45.14**
	65.00	280.40	17.40	297.80	148.90	**129.22**	**64.61**	**193.57**	**96.79**	**93.35**	**46.68**
	66.00	289.20	17.60	306.80	153.40	**133.27**	**66.64**	**199.42**	**99.71**	**96.43**	**48.22**
	67.00	297.90	17.90	315.80	157.90	**137.32**	**68.66**	**205.27**	**102.64**	**99.48**	**49.74**
	68.00	306.70	18.10	324.80	162.40	**141.37**	**70.69**	**211.12**	**105.56**	**102.56**	**51.28**
	69.00	315.50	18.40	333.90	166.95	**145.47**	**72.73**	**217.04**	**108.52**	**105.64**	**52.82**
	70.00	324.30	18.60	342.90	171.45	**149.52**	**74.76**	**222.89**	**111.44**	**108.72**	**54.36**
	71.00	333.10	18.80	351.90	175.95	**153.57**	**76.78**	**228.74**	**114.37**	**111.80**	**55.90**
	72.00	341.80	19.10	360.90	180.45	**157.62**	**78.81**	**234.59**	**117.29**	**114.84**	**57.42**
	73.00	350.60	19.30	369.90	184.95	**161.67**	**80.83**	**240.44**	**120.22**	**117.92**	**58.96**
	74.00	359.40	19.60	379.00	189.50	**165.76**	**82.88**	**246.35**	**123.18**	**121.00**	**60.50**
	75.00	368.20	19.80	388.00	194.00	**169.81**	**84.91**	**252.20**	**126.10**	**124.08**	**62.04**
	76.00	376.90	20.10	397.00	198.50	**173.86**	**86.93**	**258.05**	**129.03**	**127.13**	**63.56**
	77.00	385.70	20.30	406.00	203.00	**177.91**	**88.96**	**263.90**	**131.95**	**130.21**	**65.10**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	78.00	394.50	20.50	415.00	207.50	181.96	90.98	269.75	134.88	133.29	66.64
	79.00	403.30	20.80	424.10	212.05	186.06	93.03	275.67	137.83	136.37	68.18
	80.00	412.10	21.00	433.10	216.55	190.11	95.05	281.52	140.76	139.45	69.72
	81.00	420.80	21.30	442.10	221.05	194.16	97.08	287.37	143.68	142.49	71.25
	82.00	429.60	21.50	451.10	225.55	198.21	99.10	293.22	146.61	145.57	72.79
	83.00	438.40	21.80	460.20	230.10	202.30	101.15	299.13	149.57	148.65	74.33
	84.00	447.20	22.00	469.20	234.60	206.35	103.18	304.98	152.49	151.73	75.87
	85.00	455.90	22.20	478.10	239.05	210.36	105.18	310.77	155.38	154.78	77.39
	86.00	464.70	22.50	487.20	243.60	214.45	107.23	316.68	158.34	157.86	78.93
	87.00	473.50	22.70	496.20	248.10	218.50	109.25	322.53	161.27	160.94	80.47
	88.00	482.30	22.90	505.20	252.60	222.55	111.28	328.38	164.19	164.02	82.01
	89.00	491.10	23.10	514.20	257.10	226.60	113.30	334.23	167.12	167.10	83.55
	90.00	499.80	23.20	523.00	261.50	230.56	115.28	339.95	169.98	170.14	85.07
	91.00	508.60	23.20	531.80	265.90	234.52	117.26	345.67	172.84	173.22	86.61
	92.00	517.40	23.20	540.60	270.30	238.48	119.24	351.39	175.70	176.30	88.15
	93.00	526.20	23.20	549.40	274.70	242.44	121.22	357.11	178.56	179.38	89.69
	94.00	534.90	23.20	558.10	279.05	246.36	123.18	362.77	181.38	182.43	91.21
	95.00	543.70	23.20	566.90	283.45	250.32	125.16	368.49	184.24	185.51	92.75
	96.00	552.50	23.20	575.70	287.85	254.28	127.14	374.21	187.10	188.59	94.29
Sand	97.00	561.30	23.20	584.50	292.25	258.24	129.12	379.93	189.96	191.67	95.83
	98.00	570.10	23.20	593.30	296.65	262.20	131.10	385.65	192.82	194.75	97.37
	99.00	578.80	23.20	602.00	301.00	266.11	133.06	391.30	195.65	197.79	98.90
	100.00	587.60	23.20	610.80	305.40	270.07	135.04	397.02	198.51	200.87	100.44
	101.00	596.40	23.20	619.60	309.80	274.03	137.02	402.74	201.37	203.95	101.98
	102.00	605.20	23.20	628.40	314.20	277.99	139.00	408.46	204.23	207.03	103.52
	103.00	614.00	23.20	637.20	318.60	281.95	140.98	414.18	207.09	210.11	105.06
	104.00	622.70	23.20	645.90	322.95	285.87	142.93	419.84	209.92	213.16	106.58
	105.00	631.50	23.20	654.70	327.35	289.83	144.91	425.56	212.78	216.24	108.12
	106.00	640.30	23.20	663.50	331.75	293.79	146.89	431.28	215.64	219.32	109.66
	107.00	649.10	23.20	672.30	336.15	297.75	148.87	437.00	218.50	222.40	111.20
	108.00	657.80	23.20	681.00	340.50	301.66	150.83	442.65	221.33	225.44	112.72
	109.00	666.60	23.20	689.80	344.90	305.62	152.81	448.37	224.19	228.52	114.26
	110.00	675.40	23.20	698.60	349.30	309.58	154.79	454.09	227.05	231.60	115.80
	111.00	684.20	23.20	707.40	353.70	313.54	156.77	459.81	229.91	234.68	117.34
	112.00	693.00	23.20	716.20	358.10	317.50	158.75	465.53	232.77	237.76	118.88
	113.00	701.70	23.20	724.90	362.45	321.42	160.71	471.19	235.59	240.81	120.40
	114.00	710.50	23.20	733.70	366.85	325.38	162.69	476.91	238.45	243.89	121.94
	115.00	719.30	23.20	742.50	371.25	329.34	164.67	482.63	241.31	246.97	123.48

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.40	0.40	0.20	**0.18**	**0.09**	**0.26**	**0.13**	**0.00**	**0.00**
	1.00	0.00	0.60	0.60	0.30	**0.27**	**0.14**	**0.39**	**0.20**	**0.00**	**0.00**
	2.00	0.00	0.80	0.80	0.40	**0.36**	**0.18**	**0.52**	**0.26**	**0.00**	**0.00**
	3.00	0.00	1.10	1.10	0.55	**0.50**	**0.25**	**0.72**	**0.36**	**0.00**	**0.00**
	4.00	0.00	1.30	1.30	0.65	**0.59**	**0.29**	**0.85**	**0.42**	**0.00**	**0.00**
	0.00	0.00	1.50	1.50	0.75	**0.68**	**0.34**	**0.98**	**0.49**	**0.00**	**0.00**
	1.00	2.60	1.80	4.40	2.20	**1.98**	**0.99**	**2.86**	**1.43**	**0.91**	**0.46**
	2.00	3.60	2.00	5.60	2.80	**2.52**	**1.26**	**3.64**	**1.82**	**1.26**	**0.63**
	3.00	4.70	2.20	6.90	3.45	**3.11**	**1.55**	**4.49**	**2.24**	**1.65**	**0.82**
Sand	**4.00**	5.90	2.50	8.40	4.20	**3.78**	**1.89**	**5.46**	**2.73**	**2.07**	**1.03**
	5.00	7.30	2.70	10.00	5.00	**4.50**	**2.25**	**6.50**	**3.25**	**2.56**	**1.28**
	6.00	8.80	2.10	10.90	5.45	**4.91**	**2.45**	**7.09**	**3.54**	**3.08**	**1.54**
	7.00	10.50	1.40	11.90	5.95	**5.36**	**2.68**	**7.74**	**3.87**	**3.68**	**1.84**
	8.00	12.30	0.60	12.90	6.45	**5.81**	**2.90**	**8.39**	**4.19**	**4.31**	**2.15**
	9.00	13.90	0.60	14.50	7.25	**6.31**	**3.15**	**9.43**	**4.71**	**4.71**	**2.35**
	10.00	15.20	0.60	15.80	7.90	**6.76**	**3.38**	**10.27**	**5.14**	**5.03**	**2.52**
	11.00	16.60	0.60	17.20	8.60	**7.25**	**3.63**	**11.18**	**5.59**	**5.38**	**2.69**
	12.00	18.00	0.60	18.60	9.30	**7.74**	**3.87**	**12.09**	**6.05**	**5.73**	**2.87**
	13.00	19.50	0.60	20.10	10.05	**8.27**	**4.13**	**13.07**	**6.53**	**6.11**	**3.05**
	14.00	21.00	0.60	21.60	10.80	**8.79**	**4.40**	**14.04**	**7.02**	**6.48**	**3.24**
	15.00	22.60	0.60	23.20	11.60	**9.35**	**4.68**	**15.08**	**7.54**	**6.88**	**3.44**
	16.00	24.20	0.60	24.80	12.40	**9.91**	**4.96**	**16.12**	**8.06**	**7.28**	**3.64**
	17.00	25.80	0.60	26.40	13.20	**10.47**	**5.24**	**17.16**	**8.58**	**7.68**	**3.84**
	18.00	27.50	0.60	28.10	14.05	**11.07**	**5.53**	**18.27**	**9.13**	**8.11**	**4.05**
Clay	**19.00**	29.10	0.60	29.70	14.85	**11.63**	**5.81**	**19.31**	**9.65**	**8.51**	**4.25**
	20.00	30.80	0.60	31.40	15.70	**12.22**	**6.11**	**20.41**	**10.21**	**8.93**	**4.47**
	21.00	32.50	0.60	33.10	16.55	**12.82**	**6.41**	**21.52**	**10.76**	**9.36**	**4.68**
	22.00	34.10	0.60	34.70	17.35	**13.38**	**6.69**	**22.56**	**11.28**	**9.76**	**4.88**
	23.00	35.80	0.60	36.40	18.20	**13.97**	**6.99**	**23.66**	**11.83**	**10.18**	**5.09**
	24.00	37.50	0.60	38.10	19.05	**14.57**	**7.28**	**24.77**	**12.38**	**10.61**	**5.30**
	25.00	39.10	0.60	39.70	19.85	**15.13**	**7.56**	**25.81**	**12.90**	**11.01**	**5.50**
	26.00	40.80	0.60	41.40	20.70	**15.72**	**7.86**	**26.91**	**13.46**	**11.43**	**5.72**
	27.00	42.40	0.60	43.00	21.50	**16.28**	**8.14**	**27.95**	**13.98**	**11.83**	**5.92**
	28.00	44.10	0.60	44.70	22.35	**16.88**	**8.44**	**29.06**	**14.53**	**12.26**	**6.13**
	29.00	45.80	0.60	46.40	23.20	**17.47**	**8.74**	**30.16**	**15.08**	**12.68**	**6.34**
	30.00	47.40	0.60	48.00	24.00	**18.03**	**9.02**	**31.20**	**15.60**	**13.08**	**6.54**
	31.00	49.10	0.60	49.70	24.85	**18.63**	**9.31**	**32.31**	**16.15**	**13.51**	**6.75**
	32.00	50.80	0.60	51.40	25.70	**19.22**	**9.61**	**33.41**	**16.71**	**13.93**	**6.97**
	33.00	52.40	0.60	53.00	26.50	**19.78**	**9.89**	**34.45**	**17.23**	**14.33**	**7.17**
	34.00	54.10	0.60	54.70	27.35	**20.38**	**10.19**	**35.56**	**17.78**	**14.76**	**7.38**
Clay	**35.00**	55.80	0.70	56.50	28.25	**21.01**	**10.50**	**36.73**	**18.36**	**15.18**	**7.59**
	36.00	57.40	4.80	62.20	31.10	**23.00**	**11.50**	**40.43**	**20.22**	**15.58**	**7.79**
	37.00	59.10	8.90	68.00	34.00	**25.03**	**12.52**	**44.20**	**22.10**	**16.01**	**8.00**
	38.00	60.80	13.20	74.00	37.00	**27.13**	**13.57**	**48.10**	**24.05**	**16.43**	**8.22**
Sand	**39.00**	65.00	13.50	78.50	39.25	**30.48**	**15.24**	**51.03**	**25.51**	**17.90**	**8.95**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	72.00	13.80	85.80	42.90	**33.76**	**16.88**	**55.77**	**27.89**	**20.35**	**10.18**
	41.00	79.20	14.10	93.30	46.65	**37.14**	**18.57**	**60.65**	**30.32**	**22.87**	**11.44**
	42.00	86.50	14.40	100.90	50.45	**40.56**	**20.28**	**65.59**	**32.79**	**25.43**	**12.71**
	43.00	94.00	14.70	108.70	54.35	**44.07**	**22.03**	**70.66**	**35.33**	**28.05**	**14.03**
	44.00	101.60	15.00	116.60	58.30	**47.62**	**23.81**	**75.79**	**37.90**	**30.71**	**15.36**
	45.00	109.40	15.30	124.70	62.35	**51.27**	**25.63**	**81.06**	**40.53**	**33.44**	**16.72**
	46.00	117.30	15.60	132.90	66.45	**54.96**	**27.48**	**86.39**	**43.19**	**36.21**	**18.10**
	47.00	125.40	15.90	141.30	70.65	**58.74**	**29.37**	**91.85**	**45.92**	**39.04**	**19.52**
	48.00	133.60	16.20	149.80	74.90	**62.56**	**31.28**	**97.37**	**48.69**	**41.91**	**20.96**
	49.00	142.10	16.50	158.60	79.30	**66.52**	**33.26**	**103.09**	**51.55**	**44.89**	**22.44**
	50.00	150.60	16.80	167.40	83.70	**70.48**	**35.24**	**108.81**	**54.41**	**47.86**	**23.93**
	51.00	159.30	17.10	176.40	88.20	**74.53**	**37.27**	**114.66**	**57.33**	**50.91**	**25.45**
	52.00	168.20	17.30	185.50	92.75	**78.63**	**39.31**	**120.58**	**60.29**	**54.02**	**27.01**
	53.00	177.10	17.60	194.70	97.35	**82.77**	**41.38**	**126.56**	**63.28**	**57.14**	**28.57**
	54.00	186.00	17.90	203.90	101.95	**86.91**	**43.45**	**132.54**	**66.27**	**60.25**	**30.13**
	55.00	194.90	18.20	213.10	106.55	**91.05**	**45.52**	**138.52**	**69.26**	**63.37**	**31.68**
	56.00	203.70	18.50	222.20	111.10	**95.14**	**47.57**	**144.43**	**72.22**	**66.45**	**33.22**
Sand	**57.00**	212.60	18.80	231.40	115.70	**99.28**	**49.64**	**150.41**	**75.21**	**69.56**	**34.78**
	58.00	221.50	19.10	240.60	120.30	**103.42**	**51.71**	**156.39**	**78.20**	**72.68**	**36.34**
	59.00	230.40	19.40	249.80	124.90	**107.56**	**53.78**	**162.37**	**81.19**	**75.79**	**37.90**
	60.00	239.30	19.70	259.00	129.50	**111.70**	**55.85**	**168.35**	**84.18**	**78.91**	**39.45**
	61.00	248.10	20.00	268.10	134.05	**115.80**	**57.90**	**174.27**	**87.13**	**81.99**	**40.99**
	62.00	257.00	20.30	277.30	138.65	**119.94**	**59.97**	**180.25**	**90.12**	**85.10**	**42.55**
	63.00	265.90	20.60	286.50	143.25	**124.08**	**62.04**	**186.23**	**93.11**	**88.22**	**44.11**
	64.00	274.80	20.90	295.70	147.85	**128.22**	**64.11**	**192.21**	**96.10**	**91.33**	**45.67**
	65.00	283.70	21.20	304.90	152.45	**132.36**	**66.18**	**198.19**	**99.09**	**94.45**	**47.22**
	66.00	292.50	21.50	314.00	157.00	**136.45**	**68.23**	**204.10**	**102.05**	**97.53**	**48.76**
	67.00	301.40	21.80	323.20	161.60	**140.59**	**70.30**	**210.08**	**105.04**	**100.64**	**50.32**
	68.00	310.30	22.10	332.40	166.20	**144.73**	**72.37**	**216.06**	**108.03**	**103.76**	**51.88**
	69.00	319.20	22.40	341.60	170.80	**148.87**	**74.44**	**222.04**	**111.02**	**106.87**	**53.44**
	70.00	328.10	22.70	350.80	175.40	**153.01**	**76.51**	**228.02**	**114.01**	**109.99**	**54.99**
	71.00	337.00	23.00	360.00	180.00	**157.15**	**78.58**	**234.00**	**117.00**	**113.10**	**56.55**
	72.00	345.80	23.30	369.10	184.55	**161.25**	**80.62**	**239.92**	**119.96**	**116.18**	**58.09**
	73.00	354.70	23.60	378.30	189.15	**165.39**	**82.69**	**245.90**	**122.95**	**119.30**	**59.65**
	74.00	363.60	23.90	387.50	193.75	**169.53**	**84.76**	**251.88**	**125.94**	**122.41**	**61.21**
	75.00	372.50	24.20	396.70	198.35	**173.67**	**86.83**	**257.86**	**128.93**	**125.53**	**62.76**
	76.00	381.40	24.50	405.90	202.95	**177.81**	**88.90**	**263.84**	**131.92**	**128.64**	**64.32**
	77.00	390.20	24.80	415.00	207.50	**181.90**	**90.95**	**269.75**	**134.88**	**131.72**	**65.86**
	78.00	399.10	25.10	424.20	212.10	**186.04**	**93.02**	**275.73**	**137.87**	**134.84**	**67.42**

Steel H-Pile Capacities
B64-2 - Piers 1 and 2
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	79.00	408.00	25.40	433.40	216.70	**190.18**	**95.09**	**281.71**	**140.86**	**137.95**	**68.98**
	80.00	416.90	25.70	442.60	221.30	**194.32**	**97.16**	**287.69**	**143.85**	**141.07**	**70.53**
	81.00	425.80	25.90	451.70	225.85	**198.42**	**99.21**	**293.61**	**146.80**	**144.18**	**72.09**
	82.00	434.60	26.20	460.80	230.40	**202.51**	**101.26**	**299.52**	**149.76**	**147.26**	**73.63**
	83.00	443.50	26.50	470.00	235.00	**206.65**	**103.33**	**305.50**	**152.75**	**150.38**	**75.19**
	84.00	452.40	26.80	479.20	239.60	**210.79**	**105.40**	**311.48**	**155.74**	**153.49**	**76.75**
	85.00	461.30	27.10	488.40	244.20	**214.93**	**107.47**	**317.46**	**158.73**	**156.61**	**78.30**
	86.00	470.20	27.40	497.60	248.80	**219.07**	**109.54**	**323.44**	**161.72**	**159.72**	**79.86**
	87.00	479.00	27.70	506.70	253.35	**223.17**	**111.58**	**329.36**	**164.68**	**162.80**	**81.40**
	88.00	487.90	28.00	515.90	257.95	**227.31**	**113.65**	**335.34**	**167.67**	**165.92**	**82.96**
	89.00	496.80	28.20	525.00	262.50	**231.40**	**115.70**	**341.25**	**170.63**	**169.03**	**84.52**
	90.00	505.70	28.30	534.00	267.00	**235.45**	**117.73**	**347.10**	**173.55**	**172.15**	**86.07**
	91.00	514.60	28.30	542.90	271.45	**239.46**	**119.73**	**352.89**	**176.44**	**175.26**	**87.63**
	92.00	523.40	28.30	551.70	275.85	**243.42**	**121.71**	**358.61**	**179.30**	**178.34**	**89.17**
	93.00	532.30	28.30	560.60	280.30	**247.42**	**123.71**	**364.39**	**182.20**	**181.46**	**90.73**
	94.00	541.20	28.30	569.50	284.75	**251.43**	**125.71**	**370.18**	**185.09**	**184.57**	**92.29**
	95.00	550.10	28.30	578.40	289.20	**255.43**	**127.72**	**375.96**	**187.98**	**187.69**	**93.84**
Sand	**96.00**	559.00	28.30	587.30	293.65	**259.44**	**129.72**	**381.75**	**190.87**	**190.80**	**95.40**
	97.00	567.90	28.30	596.20	298.10	**263.44**	**131.72**	**387.53**	**193.77**	**193.92**	**96.96**
	98.00	576.70	28.30	605.00	302.50	**267.40**	**133.70**	**393.25**	**196.63**	**197.00**	**98.50**
	99.00	585.60	28.30	613.90	306.95	**271.41**	**135.70**	**399.04**	**199.52**	**200.11**	**100.06**
	100.00	594.50	28.30	622.80	311.40	**275.41**	**137.71**	**404.82**	**202.41**	**203.23**	**101.61**
	101.00	603.40	28.30	631.70	315.85	**279.42**	**139.71**	**410.61**	**205.30**	**206.34**	**103.17**
	102.00	612.30	28.30	640.60	320.30	**283.42**	**141.71**	**416.39**	**208.20**	**209.46**	**104.73**
	103.00	621.10	28.30	649.40	324.70	**287.38**	**143.69**	**422.11**	**211.06**	**212.54**	**106.27**
	104.00	630.00	28.30	658.30	329.15	**291.39**	**145.69**	**427.90**	**213.95**	**215.65**	**107.83**
	105.00	638.90	28.30	667.20	333.60	**295.39**	**147.70**	**433.68**	**216.84**	**218.77**	**109.38**
	106.00	647.80	28.30	676.10	338.05	**299.40**	**149.70**	**439.47**	**219.73**	**221.88**	**110.94**
	107.00	656.70	28.30	685.00	342.50	**303.40**	**151.70**	**445.25**	**222.63**	**225.00**	**112.50**
	108.00	665.50	28.30	693.80	346.90	**307.36**	**153.68**	**450.97**	**225.49**	**228.08**	**114.04**
	109.00	674.40	28.30	702.70	351.35	**311.37**	**155.68**	**456.76**	**228.38**	**231.19**	**115.60**
	110.00	683.30	28.30	711.60	355.80	**315.37**	**157.69**	**462.54**	**231.27**	**234.31**	**117.15**
	111.00	692.20	28.30	720.50	360.25	**319.38**	**159.69**	**468.33**	**234.16**	**237.42**	**118.71**
	112.00	701.10	28.30	729.40	364.70	**323.38**	**161.69**	**474.11**	**237.06**	**240.54**	**120.27**
	113.00	709.90	28.30	738.20	369.10	**327.34**	**163.67**	**479.83**	**239.92**	**243.62**	**121.81**
	114.00	718.80	28.30	747.10	373.55	**331.35**	**165.67**	**485.62**	**242.81**	**246.73**	**123.37**
	115.00	727.70	28.30	756.00	378.00	**335.35**	**167.68**	**491.40**	**245.70**	**249.85**	**124.92**

Steel H-Pile Capacities
B64-2 - Piers 3-6
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation= 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand	0.00	0.00	0.20	0.20	0.10	0.09	0.05	0.13	0.07	0.00	0.00
	1.00	0.00	0.30	0.30	0.15	0.14	0.07	0.20	0.10	0.00	0.00
	2.00	0.00	0.50	0.50	0.25	0.23	0.11	0.33	0.16	0.00	0.00
	3.00	0.00	0.60	0.60	0.30	0.27	0.14	0.39	0.20	0.00	0.00
	4.00	0.00	0.70	0.70	0.35	0.32	0.16	0.46	0.23	0.00	0.00
	0.00	0.00	0.90	0.90	0.45	0.41	0.20	0.59	0.29	0.00	0.00
	1.00	2.20	1.00	3.20	1.60	1.44	0.72	2.08	1.04	0.77	0.39
	2.00	3.00	1.20	4.20	2.10	1.89	0.95	2.73	1.37	1.05	0.53
Sand	3.00	3.90	1.10	5.00	2.50	2.25	1.13	3.25	1.63	1.37	0.68
	4.00	4.90	0.80	5.70	2.85	2.57	1.28	3.71	1.85	1.72	0.86
	5.00	6.10	0.50	6.60	3.30	2.97	1.49	4.29	2.15	2.14	1.07
	6.00	7.30	0.50	7.80	3.90	3.34	1.67	5.07	2.54	2.44	1.22
	7.00	8.50	0.50	9.00	4.50	3.76	1.88	5.85	2.93	2.74	1.37
	8.00	9.70	0.50	10.20	5.10	4.18	2.09	6.63	3.32	3.04	1.52
	9.00	11.00	0.50	11.50	5.75	4.64	2.32	7.48	3.74	3.36	1.68
	10.00	12.30	0.50	12.80	6.40	5.09	2.55	8.32	4.16	3.69	1.84
	11.00	13.70	0.50	14.20	7.10	5.58	2.79	9.23	4.62	4.04	2.02
	12.00	15.10	0.50	15.60	7.80	6.07	3.04	10.14	5.07	4.39	2.19
	13.00	16.60	0.50	17.10	8.55	6.60	3.30	11.12	5.56	4.76	2.38
	14.00	18.10	0.50	18.60	9.30	7.12	3.56	12.09	6.05	5.14	2.57
	15.00	19.70	0.50	20.20	10.10	7.68	3.84	13.13	6.57	5.54	2.77
	16.00	21.30	0.50	21.80	10.90	8.24	4.12	14.17	7.09	5.94	2.97
	17.00	22.90	0.50	23.40	11.70	8.80	4.40	15.21	7.61	6.34	3.17
Clay	18.00	24.60	0.50	25.10	12.55	9.40	4.70	16.32	8.16	6.76	3.38
	19.00	26.30	0.50	26.80	13.40	9.99	5.00	17.42	8.71	7.19	3.59
	20.00	28.00	0.50	28.50	14.25	10.59	5.29	18.53	9.26	7.61	3.81
	21.00	29.80	0.50	30.30	15.15	11.22	5.61	19.70	9.85	8.06	4.03
	22.00	31.60	0.50	32.10	16.05	11.85	5.92	20.87	10.43	8.51	4.26
	23.00	33.40	0.50	33.90	16.95	12.48	6.24	22.04	11.02	8.96	4.48
	24.00	35.30	0.50	35.80	17.90	13.14	6.57	23.27	11.64	9.44	4.72
	25.00	37.20	0.50	37.70	18.85	13.81	6.90	24.51	12.25	9.91	4.96
	26.00	39.20	0.50	39.70	19.85	14.51	7.25	25.81	12.90	10.41	5.21
	27.00	41.10	0.50	41.60	20.80	15.17	7.59	27.04	13.52	10.89	5.44
	28.00	43.10	0.50	43.60	21.80	15.87	7.94	28.34	14.17	11.39	5.69
	29.00	45.10	1.90	47.00	23.50	17.06	8.53	30.55	15.28	11.89	5.94
	30.00	47.10	4.60	51.70	25.85	18.71	9.35	33.61	16.80	12.39	6.19
	31.00	49.10	7.40	56.50	28.25	20.39	10.19	36.73	18.36	12.89	6.44
Sand	32.00	52.60	7.60	60.20	30.10	22.79	11.40	39.13	19.57	14.11	7.06
	33.00	57.80	7.80	65.60	32.80	25.22	12.61	42.64	21.32	15.93	7.97
	34.00	63.10	8.00	71.10	35.55	27.70	13.85	46.22	23.11	17.79	8.89
	35.00	68.60	8.20	76.80	38.40	30.26	15.13	49.92	24.96	19.71	9.86
	36.00	74.10	8.40	82.50	41.25	32.83	16.41	53.63	26.81	21.64	10.82
	37.00	79.90	8.60	88.50	44.25	35.53	17.76	57.53	28.76	23.67	11.83
	38.00	85.70	8.80	94.50	47.25	38.23	19.11	61.43	30.71	25.70	12.85
	39.00	91.70	9.00	100.70	50.35	41.02	20.51	65.46	32.73	27.80	13.90

Steel H-Pile Capacities
B64-2 - Piers 3-6
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation= 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	97.90	9.20	107.10	53.55	**43.90**	**21.95**	**69.62**	**34.81**	**29.97**	**14.98**
	41.00	104.20	9.40	113.60	56.80	**46.82**	**23.41**	**73.84**	**36.92**	**32.17**	**16.09**
	42.00	110.60	9.60	120.20	60.10	**49.79**	**24.90**	**78.13**	**39.07**	**34.41**	**17.21**
	43.00	117.10	9.80	126.90	63.45	**52.81**	**26.40**	**82.49**	**41.24**	**36.69**	**18.34**
	44.00	123.80	10.00	133.80	66.90	**55.91**	**27.96**	**86.97**	**43.49**	**39.03**	**19.52**
	45.00	130.70	10.20	140.90	70.45	**59.11**	**29.55**	**91.59**	**45.79**	**41.45**	**20.72**
	46.00	137.60	10.40	148.00	74.00	**62.30**	**31.15**	**96.20**	**48.10**	**43.86**	**21.93**
	47.00	144.70	10.60	155.30	77.65	**65.59**	**32.79**	**100.95**	**50.47**	**46.35**	**23.17**
	48.00	152.00	10.80	162.80	81.40	**68.96**	**34.48**	**105.82**	**52.91**	**48.90**	**24.45**
	49.00	159.40	11.00	170.40	85.20	**72.38**	**36.19**	**110.76**	**55.38**	**51.49**	**25.75**
	50.00	166.90	11.20	178.10	89.05	**75.85**	**37.92**	**115.77**	**57.88**	**54.12**	**27.06**
	51.00	174.50	11.40	185.90	92.95	**79.36**	**39.68**	**120.84**	**60.42**	**56.78**	**28.39**
	52.00	182.30	11.60	193.90	96.95	**82.96**	**41.48**	**126.04**	**63.02**	**59.51**	**29.75**
	53.00	190.00	11.80	201.80	100.90	**86.51**	**43.26**	**131.17**	**65.59**	**62.20**	**31.10**
	54.00	197.70	12.00	209.70	104.85	**90.07**	**45.03**	**136.31**	**68.15**	**64.90**	**32.45**
	55.00	205.40	12.20	217.60	108.80	**93.62**	**46.81**	**141.44**	**70.72**	**67.59**	**33.80**
	56.00	213.10	12.40	225.50	112.75	**97.18**	**48.59**	**146.58**	**73.29**	**70.29**	**35.14**
	57.00	220.80	12.60	233.40	116.70	**100.73**	**50.37**	**151.71**	**75.86**	**72.98**	**36.49**
Sand	**58.00**	228.50	12.80	241.30	120.65	**104.29**	**52.14**	**156.85**	**78.42**	**75.68**	**37.84**
	59.00	236.20	13.00	249.20	124.60	**107.84**	**53.92**	**161.98**	**80.99**	**78.37**	**39.19**
	60.00	243.90	13.20	257.10	128.55	**111.40**	**55.70**	**167.12**	**83.56**	**81.07**	**40.53**
	61.00	251.60	13.40	265.00	132.50	**114.95**	**57.48**	**172.25**	**86.13**	**83.76**	**41.88**
	62.00	259.30	13.60	272.90	136.45	**118.51**	**59.25**	**177.39**	**88.69**	**86.46**	**43.23**
	63.00	267.00	13.80	280.80	140.40	**122.06**	**61.03**	**182.52**	**91.26**	**89.15**	**44.58**
	64.00	274.70	14.00	288.70	144.35	**125.62**	**62.81**	**187.66**	**93.83**	**91.85**	**45.92**
	65.00	282.40	14.20	296.60	148.30	**129.17**	**64.59**	**192.79**	**96.40**	**94.54**	**47.27**
	66.00	290.10	14.40	304.50	152.25	**132.73**	**66.36**	**197.93**	**98.96**	**97.24**	**48.62**
	67.00	297.80	14.60	312.40	156.20	**136.28**	**68.14**	**203.06**	**101.53**	**99.93**	**49.97**
	68.00	305.50	14.80	320.30	160.15	**139.84**	**69.92**	**208.20**	**104.10**	**102.63**	**51.31**
	69.00	313.20	15.00	328.20	164.10	**143.39**	**71.70**	**213.33**	**106.67**	**105.32**	**52.66**
	70.00	320.90	15.20	336.10	168.05	**146.95**	**73.47**	**218.47**	**109.23**	**108.02**	**54.01**
	71.00	328.60	15.40	344.00	172.00	**150.50**	**75.25**	**223.60**	**111.80**	**110.71**	**55.36**
	72.00	336.30	15.60	351.90	175.95	**154.06**	**77.03**	**228.74**	**114.37**	**113.41**	**56.70**
	73.00	344.00	15.70	359.70	179.85	**157.57**	**78.78**	**233.81**	**116.90**	**116.10**	**58.05**
	74.00	351.70	15.90	367.60	183.80	**161.12**	**80.56**	**238.94**	**119.47**	**118.80**	**59.40**
	75.00	359.40	16.10	375.50	187.75	**164.68**	**82.34**	**244.08**	**122.04**	**121.49**	**60.75**
	76.00	367.10	16.30	383.40	191.70	**168.23**	**84.12**	**249.21**	**124.61**	**124.19**	**62.09**
	77.00	374.80	16.50	391.30	195.65	**171.79**	**85.89**	**254.35**	**127.17**	**126.88**	**63.44**
	78.00	382.50	16.70	399.20	199.60	**175.34**	**87.67**	**259.48**	**129.74**	**129.58**	**64.79**

Steel H-Pile Capacities
B64-2 - Piers 3-6
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation= 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand	**79.00**	390.20	16.90	407.10	203.55	**178.90**	**89.45**	**264.62**	**132.31**	**132.27**	**66.14**
	80.00	397.90	17.10	415.00	207.50	**182.45**	**91.23**	**269.75**	**134.88**	**134.97**	**67.48**
	81.00	405.60	17.30	422.90	211.45	**186.01**	**93.00**	**274.89**	**137.44**	**137.66**	**68.83**
	82.00	413.40	17.50	430.90	215.45	**189.61**	**94.80**	**280.09**	**140.04**	**140.39**	**70.20**
	83.00	421.10	17.70	438.80	219.40	**193.16**	**96.58**	**285.22**	**142.61**	**143.09**	**71.54**
	84.00	428.80	17.90	446.70	223.35	**196.72**	**98.36**	**290.36**	**145.18**	**145.78**	**72.89**
	85.00	436.50	18.10	454.60	227.30	**200.27**	**100.14**	**295.49**	**147.75**	**148.48**	**74.24**
	86.00	444.20	18.30	462.50	231.25	**203.83**	**101.91**	**300.63**	**150.31**	**151.17**	**75.59**
	87.00	451.90	18.50	470.40	235.20	**207.38**	**103.69**	**305.76**	**152.88**	**153.87**	**76.93**
	88.00	459.60	18.70	478.30	239.15	**210.94**	**105.47**	**310.90**	**155.45**	**156.56**	**78.28**
	89.00	467.30	18.90	486.20	243.10	**214.49**	**107.25**	**316.03**	**158.02**	**159.26**	**79.63**
	90.00	475.00	19.10	494.10	247.05	**218.05**	**109.02**	**321.17**	**160.58**	**161.95**	**80.98**
	91.00	482.70	19.30	502.00	251.00	**221.60**	**110.80**	**326.30**	**163.15**	**164.65**	**82.32**
	92.00	490.40	19.40	509.80	254.90	**225.11**	**112.56**	**331.37**	**165.69**	**167.34**	**83.67**
	93.00	498.10	19.40	517.50	258.75	**228.58**	**114.29**	**336.38**	**168.19**	**170.04**	**85.02**
	94.00	505.80	19.40	525.20	262.60	**232.04**	**116.02**	**341.38**	**170.69**	**172.73**	**86.37**
	95.00	513.50	19.40	532.90	266.45	**235.51**	**117.75**	**346.39**	**173.19**	**175.43**	**87.71**
	96.00	521.20	19.40	540.60	270.30	**238.97**	**119.49**	**351.39**	**175.70**	**178.12**	**89.06**
	97.00	528.90	19.40	548.30	274.15	**242.44**	**121.22**	**356.40**	**178.20**	**180.82**	**90.41**
	98.00	536.60	19.40	556.00	278.00	**245.90**	**122.95**	**361.40**	**180.70**	**183.51**	**91.76**
	99.00	544.30	19.40	563.70	281.85	**249.37**	**124.68**	**366.41**	**183.20**	**186.21**	**93.10**
	100.00	552.00	19.40	571.40	285.70	**252.83**	**126.42**	**371.41**	**185.71**	**188.90**	**94.45**
	101.00	559.70	19.40	579.10	289.55	**256.30**	**128.15**	**376.42**	**188.21**	**191.60**	**95.80**
	102.00	567.40	19.40	586.80	293.40	**259.76**	**129.88**	**381.42**	**190.71**	**194.29**	**97.15**
	103.00	575.10	19.40	594.50	297.25	**263.23**	**131.61**	**386.43**	**193.21**	**196.99**	**98.49**
	104.00	582.80	19.40	602.20	301.10	**266.69**	**133.35**	**391.43**	**195.72**	**199.68**	**99.84**
	105.00	590.50	19.40	609.90	304.95	**270.16**	**135.08**	**396.44**	**198.22**	**202.38**	**101.19**
	106.00	598.20	19.40	617.60	308.80	**273.62**	**136.81**	**401.44**	**200.72**	**205.07**	**102.54**
	107.00	605.90	19.40	625.30	312.65	**277.09**	**138.54**	**406.45**	**203.22**	**207.77**	**103.88**
	108.00	613.60	19.40	633.00	316.50	**280.55**	**140.28**	**411.45**	**205.73**	**210.46**	**105.23**
	109.00	621.30	19.40	640.70	320.35	**284.02**	**142.01**	**416.46**	**208.23**	**213.16**	**106.58**
	110.00	629.00	19.40	648.40	324.20	**287.48**	**143.74**	**421.46**	**210.73**	**215.85**	**107.93**
	111.00	636.80	19.40	656.20	328.10	**290.99**	**145.50**	**426.53**	**213.27**	**218.58**	**109.29**

Steel H-Pile Capacities
B64-2 - Piers 3-6
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation= 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand ↓	**112.00**	644.50	19.40	663.90	331.95	**294.46**	**147.23**	**431.54**	**215.77**	**221.28**	**110.64**
	113.00	652.20	19.40	671.60	335.80	**297.92**	**148.96**	**436.54**	**218.27**	**223.97**	**111.99**
	114.00	659.90	19.40	679.30	339.65	**301.39**	**150.69**	**441.55**	**220.77**	**226.67**	**113.33**
	115.00	667.60	19.40	687.00	343.50	**304.85**	**152.43**	**446.55**	**223.28**	**229.36**	**114.68**

Steel H-Pile Capacities
B64-2 - Piers 3-6
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.30	0.30	0.15	**0.14**	**0.07**	**0.20**	**0.10**	**0.00**	**0.00**
	1.00	0.00	0.50	0.50	0.25	**0.23**	**0.11**	**0.33**	**0.16**	**0.00**	**0.00**
	2.00	0.00	0.70	0.70	0.35	**0.32**	**0.16**	**0.46**	**0.23**	**0.00**	**0.00**
	3.00	0.00	0.90	0.90	0.45	**0.41**	**0.20**	**0.59**	**0.29**	**0.00**	**0.00**
	4.00	0.00	1.10	1.10	0.55	**0.50**	**0.25**	**0.72**	**0.36**	**0.00**	**0.00**
Sand	0.00	0.00	1.20	1.20	0.60	**0.54**	**0.27**	**0.78**	**0.39**	**0.00**	**0.00**
	1.00	2.60	1.40	4.00	2.00	**1.80**	**0.90**	**2.60**	**1.30**	**0.91**	**0.46**
	2.00	3.50	1.60	5.10	2.55	**2.30**	**1.15**	**3.32**	**1.66**	**1.23**	**0.61**
Sand	**3.00**	4.60	1.40	6.00	3.00	**2.70**	**1.35**	**3.90**	**1.95**	**1.61**	**0.81**
	4.00	5.80	1.10	6.90	3.45	**3.11**	**1.55**	**4.49**	**2.24**	**2.03**	**1.02**
	5.00	7.20	0.70	7.90	3.95	**3.56**	**1.78**	**5.14**	**2.57**	**2.52**	**1.26**
	6.00	8.60	0.70	9.30	4.65	**3.98**	**1.99**	**6.05**	**3.02**	**2.87**	**1.44**
	7.00	10.00	0.70	10.70	5.35	**4.47**	**2.23**	**6.96**	**3.48**	**3.22**	**1.61**
	8.00	11.50	0.70	12.20	6.10	**4.99**	**2.50**	**7.93**	**3.97**	**3.60**	**1.80**
	9.00	13.00	0.70	13.70	6.85	**5.52**	**2.76**	**8.91**	**4.45**	**3.97**	**1.99**
	10.00	14.60	0.70	15.30	7.65	**6.08**	**3.04**	**9.95**	**4.97**	**4.37**	**2.19**
	11.00	16.20	0.70	16.90	8.45	**6.64**	**3.32**	**10.99**	**5.49**	**4.77**	**2.39**
	12.00	17.90	0.70	18.60	9.30	**7.23**	**3.62**	**12.09**	**6.05**	**5.20**	**2.60**
	13.00	19.70	0.70	20.40	10.20	**7.86**	**3.93**	**13.26**	**6.63**	**5.65**	**2.82**
	14.00	21.40	0.70	22.10	11.05	**8.46**	**4.23**	**14.37**	**7.18**	**6.07**	**3.04**
	15.00	23.30	0.70	24.00	12.00	**9.12**	**4.56**	**15.60**	**7.80**	**6.55**	**3.27**
	16.00	25.20	0.70	25.90	12.95	**9.79**	**4.89**	**16.84**	**8.42**	**7.02**	**3.51**
	17.00	27.10	0.70	27.80	13.90	**10.45**	**5.23**	**18.07**	**9.04**	**7.50**	**3.75**
Clay	**18.00**	29.10	0.70	29.80	14.90	**11.15**	**5.58**	**19.37**	**9.69**	**8.00**	**4.00**
	19.00	31.10	0.70	31.80	15.90	**11.85**	**5.93**	**20.67**	**10.34**	**8.50**	**4.25**
	20.00	33.10	0.70	33.80	16.90	**12.55**	**6.28**	**21.97**	**10.99**	**9.00**	**4.50**
	21.00	35.20	0.70	35.90	17.95	**13.29**	**6.64**	**23.34**	**11.67**	**9.52**	**4.76**
	22.00	37.40	0.70	38.10	19.05	**14.06**	**7.03**	**24.77**	**12.38**	**10.07**	**5.04**
	23.00	39.60	0.70	40.30	20.15	**14.83**	**7.41**	**26.20**	**13.10**	**10.62**	**5.31**
	24.00	41.80	0.70	42.50	21.25	**15.60**	**7.80**	**27.63**	**13.81**	**11.17**	**5.59**
	25.00	44.00	0.70	44.70	22.35	**16.37**	**8.18**	**29.06**	**14.53**	**11.72**	**5.86**
	26.00	46.30	0.70	47.00	23.50	**17.17**	**8.59**	**30.55**	**15.28**	**12.30**	**6.15**
	27.00	48.70	0.70	49.40	24.70	**18.01**	**9.01**	**32.11**	**16.06**	**12.90**	**6.45**
	28.00	51.00	0.70	51.70	25.85	**18.82**	**9.41**	**33.61**	**16.80**	**13.47**	**6.74**
	29.00	53.40	3.80	57.20	28.60	**20.74**	**10.37**	**37.18**	**18.59**	**14.07**	**7.04**
	30.00	55.70	7.00	62.70	31.35	**22.67**	**11.33**	**40.76**	**20.38**	**14.65**	**7.32**
	31.00	58.10	10.30	68.40	34.20	**24.66**	**12.33**	**44.46**	**22.23**	**15.25**	**7.62**
	32.00	62.30	10.60	72.90	36.45	**27.72**	**13.86**	**47.39**	**23.69**	**16.72**	**8.36**
	33.00	68.40	10.80	79.20	39.60	**30.55**	**15.28**	**51.48**	**25.74**	**18.85**	**9.43**
	34.00	74.70	11.10	85.80	42.90	**33.52**	**16.76**	**55.77**	**27.89**	**21.06**	**10.53**
Sand	**35.00**	81.10	11.40	92.50	46.25	**36.54**	**18.27**	**60.13**	**30.06**	**23.30**	**11.65**
	36.00	87.70	11.70	99.40	49.70	**39.64**	**19.82**	**64.61**	**32.31**	**25.61**	**12.80**
	37.00	94.50	11.90	106.40	53.20	**42.79**	**21.40**	**69.16**	**34.58**	**27.99**	**13.99**
	38.00	101.50	12.20	113.70	56.85	**46.08**	**23.04**	**73.91**	**36.95**	**30.44**	**15.22**
	39.00	108.60	12.50	121.10	60.55	**49.41**	**24.70**	**78.72**	**39.36**	**32.92**	**16.46**

Steel H-Pile Capacities
B64-2 - Piers 3-6
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	115.80	12.80	128.60	64.30	52.78	26.39	83.59	41.80	35.44	17.72
	41.00	123.30	13.00	136.30	68.15	56.25	28.12	88.60	44.30	38.07	19.03
	42.00	130.90	13.30	144.20	72.10	59.80	29.90	93.73	46.87	40.73	20.36
	43.00	138.60	13.60	152.20	76.10	63.40	31.70	98.93	49.47	43.42	21.71
	44.00	146.50	13.90	160.40	80.20	67.09	33.55	104.26	52.13	46.19	23.09
	45.00	154.60	14.10	168.70	84.35	70.83	35.41	109.66	54.83	49.02	24.51
	46.00	162.90	14.40	177.30	88.65	74.70	37.35	115.25	57.62	51.93	25.96
	47.00	171.30	14.70	186.00	93.00	78.61	39.31	120.90	60.45	54.87	27.43
	48.00	179.90	14.90	194.80	97.40	82.57	41.29	126.62	63.31	57.88	28.94
	49.00	188.60	15.20	203.80	101.90	86.62	43.31	132.47	66.24	60.92	30.46
	50.00	197.50	15.50	213.00	106.50	90.76	45.38	138.45	69.23	64.04	32.02
	51.00	206.60	15.80	222.40	111.20	94.99	47.50	144.56	72.28	67.22	33.61
	52.00	215.70	16.00	231.70	115.85	99.18	49.59	150.61	75.30	70.41	35.20
	53.00	224.80	16.30	241.10	120.55	103.41	51.70	156.72	78.36	73.59	36.80
	54.00	233.90	16.60	250.50	125.25	107.64	53.82	162.83	81.41	76.78	38.39
	55.00	243.00	16.90	259.90	129.95	111.87	55.93	168.94	84.47	79.96	39.98
	56.00	252.10	17.10	269.20	134.60	116.05	58.03	174.98	87.49	83.15	41.57
	57.00	261.30	17.40	278.70	139.35	120.33	60.16	181.16	90.58	86.37	43.18
Sand	58.00	270.40	17.70	288.10	144.05	124.56	62.28	187.27	93.63	89.55	44.78
	59.00	279.50	18.00	297.50	148.75	128.79	64.39	193.38	96.69	92.74	46.37
	60.00	288.60	18.20	306.80	153.40	132.97	66.49	199.42	99.71	95.92	47.96
	61.00	297.70	18.50	316.20	158.10	137.20	68.60	205.53	102.77	99.11	49.55
	62.00	306.80	18.80	325.60	162.80	141.43	70.72	211.64	105.82	102.29	51.15
	63.00	316.00	19.10	335.10	167.55	145.71	72.85	217.82	108.91	105.51	52.76
	64.00	325.10	19.30	344.40	172.20	149.89	74.95	223.86	111.93	108.70	54.35
	65.00	334.20	19.60	353.80	176.90	154.12	77.06	229.97	114.99	111.88	55.94
	66.00	343.30	19.90	363.20	181.60	158.35	79.18	236.08	118.04	115.07	57.53
	67.00	352.40	20.20	372.60	186.30	162.58	81.29	242.19	121.10	118.25	59.13
	68.00	361.50	20.40	381.90	190.95	166.77	83.38	248.24	124.12	121.44	60.72
	69.00	370.70	20.70	391.40	195.70	171.04	85.52	254.41	127.21	124.66	62.33
	70.00	379.80	21.00	400.80	200.40	175.27	87.64	260.52	130.26	127.84	63.92
	71.00	388.90	21.30	410.20	205.10	179.50	89.75	266.63	133.32	131.03	65.51
	72.00	398.00	21.50	419.50	209.75	183.69	91.84	272.68	136.34	134.21	67.11
	73.00	407.10	21.80	428.90	214.45	187.92	93.96	278.79	139.39	137.40	68.70
	74.00	416.20	22.10	438.30	219.15	192.15	96.07	284.90	142.45	140.58	70.29
	75.00	425.40	22.40	447.80	223.90	196.42	98.21	291.07	145.54	143.80	71.90
	76.00	434.50	22.60	457.10	228.55	200.61	100.30	297.12	148.56	146.99	73.49
	77.00	443.60	22.90	466.50	233.25	204.84	102.42	303.23	151.61	150.17	75.09
	78.00	452.70	23.20	475.90	237.95	209.07	104.53	309.34	154.67	153.36	76.68

Steel H-Pile Capacities
B64-2 - Piers 3-6
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	79.00	461.80	23.50	485.30	242.65	**213.30**	**106.65**	**315.45**	**157.72**	**156.54**	**78.27**
	80.00	470.90	23.70	494.60	247.30	**217.48**	**108.74**	**321.49**	**160.75**	**159.73**	**79.86**
	81.00	480.10	24.00	504.10	252.05	**221.76**	**110.88**	**327.67**	**163.83**	**162.95**	**81.47**
	82.00	489.20	24.30	513.50	256.75	**225.99**	**112.99**	**333.78**	**166.89**	**166.13**	**83.07**
	83.00	498.30	24.60	522.90	261.45	**230.22**	**115.11**	**339.89**	**169.94**	**169.32**	**84.66**
	84.00	507.40	24.80	532.20	266.10	**234.40**	**117.20**	**345.93**	**172.97**	**172.50**	**86.25**
	85.00	516.50	25.10	541.60	270.80	**238.63**	**119.32**	**352.04**	**176.02**	**175.69**	**87.84**
	86.00	525.60	25.40	551.00	275.50	**242.86**	**121.43**	**358.15**	**179.08**	**178.87**	**89.44**
	87.00	534.80	25.60	560.40	280.20	**247.09**	**123.55**	**364.26**	**182.13**	**182.09**	**91.05**
	88.00	543.90	25.90	569.80	284.90	**251.32**	**125.66**	**370.37**	**185.19**	**185.28**	**92.64**
	89.00	553.00	26.20	579.20	289.60	**255.55**	**127.78**	**376.48**	**188.24**	**188.46**	**94.23**
	90.00	562.10	26.40	588.50	294.25	**259.74**	**129.87**	**382.53**	**191.26**	**191.65**	**95.82**
	91.00	571.20	26.60	597.80	298.90	**263.92**	**131.96**	**388.57**	**194.29**	**194.83**	**97.42**
	92.00	580.30	26.70	607.00	303.50	**268.06**	**134.03**	**394.55**	**197.28**	**198.02**	**99.01**
	93.00	589.50	26.80	616.30	308.15	**272.25**	**136.12**	**400.60**	**200.30**	**201.24**	**100.62**
	94.00	598.60	26.80	625.40	312.70	**276.34**	**138.17**	**406.51**	**203.26**	**204.42**	**102.21**
	95.00	607.70	26.80	634.50	317.25	**280.44**	**140.22**	**412.43**	**206.21**	**207.61**	**103.80**
Sand	**96.00**	616.80	26.80	643.60	321.80	**284.53**	**142.27**	**418.34**	**209.17**	**210.79**	**105.40**
	97.00	625.90	26.80	652.70	326.35	**288.63**	**144.31**	**424.26**	**212.13**	**213.98**	**106.99**
	98.00	635.00	26.80	661.80	330.90	**292.72**	**146.36**	**430.17**	**215.09**	**217.16**	**108.58**
	99.00	644.10	26.80	670.90	335.45	**296.82**	**148.41**	**436.09**	**218.04**	**220.35**	**110.17**
	100.00	653.30	26.80	680.10	340.05	**300.96**	**150.48**	**442.07**	**221.03**	**223.57**	**111.78**
	101.00	662.40	26.80	689.20	344.60	**305.05**	**152.53**	**447.98**	**223.99**	**226.75**	**113.38**
	102.00	671.50	26.80	698.30	349.15	**309.15**	**154.57**	**453.90**	**226.95**	**229.94**	**114.97**
	103.00	680.60	26.80	707.40	353.70	**313.24**	**156.62**	**459.81**	**229.91**	**233.12**	**116.56**
	104.00	689.70	26.80	716.50	358.25	**317.34**	**158.67**	**465.73**	**232.86**	**236.31**	**118.15**
	105.00	698.80	26.80	725.60	362.80	**321.43**	**160.72**	**471.64**	**235.82**	**239.49**	**119.75**
	106.00	708.00	26.80	734.80	367.40	**325.57**	**162.79**	**477.62**	**238.81**	**242.71**	**121.36**
	107.00	717.10	26.80	743.90	371.95	**329.67**	**164.83**	**483.54**	**241.77**	**245.90**	**122.95**
	108.00	726.20	26.80	753.00	376.50	**333.76**	**166.88**	**489.45**	**244.73**	**249.08**	**124.54**
	109.00	735.30	26.80	762.10	381.05	**337.86**	**168.93**	**495.37**	**247.68**	**252.27**	**126.13**
	110.00	744.40	26.80	771.20	385.60	**341.95**	**170.98**	**501.28**	**250.64**	**255.45**	**127.73**
	111.00	753.50	26.80	780.30	390.15	**346.05**	**173.02**	**507.20**	**253.60**	**258.64**	**129.32**
	112.00	762.70	26.80	789.50	394.75	**350.19**	**175.09**	**513.18**	**256.59**	**261.86**	**130.93**
	113.00	771.80	26.80	798.60	399.30	**354.28**	**177.14**	**519.09**	**259.55**	**265.04**	**132.52**
	114.00	780.90	26.80	807.70	403.85	**358.38**	**179.19**	**525.01**	**262.50**	**268.23**	**134.11**
	115.00	790.00	26.80	816.80	408.40	**362.47**	**181.24**	**530.92**	**265.46**	**271.41**	**135.71**

Steel H-Pile Capacities
B64-2 - Piers 3-6
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.40	0.40	0.20	**0.18**	**0.09**	**0.26**	**0.13**	**0.00**	**0.00**
	1.00	0.00	0.60	0.60	0.30	**0.27**	**0.14**	**0.39**	**0.20**	**0.00**	**0.00**
	2.00	0.00	0.80	0.80	0.40	**0.36**	**0.18**	**0.52**	**0.26**	**0.00**	**0.00**
	3.00	0.00	1.10	1.10	0.55	**0.50**	**0.25**	**0.72**	**0.36**	**0.00**	**0.00**
	4.00	0.00	1.30	1.30	0.65	**0.59**	**0.29**	**0.85**	**0.42**	**0.00**	**0.00**
	0.00	0.00	1.50	1.50	0.75	**0.68**	**0.34**	**0.98**	**0.49**	**0.00**	**0.00**
	1.00	2.60	1.80	4.40	2.20	**1.98**	**0.99**	**2.86**	**1.43**	**0.91**	**0.46**
Sand	**2.00**	3.60	2.00	5.60	2.80	**2.52**	**1.26**	**3.64**	**1.82**	**1.26**	**0.63**
	3.00	4.70	1.70	6.40	3.20	**2.88**	**1.44**	**4.16**	**2.08**	**1.65**	**0.82**
	4.00	5.90	1.30	7.20	3.60	**3.24**	**1.62**	**4.68**	**2.34**	**2.07**	**1.03**
	5.00	7.30	0.80	8.10	4.05	**3.65**	**1.82**	**5.27**	**2.63**	**2.56**	**1.28**
	6.00	8.70	0.80	9.50	4.75	**4.06**	**2.03**	**6.18**	**3.09**	**2.91**	**1.45**
	7.00	10.10	0.80	10.90	5.45	**4.55**	**2.27**	**7.09**	**3.54**	**3.26**	**1.63**
	8.00	11.60	0.80	12.40	6.20	**5.07**	**2.54**	**8.06**	**4.03**	**3.63**	**1.82**
	9.00	13.20	0.80	14.00	7.00	**5.63**	**2.82**	**9.10**	**4.55**	**4.03**	**2.02**
	10.00	14.80	0.80	15.60	7.80	**6.19**	**3.10**	**10.14**	**5.07**	**4.43**	**2.22**
	11.00	16.40	0.80	17.20	8.60	**6.75**	**3.38**	**11.18**	**5.59**	**4.83**	**2.42**
	12.00	18.10	0.80	18.90	9.45	**7.35**	**3.67**	**12.29**	**6.14**	**5.26**	**2.63**
	13.00	19.90	0.80	20.70	10.35	**7.98**	**3.99**	**13.46**	**6.73**	**5.71**	**2.85**
	14.00	21.70	0.80	22.50	11.25	**8.61**	**4.30**	**14.63**	**7.31**	**6.16**	**3.08**
	15.00	23.60	0.80	24.40	12.20	**9.27**	**4.64**	**15.86**	**7.93**	**6.63**	**3.32**
	16.00	25.50	0.80	26.30	13.15	**9.94**	**4.97**	**17.10**	**8.55**	**7.11**	**3.55**
	17.00	27.40	0.80	28.20	14.10	**10.60**	**5.30**	**18.33**	**9.17**	**7.58**	**3.79**
Clay	**18.00**	29.40	0.80	30.20	15.10	**11.30**	**5.65**	**19.63**	**9.82**	**8.08**	**4.04**
	19.00	31.40	0.80	32.20	16.10	**12.00**	**6.00**	**20.93**	**10.47**	**8.58**	**4.29**
	20.00	33.50	0.80	34.30	17.15	**12.74**	**6.37**	**22.30**	**11.15**	**9.11**	**4.55**
	21.00	35.70	0.80	36.50	18.25	**13.51**	**6.75**	**23.73**	**11.86**	**9.66**	**4.83**
	22.00	37.80	0.80	38.60	19.30	**14.24**	**7.12**	**25.09**	**12.55**	**10.18**	**5.09**
	23.00	40.00	0.80	40.80	20.40	**15.01**	**7.51**	**26.52**	**13.26**	**10.73**	**5.37**
	24.00	42.30	0.80	43.10	21.55	**15.82**	**7.91**	**28.02**	**14.01**	**11.31**	**5.65**
	25.00	44.60	0.80	45.40	22.70	**16.62**	**8.31**	**29.51**	**14.76**	**11.88**	**5.94**
	26.00	46.90	0.80	47.70	23.85	**17.43**	**8.71**	**31.01**	**15.50**	**12.46**	**6.23**
	27.00	49.20	0.80	50.00	25.00	**18.23**	**9.12**	**32.50**	**16.25**	**13.03**	**6.52**
	28.00	51.60	0.90	52.50	26.25	**19.11**	**9.55**	**34.13**	**17.06**	**13.63**	**6.82**
	29.00	54.00	4.70	58.70	29.35	**21.28**	**10.64**	**38.16**	**19.08**	**14.23**	**7.12**
	30.00	56.40	8.60	65.00	32.50	**23.48**	**11.74**	**42.25**	**21.13**	**14.83**	**7.42**
	31.00	58.80	12.60	71.40	35.70	**25.72**	**12.86**	**46.41**	**23.21**	**15.43**	**7.72**
	32.00	63.00	12.90	75.90	37.95	**29.01**	**14.50**	**49.34**	**24.67**	**16.90**	**8.45**
	33.00	69.20	13.20	82.40	41.20	**31.93**	**15.97**	**53.56**	**26.78**	**19.07**	**9.54**
	34.00	75.60	13.60	89.20	44.60	**34.99**	**17.50**	**57.98**	**28.99**	**21.31**	**10.66**
Sand	**35.00**	82.10	13.90	96.00	48.00	**38.05**	**19.03**	**62.40**	**31.20**	**23.59**	**11.79**
	36.00	88.80	14.20	103.00	51.50	**41.20**	**20.60**	**66.95**	**33.48**	**25.93**	**12.97**
	37.00	95.60	14.60	110.20	55.10	**44.44**	**22.22**	**71.63**	**35.82**	**28.31**	**14.16**
	38.00	102.70	14.90	117.60	58.80	**47.77**	**23.89**	**76.44**	**38.22**	**30.80**	**15.40**
	39.00	109.80	15.20	125.00	62.50	**51.10**	**25.55**	**81.25**	**40.63**	**33.28**	**16.64**

Steel H-Pile Capacities
B64-2 - Piers 3-6
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	117.20	15.60	132.80	66.40	**54.61**	**27.31**	**86.32**	**43.16**	**35.87**	**17.94**
	41.00	124.70	15.90	140.60	70.30	**58.12**	**29.06**	**91.39**	**45.70**	**38.50**	**19.25**
	42.00	132.40	16.20	148.60	74.30	**61.72**	**30.86**	**96.59**	**48.30**	**41.19**	**20.60**
	43.00	140.20	16.60	156.80	78.40	**65.41**	**32.71**	**101.92**	**50.96**	**43.92**	**21.96**
	44.00	148.30	16.90	165.20	82.60	**69.19**	**34.60**	**107.38**	**53.69**	**46.76**	**23.38**
	45.00	156.40	17.20	173.60	86.80	**72.97**	**36.49**	**112.84**	**56.42**	**49.59**	**24.80**
	46.00	164.80	17.60	182.40	91.20	**76.93**	**38.47**	**118.56**	**59.28**	**52.53**	**26.27**
	47.00	173.30	17.90	191.20	95.60	**80.89**	**40.45**	**124.28**	**62.14**	**55.51**	**27.75**
	48.00	182.00	18.20	200.20	100.10	**84.94**	**42.47**	**130.13**	**65.07**	**58.55**	**29.28**
	49.00	190.80	18.60	209.40	104.70	**89.08**	**44.54**	**136.11**	**68.06**	**61.63**	**30.82**
	50.00	199.80	18.90	218.70	109.35	**93.27**	**46.63**	**142.16**	**71.08**	**64.78**	**32.39**
	51.00	209.00	19.20	228.20	114.10	**97.54**	**48.77**	**148.33**	**74.17**	**68.00**	**34.00**
	52.00	218.20	19.60	237.80	118.90	**101.86**	**50.93**	**154.57**	**77.29**	**71.22**	**35.61**
	53.00	227.40	19.90	247.30	123.65	**106.14**	**53.07**	**160.75**	**80.37**	**74.44**	**37.22**
	54.00	236.70	20.20	256.90	128.45	**110.46**	**55.23**	**166.99**	**83.49**	**77.70**	**38.85**
	55.00	245.90	20.60	266.50	133.25	**114.78**	**57.39**	**173.23**	**86.61**	**80.92**	**40.46**
	56.00	255.10	20.90	276.00	138.00	**119.05**	**59.53**	**179.40**	**89.70**	**84.14**	**42.07**
	57.00	264.30	21.20	285.50	142.75	**123.33**	**61.66**	**185.58**	**92.79**	**87.36**	**43.68**
Sand	**58.00**	273.50	21.60	295.10	147.55	**127.65**	**63.82**	**191.82**	**95.91**	**90.58**	**45.29**
	59.00	282.80	21.90	304.70	152.35	**131.97**	**65.98**	**198.06**	**99.03**	**93.83**	**46.92**
	60.00	292.00	22.30	314.30	157.15	**136.29**	**68.14**	**204.30**	**102.15**	**97.05**	**48.53**
	61.00	301.20	22.60	323.80	161.90	**140.56**	**70.28**	**210.47**	**105.24**	**100.27**	**50.14**
	62.00	310.40	22.90	333.30	166.65	**144.84**	**72.42**	**216.65**	**108.32**	**103.49**	**51.75**
	63.00	319.70	23.30	343.00	171.50	**149.20**	**74.60**	**222.95**	**111.48**	**106.75**	**53.37**
	64.00	328.90	23.60	352.50	176.25	**153.48**	**76.74**	**229.13**	**114.56**	**109.97**	**54.98**
	65.00	338.10	23.90	362.00	181.00	**157.75**	**78.88**	**235.30**	**117.65**	**113.19**	**56.59**
	66.00	347.30	24.30	371.60	185.80	**162.07**	**81.04**	**241.54**	**120.77**	**116.41**	**58.20**
	67.00	356.50	24.60	381.10	190.55	**166.35**	**83.17**	**247.72**	**123.86**	**119.63**	**59.81**
	68.00	365.80	24.90	390.70	195.35	**170.67**	**85.33**	**253.96**	**126.98**	**122.88**	**61.44**
	69.00	375.00	25.30	400.30	200.15	**174.99**	**87.49**	**260.20**	**130.10**	**126.10**	**63.05**
	70.00	384.20	25.60	409.80	204.90	**179.26**	**89.63**	**266.37**	**133.19**	**129.32**	**64.66**
	71.00	393.40	25.90	419.30	209.65	**183.54**	**91.77**	**272.55**	**136.27**	**132.54**	**66.27**
	72.00	402.70	26.30	429.00	214.50	**187.90**	**93.95**	**278.85**	**139.43**	**135.80**	**67.90**
	73.00	411.90	26.60	438.50	219.25	**192.18**	**96.09**	**285.03**	**142.51**	**139.02**	**69.51**
	74.00	421.10	26.90	448.00	224.00	**196.45**	**98.23**	**291.20**	**145.60**	**142.24**	**71.12**
	75.00	430.30	27.30	457.60	228.80	**200.77**	**100.39**	**297.44**	**148.72**	**145.46**	**72.73**
	76.00	439.60	27.60	467.20	233.60	**205.09**	**102.55**	**303.68**	**151.84**	**148.71**	**74.36**
	77.00	448.80	27.90	476.70	238.35	**209.37**	**104.68**	**309.86**	**154.93**	**151.93**	**75.97**
	78.00	458.00	28.30	486.30	243.15	**213.69**	**106.84**	**316.10**	**158.05**	**155.15**	**77.58**

Steel H-Pile Capacities
B64-2 - Piers 3-6
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Static Analysis Method		ϕR_n Total Factored Geotechnical Axial Compressive Resistance Dynamic Analysis Method		ϕR_n Total Factored Geotechnical Axial Uplift Resistance Static Analysis Method	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	79.00	467.20	28.60	495.80	247.90	**217.96**	**108.98**	**322.27**	**161.14**	**158.37**	**79.19**
	80.00	476.40	28.90	505.30	252.65	**222.24**	**111.12**	**328.45**	**164.22**	**161.59**	**80.80**
	81.00	485.70	29.30	515.00	257.50	**226.60**	**113.30**	**334.75**	**167.38**	**164.85**	**82.42**
	82.00	494.90	29.60	524.50	262.25	**230.88**	**115.44**	**340.93**	**170.46**	**168.07**	**84.03**
	83.00	504.10	29.90	534.00	267.00	**235.15**	**117.58**	**347.10**	**173.55**	**171.29**	**85.64**
	84.00	513.30	30.30	543.60	271.80	**239.47**	**119.74**	**353.34**	**176.67**	**174.51**	**87.25**
	85.00	522.60	30.60	553.20	276.60	**243.79**	**121.90**	**359.58**	**179.79**	**177.76**	**88.88**
	86.00	531.80	31.00	562.80	281.40	**248.11**	**124.06**	**365.82**	**182.91**	**180.98**	**90.49**
	87.00	541.00	31.30	572.30	286.15	**252.39**	**126.19**	**372.00**	**186.00**	**184.20**	**92.10**
	88.00	550.20	31.60	581.80	290.90	**256.66**	**128.33**	**378.17**	**189.09**	**187.42**	**93.71**
	89.00	559.50	32.00	591.50	295.75	**261.03**	**130.51**	**384.48**	**192.24**	**190.68**	**95.34**
	90.00	568.70	32.30	601.00	300.50	**265.30**	**132.65**	**390.65**	**195.33**	**193.90**	**96.95**
	91.00	577.90	32.50	610.40	305.20	**269.53**	**134.77**	**396.76**	**198.38**	**197.12**	**98.56**
	92.00	587.10	32.60	619.70	309.85	**273.72**	**136.86**	**402.81**	**201.40**	**200.34**	**100.17**
	93.00	596.30	32.60	628.90	314.45	**277.86**	**138.93**	**408.79**	**204.39**	**203.56**	**101.78**
	94.00	605.60	32.60	638.20	319.10	**282.04**	**141.02**	**414.83**	**207.42**	**206.81**	**103.41**
	95.00	614.80	32.60	647.40	323.70	**286.18**	**143.09**	**420.81**	**210.41**	**210.03**	**105.02**
Sand	**96.00**	624.00	32.60	656.60	328.30	**290.32**	**145.16**	**426.79**	**213.40**	**213.25**	**106.63**
	97.00	633.20	32.60	665.80	332.90	**294.46**	**147.23**	**432.77**	**216.39**	**216.47**	**108.24**
	98.00	642.50	32.60	675.10	337.55	**298.65**	**149.32**	**438.82**	**219.41**	**219.73**	**109.86**
	99.00	651.70	32.60	684.30	342.15	**302.79**	**151.39**	**444.80**	**222.40**	**222.95**	**111.47**
	100.00	660.90	32.60	693.50	346.75	**306.93**	**153.46**	**450.78**	**225.39**	**226.17**	**113.08**
	101.00	670.10	32.60	702.70	351.35	**311.07**	**155.53**	**456.76**	**228.38**	**229.39**	**114.69**
	102.00	679.40	32.60	712.00	356.00	**315.25**	**157.63**	**462.80**	**231.40**	**232.64**	**116.32**
	103.00	688.60	32.60	721.20	360.60	**319.39**	**159.70**	**468.78**	**234.39**	**235.86**	**117.93**
	104.00	697.80	32.60	730.40	365.20	**323.53**	**161.77**	**474.76**	**237.38**	**239.08**	**119.54**
	105.00	707.00	32.60	739.60	369.80	**327.67**	**163.84**	**480.74**	**240.37**	**242.30**	**121.15**
	106.00	716.20	32.60	748.80	374.40	**331.81**	**165.91**	**486.72**	**243.36**	**245.52**	**122.76**
	107.00	725.50	32.60	758.10	379.05	**336.00**	**168.00**	**492.77**	**246.38**	**248.78**	**124.39**
	108.00	734.70	32.60	767.30	383.65	**340.14**	**170.07**	**498.75**	**249.37**	**252.00**	**126.00**
	109.00	743.90	32.60	776.50	388.25	**344.28**	**172.14**	**504.73**	**252.36**	**255.22**	**127.61**
	110.00	753.10	32.60	785.70	392.85	**348.42**	**174.21**	**510.71**	**255.35**	**258.44**	**129.22**
	111.00	762.40	32.60	795.00	397.50	**352.60**	**176.30**	**516.75**	**258.38**	**261.69**	**130.85**
	112.00	771.60	32.60	804.20	402.10	**356.74**	**178.37**	**522.73**	**261.37**	**264.91**	**132.46**
	113.00	780.80	32.60	813.40	406.70	**360.88**	**180.44**	**528.71**	**264.36**	**268.13**	**134.07**
	114.00	790.00	32.60	822.60	411.30	**365.02**	**182.51**	**534.69**	**267.35**	**271.35**	**135.68**
	115.00	799.30	32.60	831.90	415.95	**369.21**	**184.60**	**540.74**	**270.37**	**274.61**	**137.30**

Steel H-Pile Driving Resistance
B64-2 - Piers 1 and 2
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table Near Normal Pool Elevation = 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**0.00**	0.00	1.80	**1.80**	**0.90**
	1.00	2.80	2.00	**4.10**	**2.05**
	2.00	3.80	2.20	**5.05**	**2.53**
	3.00	4.90	2.20	**5.88**	**2.94**
	4.00	6.20	2.20	**6.85**	**3.43**
	5.00	7.70	2.20	**7.98**	**3.99**
	6.00	9.30	1.80	**8.78**	**4.39**
	7.00	11.10	1.10	**9.43**	**4.71**
	8.00	13.00	0.30	**10.05**	**5.03**
Clay	**9.00**	14.70	0.30	**10.90**	**5.45**
	10.00	16.10	0.30	**11.60**	**5.80**
	11.00	17.50	0.30	**12.30**	**6.15**
	12.00	18.90	0.30	**13.00**	**6.50**
	13.00	20.30	0.30	**13.70**	**6.85**
	14.00	21.60	0.30	**14.35**	**7.18**
	15.00	23.00	0.30	**15.05**	**7.53**
	16.00	24.40	0.30	**15.75**	**7.88**
	17.00	25.80	0.30	**16.45**	**8.23**
	18.00	27.20	0.30	**17.15**	**8.58**
	19.00	28.60	0.30	**17.85**	**8.93**
	20.00	30.00	0.30	**18.55**	**9.28**
	21.00	31.40	0.30	**19.25**	**9.63**
	22.00	32.80	0.30	**19.95**	**9.98**
	23.00	34.10	0.30	**20.60**	**10.30**
	24.00	35.50	0.30	**21.30**	**10.65**
	25.00	36.90	0.30	**22.00**	**11.00**
	26.00	38.30	0.30	**22.70**	**11.35**
	27.00	39.70	0.30	**23.40**	**11.70**
	28.00	41.10	0.30	**24.10**	**12.05**
	29.00	42.50	0.30	**24.80**	**12.40**
	30.00	43.90	0.30	**25.50**	**12.75**
	31.00	45.30	0.30	**26.20**	**13.10**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Clay	**32.00**	46.70	0.30	**26.90**	**13.45**
	33.00	48.00	0.30	**27.55**	**13.78**
	34.00	49.40	0.30	**28.25**	**14.13**
	35.00	50.80	0.30	**28.95**	**14.48**
	36.00	52.20	1.30	**30.65**	**15.33**
	37.00	53.60	3.10	**33.15**	**16.58**
	38.00	55.00	5.00	**35.75**	**17.88**
Sand	**39.00**	58.70	5.00	**38.53**	**19.26**
	40.00	64.90	5.00	**43.18**	**21.59**
	41.00	71.10	5.00	**47.83**	**23.91**
	42.00	77.40	5.00	**52.55**	**26.28**
	43.00	83.80	5.00	**57.35**	**28.68**
	44.00	90.20	5.00	**62.15**	**31.08**
	45.00	96.80	5.00	**67.10**	**33.55**
	46.00	103.50	5.00	**72.13**	**36.06**
	47.00	110.20	5.00	**77.15**	**38.58**
	48.00	117.10	5.00	**82.33**	**41.16**
	49.00	124.00	5.00	**87.50**	**43.75**
	50.00	131.00	5.00	**92.75**	**46.38**
	51.00	138.10	5.00	**98.08**	**49.04**
	52.00	145.30	5.00	**103.48**	**51.74**
	53.00	152.60	5.00	**108.95**	**54.48**
	54.00	160.00	5.00	**114.50**	**57.25**
	55.00	167.50	5.00	**120.13**	**60.06**
	56.00	175.00	5.00	**125.75**	**62.88**
	57.00	182.70	5.00	**131.53**	**65.76**
	58.00	190.40	5.00	**137.30**	**68.65**
	59.00	198.20	5.00	**143.15**	**71.58**
	60.00	206.20	5.00	**149.15**	**74.58**
	61.00	214.20	5.00	**155.15**	**77.58**
	62.00	222.30	5.00	**161.23**	**80.61**
	63.00	230.40	5.00	**167.30**	**83.65**

Steel H-Pile Driving Resistance
B64-2 - Piers 1 and 2
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table Near Normal Pool Elevation = 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**64.00**	238.70	5.00	**173.53**	**86.76**
	65.00	247.10	5.00	**179.83**	**89.91**
	66.00	255.50	5.00	**186.13**	**93.06**
	67.00	264.10	5.00	**192.58**	**96.29**
	68.00	272.70	5.00	**199.03**	**99.51**
	69.00	281.40	5.00	**205.55**	**102.78**
	70.00	290.30	5.00	**212.23**	**106.11**
	71.00	299.20	5.00	**218.90**	**109.45**
	72.00	308.10	5.00	**225.58**	**112.79**
	73.00	317.20	5.00	**232.40**	**116.20**
	74.00	326.40	5.00	**239.30**	**119.65**
	75.00	335.70	5.00	**246.28**	**123.14**
	76.00	345.00	5.00	**253.25**	**126.63**
	77.00	354.50	5.00	**260.38**	**130.19**
	78.00	364.00	5.00	**267.50**	**133.75**
	79.00	373.60	5.00	**274.70**	**137.35**
	80.00	383.30	5.00	**281.98**	**140.99**
	81.00	393.10	5.00	**289.33**	**144.66**
	82.00	403.00	5.00	**296.75**	**148.38**
	83.00	413.00	5.00	**304.25**	**152.13**
	84.00	423.00	5.00	**311.75**	**155.88**
	85.00	433.20	5.00	**319.40**	**159.70**
	86.00	443.40	5.00	**327.05**	**163.53**
	87.00	453.80	5.00	**334.85**	**167.43**
	88.00	464.20	5.00	**342.65**	**171.33**
	89.00	474.70	5.00	**350.53**	**175.26**
	90.00	485.30	5.00	**358.48**	**179.24**
	91.00	496.00	5.00	**366.50**	**183.25**
	92.00	506.80	5.00	**374.60**	**187.30**
	93.00	517.70	5.00	**382.78**	**191.39**
	94.00	528.60	5.00	**390.95**	**195.48**
	95.00	539.70	5.00	**399.28**	**199.64**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**96.00**	550.80	5.00	**407.60**	**203.80**
	97.00	562.10	5.00	**416.08**	**208.04**
	98.00	573.40	5.00	**424.55**	**212.28**
	99.00	584.80	5.00	**433.10**	**216.55**
	100.00	596.30	5.00	**441.73**	**220.86**
	101.00	607.90	5.00	**450.43**	**225.21**
	102.00	619.60	5.00	**459.20**	**229.60**
	103.00	631.30	5.00	**467.98**	**233.99**
	104.00	643.20	5.00	**476.90**	**238.45**
	105.00	655.20	5.00	**485.90**	**242.95**
	106.00	667.20	5.00	**494.90**	**247.45**
	107.00	679.30	5.00	**503.98**	**251.99**
	108.00	691.50	5.00	**513.13**	**256.56**
	109.00	703.80	5.00	**522.35**	**261.18**
	110.00	716.20	5.00	**531.65**	**265.83**
	111.00	728.70	5.00	**541.03**	**270.51**
	112.00	741.30	5.00	**550.48**	**275.24**
	113.00	754.00	5.00	**560.00**	**280.00**
	114.00	766.70	5.00	**569.53**	**284.76**
	115.00	779.60	5.00	**579.20**	**289.60**

Steel H-Pile Driving Resistance
B64-2 - Piers 1 and 2
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft
Water Table Near Normal Pool Elevation = 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	0.00	0.00	0.60	0.60	0.30
	1.00	3.30	2.80	5.28	2.64
	2.00	4.50	3.00	6.38	3.19
	3.00	5.80	3.10	7.45	3.73
	4.00	7.40	3.10	8.65	4.33
	5.00	9.10	3.10	9.93	4.96
	6.00	11.00	2.20	10.45	5.23
	7.00	13.10	1.30	11.13	5.56
	8.00	15.40	0.50	12.05	6.03
Clay	9.00	17.40	0.50	13.05	6.53
	10.00	19.00	0.50	13.85	6.93
	11.00	20.70	0.50	14.70	7.35
	12.00	22.30	0.50	15.50	7.75
	13.00	24.00	0.50	16.35	8.18
	14.00	25.60	0.50	17.15	8.58
	15.00	27.30	0.50	18.00	9.00
	16.00	28.90	0.50	18.80	9.40
	17.00	30.50	0.50	19.60	9.80
	18.00	32.20	0.50	20.45	10.23
	19.00	33.80	0.50	21.25	10.63
	20.00	35.50	0.50	22.10	11.05
	21.00	37.10	0.50	22.90	11.45
	22.00	38.80	0.50	23.75	11.88
	23.00	40.40	0.50	24.55	12.28
	24.00	42.10	0.50	25.40	12.70
	25.00	43.70	0.50	26.20	13.10
	26.00	45.30	0.50	27.00	13.50
	27.00	47.00	0.50	27.85	13.93
	28.00	48.60	0.50	28.65	14.33
	29.00	50.30	0.50	29.50	14.75
	30.00	51.90	0.50	30.30	15.15
	31.00	53.60	0.50	31.15	15.58

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Clay	32.00	55.20	0.50	31.95	15.98
	33.00	56.90	0.50	32.80	16.40
	34.00	58.50	0.50	33.60	16.80
	35.00	60.10	0.50	34.40	17.20
	36.00	61.80	2.60	37.35	18.68
	37.00	63.40	4.70	40.25	20.13
	38.00	65.10	6.80	43.20	21.60
Sand	39.00	69.50	6.80	46.50	23.25
	40.00	76.80	6.80	51.98	25.99
	41.00	84.10	6.80	57.45	28.73
	42.00	91.60	6.80	63.08	31.54
	43.00	99.10	6.80	68.70	34.35
	44.00	106.80	6.80	74.48	37.24
	45.00	114.60	6.80	80.33	40.16
	46.00	122.50	6.80	86.25	43.13
	47.00	130.50	6.80	92.25	46.13
	48.00	138.60	6.80	98.33	49.16
	49.00	146.80	6.80	104.48	52.24
	50.00	155.10	6.80	110.70	55.35
	51.00	163.50	6.80	117.00	58.50
	52.00	172.00	6.80	123.38	61.69
	53.00	180.60	6.80	129.83	64.91
	54.00	189.40	6.80	136.43	68.21
	55.00	198.20	6.80	143.03	71.51
	56.00	207.10	6.80	149.70	74.85
	57.00	216.20	6.80	156.53	78.26
	58.00	225.30	6.80	163.35	81.68
	59.00	234.60	6.80	170.33	85.16
	60.00	244.00	6.80	177.38	88.69
	61.00	253.50	6.80	184.50	92.25
	62.00	263.00	6.80	191.63	95.81
	63.00	272.70	6.80	198.90	99.45

Steel H-Pile Driving Resistance
B64-2 - Piers 1 and 2
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1 ft
Water Table Near Normal Pool Elevation = 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**64.00**	282.50	6.80	**206.25**	**103.13**
	65.00	292.40	6.80	**213.68**	**106.84**
	66.00	302.40	6.80	**221.18**	**110.59**
	67.00	312.50	6.80	**228.75**	**114.38**
	68.00	322.70	6.80	**236.40**	**118.20**
	69.00	333.10	6.80	**244.20**	**122.10**
	70.00	343.50	6.80	**252.00**	**126.00**
	71.00	354.00	6.80	**259.88**	**129.94**
	72.00	364.70	6.80	**267.90**	**133.95**
	73.00	375.40	6.80	**275.93**	**137.96**
	74.00	386.30	6.80	**284.10**	**142.05**
	75.00	397.20	6.80	**292.28**	**146.14**
	76.00	408.30	6.80	**300.60**	**150.30**
	77.00	419.50	6.80	**309.00**	**154.50**
	78.00	430.70	6.80	**317.40**	**158.70**
	79.00	442.10	6.80	**325.95**	**162.98**
	80.00	453.60	6.80	**334.58**	**167.29**
	81.00	465.20	6.80	**343.28**	**171.64**
	82.00	476.90	6.80	**352.05**	**176.03**
	83.00	488.70	6.80	**360.90**	**180.45**
	84.00	500.60	6.80	**369.83**	**184.91**
	85.00	512.70	6.80	**378.90**	**189.45**
	86.00	524.80	6.80	**387.98**	**193.99**
	87.00	537.00	6.80	**397.13**	**198.56**
	88.00	549.40	6.80	**406.43**	**203.21**
	89.00	561.80	6.80	**415.73**	**207.86**
	90.00	574.30	6.80	**425.10**	**212.55**
	91.00	587.00	6.80	**434.63**	**217.31**
	92.00	599.80	6.80	**444.23**	**222.11**
	93.00	612.60	6.80	**453.83**	**226.91**
	94.00	625.60	6.80	**463.58**	**231.79**
	95.00	638.70	6.80	**473.40**	**236.70**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**96.00**	651.90	6.80	**483.30**	**241.65**
	97.00	665.20	6.80	**493.28**	**246.64**
	98.00	678.60	6.80	**503.33**	**251.66**
	99.00	692.10	6.80	**513.45**	**256.73**
	100.00	705.70	6.80	**523.65**	**261.83**
	101.00	719.40	6.80	**533.93**	**266.96**
	102.00	733.20	6.80	**544.28**	**272.14**
	103.00	747.10	6.80	**554.70**	**277.35**
	104.00	761.20	6.80	**565.28**	**282.64**
	105.00	775.30	6.80	**575.85**	**287.93**
	106.00	789.60	6.80	**586.58**	**293.29**
	107.00	803.90	6.80	**597.30**	**298.65**
	108.00	818.40	6.80	**608.18**	**304.09**
	109.00	832.90	6.80	**619.05**	**309.53**
	110.00	847.60	6.80	**630.08**	**315.04**
	111.00	862.40	6.80	**641.18**	**320.59**
	112.00	877.30	6.80	**652.35**	**326.18**
	113.00	892.30	6.80	**663.60**	**331.80**
	114.00	907.40	6.80	**674.93**	**337.46**
	115.00	922.60	6.80	**686.33**	**343.16**

Steel H-Pile Driving Resistance
B64-2 Piers 1 and 2
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1ft
Water Table Near Normal Pool Elevation = 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	0.00	0.00	0.70	0.70	0.35
	1.00	3.30	3.50	5.98	2.99
	2.00	4.50	3.70	7.08	3.54
	3.00	5.90	3.70	8.13	4.06
	4.00	7.50	3.70	9.33	4.66
	5.00	9.20	3.70	10.60	5.30
	6.00	11.10	2.70	11.03	5.51
	7.00	13.30	1.60	11.58	5.79
	8.00	15.60	0.60	12.30	6.15
Clay	9.00	17.60	0.60	13.30	6.65
	10.00	19.30	0.60	14.15	7.08
	11.00	20.90	0.60	14.95	7.48
	12.00	22.60	0.60	15.80	7.90
	13.00	24.20	0.60	16.60	8.30
	14.00	25.90	0.60	17.45	8.73
	15.00	27.60	0.60	18.30	9.15
	16.00	29.20	0.60	19.10	9.55
	17.00	30.90	0.60	19.95	9.98
	18.00	32.60	0.60	20.80	10.40
	19.00	34.20	0.60	21.60	10.80
	20.00	35.90	0.60	22.45	11.23
	21.00	37.60	0.60	23.30	11.65
	22.00	39.20	0.60	24.10	12.05
	23.00	40.90	0.60	24.95	12.48
	24.00	42.50	0.60	25.75	12.88
	25.00	44.20	0.60	26.60	13.30
	26.00	45.90	0.60	27.45	13.73
	27.00	47.50	0.60	28.25	14.13
	28.00	49.20	0.60	29.10	14.55
	29.00	50.90	0.60	29.95	14.98
	30.00	52.50	0.60	30.75	15.38
	31.00	54.20	0.60	31.60	15.80
	32.00	55.90	0.60	32.45	16.23

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
	33.00	57.50	0.60	33.25	16.63
	34.00	59.20	0.60	34.10	17.05
	35.00	60.90	0.60	34.95	17.48
Clay	36.00	62.50	3.20	38.35	19.18
	37.00	64.20	5.80	41.80	20.90
	38.00	65.80	8.30	45.10	22.55
	39.00	70.30	8.30	48.48	24.24
	40.00	77.60	8.30	53.95	26.98
	41.00	85.10	8.30	59.58	29.79
	42.00	92.60	8.30	65.20	32.60
	43.00	100.30	8.30	70.98	35.49
	44.00	108.10	8.30	76.83	38.41
	45.00	115.90	8.30	82.68	41.34
	46.00	123.90	8.30	88.68	44.34
	47.00	132.00	8.30	94.75	47.38
	48.00	140.20	8.30	100.90	50.45
	49.00	148.50	8.30	107.13	53.56
	50.00	156.90	8.30	113.43	56.71
Sand	51.00	165.40	8.30	119.80	59.90
	52.00	174.00	8.30	126.25	63.13
	53.00	182.70	8.30	132.78	66.39
	54.00	191.60	8.30	139.45	69.73
	55.00	200.50	8.30	146.13	73.06
	56.00	209.60	8.30	152.95	76.48
	57.00	218.70	8.30	159.78	79.89
	58.00	228.00	8.30	166.75	83.38
	59.00	237.40	8.30	173.80	86.90
	60.00	246.80	8.30	180.85	90.43
	61.00	256.40	8.30	188.05	94.03
	62.00	266.10	8.30	195.33	97.66
	63.00	275.90	8.30	202.68	101.34
	64.00	285.80	8.30	210.10	105.05
	65.00	295.80	8.30	217.60	108.80

Steel H-Pile Driving Resistance
B64-2 Piers 1 and 2
14x89 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 434.1ft
Water Table Near Normal Pool Elevation = 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
	66.00	306.00	8.30	**225.25**	**112.63**
	67.00	316.20	8.30	**232.90**	**116.45**
	68.00	326.50	8.30	**240.63**	**120.31**
	69.00	337.00	8.30	**248.50**	**124.25**
	70.00	347.50	8.30	**256.38**	**128.19**
	71.00	358.20	8.30	**264.40**	**132.20**
	72.00	368.90	8.30	**272.43**	**136.21**
	73.00	379.80	8.30	**280.60**	**140.30**
	74.00	390.80	8.30	**288.85**	**144.43**
	75.00	401.90	8.30	**297.18**	**148.59**
	76.00	413.10	8.30	**305.58**	**152.79**
	77.00	424.40	8.30	**314.05**	**157.03**
	78.00	435.80	8.30	**322.60**	**161.30**
	79.00	447.30	8.30	**331.23**	**165.61**
	80.00	458.90	8.30	**339.93**	**169.96**
	81.00	470.70	8.30	**348.78**	**174.39**
Sand	**82.00**	482.50	8.30	**357.63**	**178.81**
	83.00	494.40	8.30	**366.55**	**183.28**
	84.00	506.50	8.30	**375.63**	**187.81**
	85.00	518.70	8.30	**384.78**	**192.39**
	86.00	530.90	8.30	**393.93**	**196.96**
	87.00	543.30	8.30	**403.23**	**201.61**
	88.00	555.80	8.30	**412.60**	**206.30**
	89.00	568.40	8.30	**422.05**	**211.03**
	90.00	581.10	8.30	**431.58**	**215.79**
	91.00	593.90	8.30	**441.18**	**220.59**
	92.00	606.80	8.30	**450.85**	**225.43**
	93.00	619.80	8.30	**460.60**	**230.30**
	94.00	632.90	8.30	**470.43**	**235.21**
	95.00	646.20	8.30	**480.40**	**240.20**
	96.00	659.50	8.30	**490.38**	**245.19**
	97.00	673.00	8.30	**500.50**	**250.25**
	98.00	686.50	8.30	**510.63**	**255.31**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
	99.00	700.20	8.30	**520.90**	**260.45**
	100.00	713.90	8.30	**531.18**	**265.59**
	101.00	727.80	8.30	**541.60**	**270.80**
	102.00	741.80	8.30	**552.10**	**276.05**
	103.00	755.90	8.30	**562.68**	**281.34**
	104.00	770.10	8.30	**573.33**	**286.66**
	105.00	784.40	8.30	**584.05**	**292.03**
	106.00	798.80	8.30	**594.85**	**297.43**
Sand	**107.00**	813.30	8.30	**605.73**	**302.86**
	108.00	828.00	8.30	**616.75**	**308.38**
	109.00	842.70	8.30	**627.78**	**313.89**
	110.00	857.50	8.30	**638.88**	**319.44**
	111.00	872.50	8.30	**650.13**	**325.06**
	112.00	887.50	8.30	**661.38**	**330.69**
	113.00	902.70	8.30	**672.78**	**336.39**
	114.00	918.00	8.30	**684.25**	**342.13**
	115.00	933.40	8.30	**695.80**	**347.90**

Steel H-Pile Driving Resistance
B64-2 Piers 3-6
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table Near Normal Pool Elevation= 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	0.00	0.00	0.40	0.40	0.20
	1.00	2.80	2.00	4.10	2.05
	2.00	3.80	2.20	5.05	2.53
	3.00	4.90	1.90	5.30	2.65
	4.00	6.20	1.20	5.25	2.63
	5.00	7.70	0.50	5.30	2.65
Clay	6.00	9.50	0.50	6.20	3.10
	7.00	11.40	0.50	7.15	3.58
	8.00	13.40	0.50	8.15	4.08
	9.00	15.40	0.50	9.15	4.58
	10.00	17.40	0.50	10.15	5.08
	11.00	19.40	0.50	11.15	5.58
	12.00	21.40	0.50	12.15	6.08
	13.00	23.40	0.50	13.15	6.58
	14.00	25.30	0.50	14.10	7.05
	15.00	27.30	0.50	15.10	7.55
	16.00	29.30	0.50	16.10	8.05
	17.00	31.30	0.50	17.60	8.80
	18.00	33.30	0.50	19.10	9.55
	19.00	35.30	0.50	20.60	10.30
	20.00	37.20	0.50	22.03	11.01
	21.00	39.20	0.50	23.53	11.76
	22.00	41.20	0.50	25.03	12.51
	23.00	43.20	0.50	26.03	13.01
	24.00	45.20	0.50	27.03	13.51
	25.00	47.20	0.50	28.03	14.01
	26.00	49.20	0.50	29.03	14.51
	27.00	51.10	0.50	29.98	14.99
	28.00	53.10	0.50	30.98	15.49
	29.00	55.10	2.00	33.48	16.74
	30.00	57.10	5.00	37.48	18.74
	31.00	59.10	7.90	41.38	20.69

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	32.00	63.10	7.90	43.38	21.69
	33.00	69.10	7.90	47.88	23.94
	34.00	75.20	7.90	52.45	26.23
	35.00	81.40	7.90	57.10	28.55
	36.00	87.80	7.90	61.90	30.95
	37.00	94.20	7.90	66.70	33.35
	38.00	100.70	7.90	71.58	35.79
	39.00	107.30	7.90	76.53	38.26
	40.00	114.00	7.90	81.55	40.78
	41.00	120.80	7.90	86.65	43.33
	42.00	127.70	7.90	91.83	45.91
	43.00	134.70	7.90	97.08	48.54
	44.00	141.80	7.90	102.40	51.20
	45.00	149.00	7.90	107.80	53.90
	46.00	156.30	7.90	113.28	56.64
	47.00	163.70	7.90	118.83	59.41
	48.00	171.20	7.90	124.45	62.23
	49.00	178.80	7.90	130.15	65.08
	50.00	186.50	7.90	135.93	67.96
	51.00	194.30	7.90	141.78	70.89
	52.00	202.20	7.90	147.70	73.85
	53.00	210.20	7.90	153.70	76.85
	54.00	218.30	7.90	159.78	79.89
	55.00	226.40	7.90	165.85	82.93
	56.00	234.70	7.90	172.08	86.04
	57.00	243.10	7.90	178.38	89.19
	58.00	251.60	7.90	184.75	92.38
	59.00	260.20	7.90	191.20	95.60
	60.00	268.80	7.90	197.65	98.83
	61.00	277.60	7.90	204.25	102.13
	62.00	286.50	7.90	210.93	105.46
	63.00	295.40	7.90	217.60	108.80

Steel H-Pile Driving Resistance
B64-2 Piers 3-6
12x53 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table Near Normal Pool Elevation= 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
	64.00	304.50	7.90	**224.43**	**112.21**
	65.00	313.70	7.90	**231.33**	**115.66**
	66.00	322.90	7.90	**238.23**	**119.11**
	67.00	332.30	7.90	**245.28**	**122.64**
	68.00	341.80	7.90	**252.40**	**126.20**
	69.00	351.30	7.90	**259.53**	**129.76**
	70.00	361.00	7.90	**266.80**	**133.40**
	71.00	370.70	7.90	**274.08**	**137.04**
	72.00	380.60	7.90	**281.50**	**140.75**
	73.00	390.50	7.90	**288.93**	**144.46**
	74.00	400.60	7.90	**296.50**	**148.25**
	75.00	410.70	7.90	**304.08**	**152.04**
	76.00	421.00	7.90	**311.80**	**155.90**
	77.00	431.30	7.90	**319.53**	**159.76**
	78.00	441.80	7.90	**327.40**	**163.70**
Sand	**79.00**	452.30	7.90	**335.28**	**167.64**
	80.00	462.90	7.90	**343.23**	**171.61**
	81.00	473.70	7.90	**351.33**	**175.66**
	82.00	484.50	7.90	**359.43**	**179.71**
	83.00	495.40	7.90	**367.60**	**183.80**
	84.00	506.50	7.90	**375.93**	**187.96**
	85.00	517.60	7.90	**384.25**	**192.13**
	86.00	528.80	7.90	**392.65**	**196.33**
	87.00	540.20	7.90	**401.20**	**200.60**
	88.00	551.60	7.90	**409.75**	**204.88**
	89.00	563.10	7.90	**418.38**	**209.19**
	90.00	574.70	7.90	**427.08**	**213.54**
	91.00	586.40	7.90	**435.85**	**217.93**
	92.00	598.30	7.90	**444.78**	**222.39**
	93.00	610.20	7.90	**453.70**	**226.85**
	94.00	622.20	7.90	**462.70**	**231.35**
	95.00	634.30	7.90	**471.78**	**235.89**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
	96.00	646.50	7.90	**480.93**	**240.46**
	97.00	658.80	7.90	**490.15**	**245.08**
	98.00	671.20	7.90	**499.45**	**249.73**
	99.00	683.70	7.90	**508.83**	**254.41**
	100.00	696.30	7.90	**518.28**	**259.14**
	101.00	709.00	7.90	**527.80**	**263.90**
	102.00	721.80	7.90	**537.40**	**268.70**
	103.00	734.70	7.90	**547.08**	**273.54**
	104.00	747.70	7.90	**556.83**	**278.41**
	105.00	760.80	7.90	**566.65**	**283.33**
	106.00	774.00	7.90	**576.55**	**288.28**
Sand	**107.00**	787.30	7.90	**586.53**	**293.26**
	108.00	800.70	7.90	**596.58**	**298.29**
	109.00	814.20	7.90	**606.70**	**303.35**
	110.00	827.70	7.90	**616.83**	**308.41**
	111.00	841.40	7.90	**627.10**	**313.55**
	112.00	855.20	7.90	**637.45**	**318.73**
	113.00	869.10	7.90	**647.88**	**323.94**
	114.00	883.10	7.90	**658.38**	**329.19**
	115.00	897.10	7.90	**668.88**	**334.44**

Steel H-Pile Driving Resistance
B64-2 - Piers 3-6
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table Near Normal Pool Elevation= 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	0.00	0.00	0.60	0.60	0.30
	1.00	3.30	2.80	5.28	2.64
	2.00	4.50	3.00	6.38	3.19
	3.00	5.80	2.30	6.33	3.16
	4.00	7.40	1.50	6.33	3.16
	5.00	9.10	0.70	6.38	3.19
Clay	6.00	11.20	0.70	7.43	3.71
	7.00	13.50	0.70	8.58	4.29
	8.00	15.90	0.70	9.78	4.89
	9.00	18.20	0.70	10.93	5.46
	10.00	20.60	0.70	12.13	6.06
	11.00	22.90	0.70	13.28	6.64
	12.00	25.30	0.70	14.48	7.24
	13.00	27.60	0.70	15.63	7.81
	14.00	30.00	0.70	16.83	8.41
	15.00	32.30	0.70	17.98	8.99
	16.00	34.70	0.70	19.18	9.59
	17.00	37.00	0.70	20.90	10.45
	18.00	39.40	0.70	22.70	11.35
	19.00	41.70	0.70	24.43	12.21
	20.00	44.10	0.70	26.23	13.11
	21.00	46.40	0.70	27.95	13.98
	22.00	48.80	0.70	29.75	14.88
	23.00	51.10	0.70	30.90	15.45
	24.00	53.50	0.70	32.10	16.05
	25.00	55.80	0.70	33.25	16.63
	26.00	58.20	0.70	34.45	17.23
	27.00	60.50	0.70	35.60	17.80
	28.00	62.90	0.70	36.80	18.40
	29.00	65.20	4.10	41.35	20.68
	30.00	67.60	7.50	45.95	22.98

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Clay	31.00	69.90	10.90	50.50	25.25
	32.00	74.60	10.90	52.85	26.43
	33.00	81.80	10.90	58.25	29.13
	34.00	89.00	10.90	63.65	31.83
	35.00	96.40	10.90	69.20	34.60
	36.00	103.80	10.90	74.75	37.38
	37.00	111.40	10.90	80.45	40.23
	38.00	119.10	10.90	86.23	43.11
	39.00	127.00	10.90	92.15	46.08
	40.00	134.90	10.90	98.08	49.04
	41.00	143.00	10.90	104.15	52.08
	42.00	151.10	10.90	110.23	55.11
	43.00	159.40	10.90	116.45	58.23
	44.00	167.80	10.90	122.75	61.38
	45.00	176.40	10.90	129.20	64.60
Sand	46.00	185.00	10.90	135.65	67.83
	47.00	193.80	10.90	142.25	71.13
	48.00	202.60	10.90	148.85	74.43
	49.00	211.60	10.90	155.60	77.80
	50.00	220.70	10.90	162.43	81.21
	51.00	229.90	10.90	169.33	84.66
	52.00	239.30	10.90	176.38	88.19
	53.00	248.70	10.90	183.43	91.71
	54.00	258.30	10.90	190.63	95.31
	55.00	268.00	10.90	197.90	98.95
	56.00	277.80	10.90	205.25	102.63
	57.00	287.70	10.90	212.68	106.34
	58.00	297.70	10.90	220.18	110.09
	59.00	307.90	10.90	227.83	113.91
	60.00	318.10	10.90	235.48	117.74
	61.00	328.50	10.90	243.28	121.64

Steel H-Pile Driving Resistance
B64-2 - Piers 3-6
14x73 H-Pile (50 ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table Near Normal Pool Elevation= 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**62.00**	339.00	10.90	**251.15**	**125.58**
	63.00	349.60	10.90	**259.10**	**129.55**
	64.00	360.40	10.90	**267.20**	**133.60**
	65.00	371.20	10.90	**275.30**	**137.65**
	66.00	382.20	10.90	**283.55**	**141.78**
	67.00	393.30	10.90	**291.88**	**145.94**
	68.00	404.50	10.90	**300.28**	**150.14**
	69.00	415.80	10.90	**308.75**	**154.38**
	70.00	427.20	10.90	**317.30**	**158.65**
	71.00	438.70	10.90	**325.93**	**162.96**
	72.00	450.40	10.90	**334.70**	**167.35**
	73.00	462.20	10.90	**343.55**	**171.78**
	74.00	474.10	10.90	**352.48**	**176.24**
	75.00	486.10	10.90	**361.48**	**180.74**
	76.00	498.20	10.90	**370.55**	**185.28**
	77.00	510.40	10.90	**379.70**	**189.85**
	78.00	522.80	10.90	**389.00**	**194.50**
	79.00	535.30	10.90	**398.38**	**199.19**
	80.00	547.90	10.90	**407.83**	**203.91**
	81.00	560.60	10.90	**417.35**	**208.68**
	82.00	573.40	10.90	**426.95**	**213.48**
	83.00	586.30	10.90	**436.63**	**218.31**
	84.00	599.40	10.90	**446.45**	**223.23**
	85.00	612.50	10.90	**456.28**	**228.14**
	86.00	625.80	10.90	**466.25**	**233.13**
	87.00	639.20	10.90	**476.30**	**238.15**
	88.00	652.80	10.90	**486.50**	**243.25**
	89.00	666.40	10.90	**496.70**	**248.35**
	90.00	680.10	10.90	**506.98**	**253.49**
	91.00	694.00	10.90	**517.40**	**258.70**
	92.00	708.00	10.90	**527.90**	**263.95**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**93.00**	722.10	10.90	**538.48**	**269.24**
	94.00	736.30	10.90	**549.13**	**274.56**
	95.00	750.60	10.90	**559.85**	**279.93**
	96.00	765.10	10.90	**570.73**	**285.36**
	97.00	779.70	10.90	**581.68**	**290.84**
	98.00	794.30	10.90	**592.63**	**296.31**
	99.00	809.10	10.90	**603.73**	**301.86**
	100.00	824.00	10.90	**614.90**	**307.45**
	101.00	839.10	10.90	**626.23**	**313.11**
	102.00	854.20	10.90	**637.55**	**318.78**
	103.00	869.50	10.90	**649.03**	**324.51**
	104.00	884.90	10.90	**660.58**	**330.29**
	105.00	900.40	10.90	**672.20**	**336.10**
	106.00	916.00	10.90	**683.90**	**341.95**
	107.00	931.70	10.90	**695.68**	**347.84**
	108.00	947.50	10.90	**707.53**	**353.76**
	109.00	963.50	10.90	**719.53**	**359.76**
	110.00	979.60	10.90	**731.60**	**365.80**
	111.00	995.80	10.90	**743.75**	**371.88**
	112.00	1012.10	10.90	**755.98**	**377.99**
	113.00	1028.50	10.90	**768.28**	**384.14**
	114.00	1045.00	10.90	**780.65**	**390.33**
	115.00	1061.70	10.90	**793.18**	**396.59**

Steel H-Pile Driving Resistance
B64-2 Piers 3-6
14x89 H-Pile (50ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table Near Normal Pool Elevation= 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	0.00	0.00	0.70	0.70	0.35
	1.00	3.30	3.50	5.98	2.99
	2.00	4.50	3.70	7.08	3.54
	3.00	5.90	2.80	6.88	3.44
	4.00	7.50	1.80	6.68	3.34
	5.00	9.20	0.80	6.53	3.26
Clay	6.00	11.30	0.80	7.58	3.79
	7.00	13.70	0.80	8.78	4.39
	8.00	16.10	0.80	9.98	4.99
	9.00	18.40	0.80	11.13	5.56
	10.00	20.80	0.80	12.33	6.16
	11.00	23.20	0.80	13.53	6.76
	12.00	25.60	0.80	14.73	7.36
	13.00	28.00	0.80	15.93	7.96
	14.00	30.30	0.80	17.08	8.54
	15.00	32.70	0.80	18.28	9.14
	16.00	35.10	0.80	19.48	9.74
	17.00	37.50	0.80	21.28	10.64
	18.00	39.80	0.80	23.00	11.50
	19.00	42.20	0.80	24.80	12.40
	20.00	44.60	0.80	26.60	13.30
	21.00	47.00	0.80	28.40	14.20
	22.00	49.40	0.80	30.20	15.10
	23.00	51.70	0.80	31.35	15.68
	24.00	54.10	0.80	32.55	16.28
	25.00	56.50	0.80	33.75	16.88
	26.00	58.90	0.80	34.95	17.48
	27.00	61.20	0.80	36.10	18.05
	28.00	63.60	0.90	37.40	18.70
	29.00	66.00	5.10	42.80	21.40
	30.00	68.40	9.20	48.10	24.05

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Clay	31.00	70.70	13.30	53.35	26.68
	32.00	75.50	13.30	55.75	27.88
	33.00	82.70	13.30	61.15	30.58
	34.00	90.00	13.30	66.63	33.31
	35.00	97.50	13.30	72.25	36.13
	36.00	105.10	13.30	77.95	38.98
	37.00	112.70	13.30	83.65	41.83
	38.00	120.50	13.30	89.50	44.75
	39.00	128.50	13.30	95.50	47.75
	40.00	136.50	13.30	101.50	50.75
	41.00	144.60	13.30	107.58	53.79
	42.00	152.90	13.30	113.80	56.90
	43.00	161.30	13.30	120.10	60.05
	44.00	169.80	13.30	126.48	63.24
	45.00	178.40	13.30	132.93	66.46
Sand	46.00	187.20	13.30	139.53	69.76
	47.00	196.00	13.30	146.13	73.06
	48.00	205.00	13.30	152.88	76.44
	49.00	214.10	13.30	159.70	79.85
	50.00	223.30	13.30	166.60	83.30
	51.00	232.60	13.30	173.58	86.79
	52.00	242.10	13.30	180.70	90.35
	53.00	251.60	13.30	187.83	93.91
	54.00	261.30	13.30	195.10	97.55
	55.00	271.10	13.30	202.45	101.23
	56.00	281.00	13.30	209.88	104.94
	57.00	291.10	13.30	217.45	108.73
	58.00	301.20	13.30	225.03	112.51
	59.00	311.50	13.30	232.75	116.38
	60.00	321.90	13.30	240.55	120.28
	61.00	332.40	13.30	248.43	124.21

Steel H-Pile Driving Resistance
B64-2 Piers 3-6
14x89 H-Pile (50ksi)

Estimated Base of Pile Cap Elevation = 439.0 ft.
Water Table Near Normal Pool Elevation= 421.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
Sand	**62.00**	343.00	13.30	**256.38**	**128.19**
	63.00	353.70	13.30	**264.40**	**132.20**
	64.00	364.60	13.30	**272.58**	**136.29**
	65.00	375.60	13.30	**280.83**	**140.41**
	66.00	386.70	13.30	**289.15**	**144.58**
	67.00	397.90	13.30	**297.55**	**148.78**
	68.00	409.20	13.30	**306.03**	**153.01**
	69.00	420.60	13.30	**314.58**	**157.29**
	70.00	432.20	13.30	**323.28**	**161.64**
	71.00	443.90	13.30	**332.05**	**166.03**
	72.00	455.70	13.30	**340.90**	**170.45**
	73.00	467.60	13.30	**349.83**	**174.91**
	74.00	479.60	13.30	**358.83**	**179.41**
	75.00	491.80	13.30	**367.98**	**183.99**
	76.00	504.00	13.30	**377.13**	**188.56**
	77.00	516.40	13.30	**386.43**	**193.21**
	78.00	528.90	13.30	**395.80**	**197.90**
	79.00	541.50	13.30	**405.25**	**202.63**
	80.00	554.30	13.30	**414.85**	**207.43**
	81.00	567.10	13.30	**424.45**	**212.23**
	82.00	580.10	13.30	**434.20**	**217.10**
	83.00	593.20	13.30	**444.03**	**222.01**
	84.00	606.40	13.30	**453.93**	**226.96**
	85.00	619.70	13.30	**463.90**	**231.95**
	86.00	633.20	13.30	**474.03**	**237.01**
	87.00	646.70	13.30	**484.15**	**242.08**
	88.00	660.40	13.30	**494.43**	**247.21**
	89.00	674.20	13.30	**504.78**	**252.39**
	90.00	688.10	13.30	**515.20**	**257.60**
	91.00	702.10	13.30	**525.70**	**262.85**
	92.00	716.30	13.30	**536.35**	**268.18**
	93.00	730.50	13.30	**547.00**	**273.50**

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	H-Pile Driving Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)
	94.00	744.90	13.30	**557.80**	**278.90**
	95.00	759.40	13.30	**568.68**	**284.34**
	96.00	774.00	13.30	**579.63**	**289.81**
	97.00	788.80	13.30	**590.73**	**295.36**
	98.00	803.60	13.30	**601.83**	**300.91**
	99.00	818.60	13.30	**613.08**	**306.54**
	100.00	833.70	13.30	**624.40**	**312.20**
	101.00	848.90	13.30	**635.80**	**317.90**
	102.00	864.20	13.30	**647.28**	**323.64**
	103.00	879.70	13.30	**658.90**	**329.45**
Sand	**104.00**	895.20	13.30	**670.53**	**335.26**
	105.00	910.90	13.30	**682.30**	**341.15**
	106.00	926.70	13.30	**694.15**	**347.08**
	107.00	942.60	13.30	**706.08**	**353.04**
	108.00	958.60	13.30	**718.08**	**359.04**
	109.00	974.80	13.30	**730.23**	**365.11**
	110.00	991.00	13.30	**742.38**	**371.19**
	111.00	1007.40	13.30	**754.68**	**377.34**
	112.00	1023.90	13.30	**767.05**	**383.53**
	113.00	1040.50	13.30	**779.50**	**389.75**
	114.00	1057.30	13.30	**792.10**	**396.05**
	115.00	1074.10	13.30	**804.70**	**402.35**

APPENDIX E
SINGLE DRILLED SHAFT EVALUATIONS

Resistance Factors for LRFD – Drilled Shafts

Axial Capacity

Side Resistance in Clays	Alpha Method	0.45
End Bearing in Clays	Total Stress	0.40
Side Resistance in Sands	Beta Method	0.55
End Bearing in Sands	SPT method	0.50

Uplift Resistance

Clays	Alpha Method	0.35
Sands	Beta Method	0.45

Shaft Axial Resistance
B64-2 - Piers 1 and 2
30-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.20	0.20	0.10	0.10	0.05	0.00	0.00
	1.00	0.00	0.30	0.30	0.15	0.15	0.08	0.00	0.00
	2.00	0.00	0.50	0.50	0.25	0.25	0.13	0.00	0.00
	3.00	0.00	0.60	0.60	0.30	0.30	0.15	0.00	0.00
	4.00	0.00	0.70	0.70	0.35	0.35	0.18	0.00	0.00
	0.00	0.00	0.90	0.90	0.45	0.45	0.23	0.00	0.00
	1.00	0.80	10.18	10.98	5.49	5.53	2.77	0.36	0.18
	2.00	1.72	11.24	12.96	6.48	6.57	3.28	0.77	0.39
	3.00	2.80	12.28	15.08	7.54	7.68	3.84	1.26	0.63
Sand	4.00	3.98	12.62	16.60	8.30	8.50	4.25	1.79	0.90
	5.00	5.32	12.54	17.86	8.93	9.20	4.60	2.39	1.20
	6.00	6.78	12.24	19.02	9.51	9.85	4.92	3.05	1.53
	7.00	8.38	12.02	20.40	10.20	10.62	5.31	3.77	1.89
	8.00	10.10	12.02	22.12	11.06	11.57	5.78	4.55	2.27
	9.00	11.62	12.02	23.64	11.82	11.05	5.52	5.08	2.54
	10.00	13.14	12.02	25.16	12.58	11.73	5.87	5.61	2.80
	11.00	14.64	12.02	26.66	13.33	12.41	6.20	6.13	3.07
	12.00	16.16	12.02	28.18	14.09	13.09	6.55	6.67	3.33
	13.00	17.66	12.02	29.68	14.84	13.77	6.88	7.19	3.60
	14.00	19.18	12.02	31.20	15.60	14.45	7.22	7.72	3.86
	15.00	20.70	12.02	32.72	16.36	15.13	7.57	8.26	4.13
	16.00	22.20	12.02	34.22	17.11	15.81	7.90	8.78	4.39
	17.00	23.72	12.02	35.74	17.87	16.49	8.25	9.31	4.66
	18.00	25.22	12.02	37.24	18.62	17.17	8.58	9.84	4.92
	19.00	26.74	12.02	38.76	19.38	17.85	8.93	10.37	5.18
	20.00	28.26	12.02	40.28	20.14	18.54	9.27	10.90	5.45
	21.00	29.76	12.02	41.78	20.89	19.21	9.61	11.43	5.71
	22.00	31.28	12.02	43.30	21.65	19.89	9.95	11.96	5.98
Clay	23.00	32.78	12.02	44.80	22.40	20.57	10.28	12.48	6.24
	24.00	34.30	12.02	46.32	23.16	21.25	10.63	13.02	6.51
	25.00	35.82	12.02	47.84	23.92	21.94	10.97	13.55	6.77
	26.00	37.32	12.02	49.34	24.67	22.61	11.31	14.07	7.04
	27.00	38.84	12.02	50.86	25.43	23.30	11.65	14.60	7.30
	28.00	40.34	12.02	52.36	26.18	23.97	11.99	15.13	7.56
	29.00	41.86	12.02	53.88	26.94	24.66	12.33	15.66	7.83
	30.00	43.38	12.02	55.40	27.70	25.34	12.67	16.19	8.10
	31.00	44.88	12.02	56.90	28.45	26.01	13.01	16.72	8.36
	32.00	46.40	12.02	58.42	29.21	26.70	13.35	17.25	8.63
	33.00	47.90	12.02	59.92	29.96	27.37	13.69	17.78	8.89
	34.00	49.42	28.74	78.16	39.08	34.75	17.37	18.31	9.15
	35.00	50.94	48.24	99.18	49.59	43.23	21.61	18.84	9.42
	36.00	52.44	64.96	117.40	58.70	50.59	25.30	19.36	9.68
	37.00	53.96	73.32	127.28	63.64	54.62	27.31	19.90	9.95
	38.00	55.46	73.32	128.78	64.39	55.30	27.65	20.42	10.21
Sand	39.00	61.74	73.32	135.06	67.53	66.08	33.04	23.25	11.62
	40.00	68.16	73.32	141.48	70.74	69.61	34.81	26.14	13.07

Shaft Axial Resistance
B64-2 - Piers 1 and 2
30-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	41.00	74.72	73.32	148.04	74.02	**73.22**	**36.61**	**29.09**	**14.54**
	42.00	81.42	73.32	154.74	77.37	**76.91**	**38.45**	**32.10**	**16.05**
	43.00	88.28	73.32	161.60	80.80	**80.68**	**40.34**	**35.19**	**17.60**
	44.00	95.26	73.32	168.58	84.29	**84.52**	**42.26**	**38.33**	**19.17**
	45.00	102.40	73.32	175.72	87.86	**88.44**	**44.22**	**41.54**	**20.77**
	46.00	109.66	73.32	182.98	91.49	**92.44**	**46.22**	**44.81**	**22.41**
	47.00	117.08	73.32	190.40	95.20	**96.52**	**48.26**	**48.15**	**24.08**
	48.00	124.64	73.32	197.96	98.98	**100.68**	**50.34**	**51.55**	**25.78**
	49.00	132.34	73.32	205.66	102.83	**104.91**	**52.46**	**55.02**	**27.51**
	50.00	140.18	73.32	213.50	106.75	**109.22**	**54.61**	**58.55**	**29.27**
	51.00	148.18	73.32	221.50	110.75	**113.62**	**56.81**	**62.15**	**31.07**
	52.00	156.30	73.32	229.62	114.81	**118.09**	**59.04**	**65.80**	**32.90**
	53.00	164.58	73.32	237.90	118.95	**122.64**	**61.32**	**69.53**	**34.76**
	54.00	172.98	73.32	246.30	123.15	**127.26**	**63.63**	**73.31**	**36.65**
	55.00	181.54	73.32	254.86	127.43	**131.97**	**65.99**	**77.16**	**38.58**
Sand	**56.00**	190.24	73.32	263.56	131.78	**136.76**	**68.38**	**81.07**	**40.54**
	57.00	199.08	73.32	272.40	136.20	**141.62**	**70.81**	**85.05**	**42.53**
	58.00	208.08	73.32	281.40	140.70	**146.57**	**73.28**	**89.10**	**44.55**
	59.00	217.20	73.32	290.52	145.26	**151.58**	**75.79**	**93.20**	**46.60**
	60.00	226.48	73.32	299.80	149.90	**156.69**	**78.34**	**97.38**	**48.69**
	61.00	235.88	73.32	309.20	154.60	**161.86**	**80.93**	**101.61**	**50.81**
	62.00	245.44	73.32	318.76	159.38	**167.12**	**83.56**	**105.91**	**52.96**
	63.00	255.14	73.32	328.46	164.23	**172.45**	**86.23**	**110.28**	**55.14**
	64.00	264.98	73.32	338.30	169.15	**177.86**	**88.93**	**114.71**	**57.35**
	65.00	274.96	73.32	348.28	174.14	**183.35**	**91.68**	**119.20**	**59.60**
	66.00	285.08	73.32	358.40	179.20	**188.92**	**94.46**	**123.75**	**61.88**
	67.00	295.36	73.32	368.68	184.34	**194.57**	**97.29**	**128.38**	**64.19**
	68.00	305.76	73.32	379.08	189.54	**200.29**	**100.15**	**133.06**	**66.53**
	69.00	316.32	73.32	389.64	194.82	**206.10**	**103.05**	**137.81**	**68.90**
	70.00	327.02	73.32	400.34	200.17	**211.99**	**105.99**	**142.62**	**71.31**
	71.00	337.86	73.32	411.18	205.59	**217.95**	**108.97**	**147.50**	**73.75**
	72.00	348.84	73.32	422.16	211.08	**223.99**	**111.99**	**152.44**	**76.22**
	73.00	359.96	73.32	433.28	216.64	**230.10**	**115.05**	**157.45**	**78.72**
	74.00	371.24	73.32	444.56	222.28	**236.31**	**118.15**	**162.52**	**81.26**
	75.00	382.64	73.32	455.96	227.98	**242.58**	**121.29**	**167.65**	**83.83**
	76.00	394.20	73.32	467.52	233.76	**248.93**	**124.47**	**172.85**	**86.43**
	77.00	405.88	73.32	479.20	239.60	**255.36**	**127.68**	**178.11**	**89.06**
	78.00	417.72	73.32	491.04	245.52	**261.87**	**130.94**	**183.44**	**91.72**
	79.00	429.70	73.32	503.02	251.51	**268.46**	**134.23**	**188.83**	**94.41**
	80.00	441.82	73.32	515.14	257.57	**275.13**	**137.56**	**194.28**	**97.14**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
30-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	81.00	454.10	73.32	527.42	263.71	**281.88**	**140.94**	**199.81**	**99.90**
	82.00	466.50	73.32	539.82	269.91	**288.70**	**144.35**	**205.39**	**102.69**
	83.00	479.06	73.32	552.38	276.19	**295.61**	**147.80**	**211.04**	**105.52**
	84.00	491.74	73.32	565.06	282.53	**302.58**	**151.29**	**216.75**	**108.37**
	85.00	504.58	73.32	577.90	288.95	**309.64**	**154.82**	**222.53**	**111.26**
	86.00	517.56	73.32	590.88	295.44	**316.78**	**158.39**	**228.37**	**114.18**
	87.00	530.68	73.32	604.00	302.00	**324.00**	**162.00**	**234.27**	**117.14**
	88.00	543.94	73.32	617.26	308.63	**331.29**	**165.65**	**240.24**	**120.12**
	89.00	557.34	73.32	630.66	315.33	**338.66**	**169.33**	**246.27**	**123.13**
	90.00	570.90	73.32	644.22	322.11	**346.12**	**173.06**	**252.37**	**126.18**
	91.00	584.60	73.32	657.92	328.96	**353.65**	**176.83**	**258.53**	**129.27**
	92.00	598.42	73.32	671.74	335.87	**361.26**	**180.63**	**264.75**	**132.38**
	93.00	612.40	73.32	685.72	342.86	**368.94**	**184.47**	**271.04**	**135.52**
	94.00	626.52	73.32	699.84	349.92	**376.71**	**188.36**	**277.40**	**138.70**
Sand	**95.00**	640.78	73.32	714.10	357.05	**384.55**	**192.28**	**283.82**	**141.91**
	96.00	655.18	73.32	728.50	364.25	**392.47**	**196.24**	**290.30**	**145.15**
	97.00	669.74	73.32	743.06	371.53	**400.48**	**200.24**	**296.85**	**148.42**
	98.00	684.42	73.32	757.74	378.87	**408.56**	**204.28**	**303.45**	**151.73**
	99.00	699.26	73.32	772.58	386.29	**416.72**	**208.36**	**310.13**	**155.07**
	100.00	714.24	73.32	787.56	393.78	**424.96**	**212.48**	**316.87**	**158.44**
	101.00	729.36	73.32	802.68	401.34	**433.27**	**216.64**	**323.68**	**161.84**
	102.00	744.62	73.32	817.94	408.97	**441.67**	**220.83**	**330.54**	**165.27**
	103.00	760.02	73.32	833.34	416.67	**450.14**	**225.07**	**337.47**	**168.74**
	104.00	775.56	73.32	848.88	424.44	**458.68**	**229.34**	**344.47**	**172.23**
	105.00	791.24	73.32	864.56	432.28	**467.31**	**233.65**	**351.52**	**175.76**
	106.00	807.08	73.32	880.40	440.20	**476.02**	**238.01**	**358.65**	**179.33**
	107.00	823.06	73.32	896.38	448.19	**484.81**	**242.40**	**365.84**	**182.92**
	108.00	839.16	73.32	912.48	456.24	**493.66**	**246.83**	**373.09**	**186.54**
	109.00	855.42	73.32	928.74	464.37	**502.61**	**251.30**	**380.40**	**190.20**
	110.00	871.82	73.32	945.14	472.57	**511.63**	**255.81**	**387.78**	**193.89**
	111.00	888.38	73.32	961.70	480.85	**520.73**	**260.37**	**395.24**	**197.62**
	112.00	905.06	73.32	978.38	489.19	**529.91**	**264.95**	**402.74**	**201.37**
	113.00	921.88	73.32	995.20	497.60	**539.16**	**269.58**	**410.31**	**205.16**
	114.00	938.86	73.32	1012.18	506.09	**548.50**	**274.25**	**417.95**	**208.98**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
36-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand	0.00	0.00	0.30	0.30	0.15	0.15	0.08	0.00	0.00
	1.00	0.00	0.50	0.50	0.25	0.25	0.13	0.00	0.00
	2.00	0.00	0.70	0.70	0.35	0.35	0.18	0.00	0.00
	3.00	0.00	0.90	0.90	0.45	0.45	0.23	0.00	0.00
	4.00	0.00	1.10	1.10	0.55	0.55	0.28	0.00	0.00
	0.00	0.00	1.20	1.20	0.60	0.60	0.30	0.00	0.00
	1.00	0.96	12.96	13.92	6.96	7.01	3.50	0.43	0.22
	2.00	2.08	14.20	16.28	8.14	8.24	4.12	0.94	0.47
	3.00	3.36	15.40	18.76	9.38	9.55	4.77	1.51	0.76
	4.00	4.78	16.32	21.10	10.55	10.79	5.39	2.15	1.08
	5.00	6.38	16.94	23.32	11.66	11.98	5.99	2.87	1.44
	6.00	8.14	17.24	25.38	12.69	13.10	6.55	3.66	1.83
	7.00	10.06	17.32	27.38	13.69	14.19	7.10	4.53	2.26
	8.00	12.12	17.32	29.44	14.72	15.33	7.66	5.45	2.73
Clay	9.00	13.94	17.32	31.26	15.63	14.41	7.21	6.09	3.05
	10.00	15.76	17.32	33.08	16.54	15.23	7.62	6.73	3.36
	11.00	17.58	17.32	34.90	17.45	16.05	8.03	7.37	3.68
	12.00	19.38	17.32	36.70	18.35	16.86	8.43	8.00	4.00
	13.00	21.20	17.32	38.52	19.26	17.68	8.84	8.63	4.32
	14.00	23.02	17.32	40.34	20.17	18.50	9.25	9.27	4.63
	15.00	24.82	17.32	42.14	21.07	19.31	9.65	9.90	4.95
	16.00	26.64	17.32	43.96	21.98	20.13	10.06	10.54	5.27
	17.00	28.46	17.32	45.78	22.89	20.95	10.47	11.17	5.59
	18.00	30.28	17.32	47.60	23.80	21.77	10.88	11.81	5.91
	19.00	32.08	17.32	49.40	24.70	22.58	11.29	12.44	6.22
	20.00	33.90	17.32	51.22	25.61	23.40	11.70	13.08	6.54
	21.00	35.72	17.32	53.04	26.52	24.21	12.11	13.71	6.86
	22.00	37.54	17.32	54.86	27.43	25.03	12.52	14.35	7.18
	23.00	39.34	17.32	56.66	28.33	25.84	12.92	14.98	7.49
	24.00	41.16	17.32	58.48	29.24	26.66	13.33	15.62	7.81
	25.00	42.98	17.32	60.30	30.15	27.48	13.74	16.26	8.13
	26.00	44.78	17.32	62.10	31.05	28.29	14.15	16.89	8.44
	27.00	46.60	17.32	63.92	31.96	29.11	14.56	17.52	8.76
	28.00	48.42	17.32	65.74	32.87	29.93	14.96	18.16	9.08
	29.00	50.24	17.32	67.56	33.78	30.75	15.37	18.80	9.40
	30.00	52.04	17.32	69.36	34.68	31.56	15.78	19.43	9.71
	31.00	53.86	17.32	71.18	35.59	32.38	16.19	20.06	10.03
	32.00	55.68	17.32	73.00	36.50	33.20	16.60	20.70	10.35
	33.00	57.48	36.04	93.52	46.76	41.49	20.75	21.33	10.67
	34.00	59.30	57.44	116.74	58.37	50.87	25.44	21.97	10.98
	35.00	61.12	81.52	142.64	71.32	61.32	30.66	22.60	11.30
	36.00	62.94	97.56	160.50	80.25	68.56	34.28	23.24	11.62
	37.00	64.74	105.58	170.32	85.16	72.58	36.29	23.87	11.94
	38.00	66.56	105.58	172.14	86.07	73.40	36.70	24.51	12.25

Shaft Axial Resistance
B64-2 - Piers 1 and 2
36-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
↑	**39.00**	74.10	105.58	179.68	89.84	**88.10**	**44.05**	**27.90**	**13.95**
	40.00	81.80	105.58	187.38	93.69	**92.34**	**46.17**	**31.37**	**15.68**
	41.00	89.66	105.58	195.24	97.62	**96.66**	**48.33**	**34.90**	**17.45**
	42.00	97.72	105.58	203.30	101.65	**101.09**	**50.55**	**38.53**	**19.27**
	43.00	105.92	105.58	211.50	105.75	**105.60**	**52.80**	**42.22**	**21.11**
	44.00	114.32	105.58	219.90	109.95	**110.22**	**55.11**	**46.00**	**23.00**
	45.00	122.86	105.58	228.44	114.22	**114.92**	**57.46**	**49.84**	**24.92**
	46.00	131.60	105.58	237.18	118.59	**119.73**	**59.86**	**53.78**	**26.89**
	47.00	140.50	105.58	246.08	123.04	**124.62**	**62.31**	**57.78**	**28.89**
	48.00	149.56	105.58	255.14	127.57	**129.60**	**64.80**	**61.86**	**30.93**
	49.00	158.80	105.58	264.38	132.19	**134.69**	**67.34**	**66.02**	**33.01**
	50.00	168.22	105.58	273.80	136.90	**139.87**	**69.93**	**70.26**	**35.13**
	51.00	177.80	105.58	283.38	141.69	**145.14**	**72.57**	**74.57**	**37.28**
	52.00	187.56	105.58	293.14	146.57	**150.50**	**75.25**	**78.96**	**39.48**
	53.00	197.48	105.58	303.06	151.53	**155.96**	**77.98**	**83.42**	**41.71**
	54.00	207.58	105.58	313.16	156.58	**161.52**	**80.76**	**87.97**	**43.98**
	55.00	217.86	105.58	323.44	161.72	**167.17**	**83.58**	**92.59**	**46.30**
	56.00	228.30	105.58	333.88	166.94	**172.91**	**86.46**	**97.29**	**48.65**
	57.00	238.90	105.58	344.48	172.24	**178.74**	**89.37**	**102.06**	**51.03**
Sand	**58.00**	249.68	105.58	355.26	177.63	**184.67**	**92.34**	**106.91**	**53.46**
	59.00	260.64	105.58	366.22	183.11	**190.70**	**95.35**	**111.84**	**55.92**
	60.00	271.76	105.58	377.34	188.67	**196.81**	**98.41**	**116.85**	**58.42**
	61.00	283.06	105.58	388.64	194.32	**203.03**	**101.51**	**121.93**	**60.97**
	62.00	294.52	105.58	400.10	200.05	**209.33**	**104.67**	**127.09**	**63.55**
	63.00	306.16	105.58	411.74	205.87	**215.73**	**107.87**	**132.33**	**66.16**
	64.00	317.98	105.58	423.56	211.78	**222.24**	**111.12**	**137.65**	**68.82**
	65.00	329.96	105.58	435.54	217.77	**228.82**	**114.41**	**143.04**	**71.52**
	66.00	342.10	105.58	447.68	223.84	**235.50**	**117.75**	**148.50**	**74.25**
	67.00	354.42	105.58	460.00	230.00	**242.28**	**121.14**	**154.05**	**77.02**
	68.00	366.92	105.58	472.50	236.25	**249.15**	**124.58**	**159.67**	**79.84**
	69.00	379.58	105.58	485.16	242.58	**256.12**	**128.06**	**165.37**	**82.68**
	70.00	392.42	105.58	498.00	249.00	**263.18**	**131.59**	**171.15**	**85.57**
	71.00	405.42	105.58	511.00	255.50	**270.33**	**135.16**	**177.00**	**88.50**
	72.00	418.60	105.58	524.18	262.09	**277.58**	**138.79**	**182.93**	**91.46**
	73.00	431.96	105.58	537.54	268.77	**284.92**	**142.46**	**188.94**	**94.47**
	74.00	445.48	105.58	551.06	275.53	**292.36**	**146.18**	**195.02**	**97.51**
	75.00	459.16	105.58	564.74	282.37	**299.88**	**149.94**	**201.18**	**100.59**
	76.00	473.04	105.58	578.62	289.31	**307.52**	**153.76**	**207.42**	**103.71**
↓	**77.00**	487.06	105.58	592.64	296.32	**315.23**	**157.61**	**213.73**	**106.87**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
36-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	78.00	501.26	105.58	606.84	303.42	**323.04**	**161.52**	**220.12**	**110.06**
	79.00	515.64	105.58	621.22	310.61	**330.95**	**165.47**	**226.59**	**113.30**
	80.00	530.20	105.58	635.78	317.89	**338.96**	**169.48**	**233.15**	**116.57**
	81.00	544.92	105.58	650.50	325.25	**347.05**	**173.53**	**239.77**	**119.89**
	82.00	559.80	105.58	665.38	332.69	**355.24**	**177.62**	**246.47**	**123.23**
	83.00	574.86	105.58	680.44	340.22	**363.52**	**181.76**	**253.24**	**126.62**
	84.00	590.10	105.58	695.68	347.84	**371.90**	**185.95**	**260.10**	**130.05**
	85.00	605.50	105.58	711.08	355.54	**380.37**	**190.19**	**267.03**	**133.52**
	86.00	621.08	105.58	726.66	363.33	**388.94**	**194.47**	**274.04**	**137.02**
	87.00	636.82	105.58	742.40	371.20	**397.60**	**198.80**	**281.13**	**140.56**
	88.00	652.74	105.58	758.32	379.16	**406.35**	**203.18**	**288.29**	**144.14**
	89.00	668.82	105.58	774.40	387.20	**415.20**	**207.60**	**295.53**	**147.76**
	90.00	685.08	105.58	790.66	395.33	**424.14**	**212.07**	**302.84**	**151.42**
	91.00	701.50	105.58	807.08	403.54	**433.17**	**216.59**	**310.23**	**155.12**
	92.00	718.10	105.58	823.68	411.84	**442.30**	**221.15**	**317.70**	**158.85**
	93.00	734.88	105.58	840.46	420.23	**451.53**	**225.77**	**325.25**	**162.63**
	94.00	751.82	105.58	857.40	428.70	**460.85**	**230.42**	**332.88**	**166.44**
	95.00	768.94	105.58	874.52	437.26	**470.26**	**235.13**	**340.58**	**170.29**
	96.00	786.22	105.58	891.80	445.90	**479.77**	**239.88**	**348.36**	**174.18**
Sand	**97.00**	803.68	105.58	909.26	454.63	**489.37**	**244.69**	**356.21**	**178.11**
	98.00	821.30	105.58	926.88	463.44	**499.06**	**249.53**	**364.14**	**182.07**
	99.00	839.10	105.58	944.68	472.34	**508.85**	**254.43**	**372.15**	**186.08**
	100.00	857.08	105.58	962.66	481.33	**518.74**	**259.37**	**380.24**	**190.12**
	101.00	875.22	105.58	980.80	490.40	**528.72**	**264.36**	**388.41**	**194.20**
	102.00	893.54	105.58	999.12	499.56	**538.79**	**269.40**	**396.65**	**198.32**
	103.00	912.02	105.58	1017.60	508.80	**548.96**	**274.48**	**404.97**	**202.48**
	104.00	930.68	105.58	1036.26	518.13	**559.22**	**279.61**	**413.36**	**206.68**
	105.00	949.50	105.58	1055.08	527.54	**569.57**	**284.79**	**421.83**	**210.92**
	106.00	968.50	105.58	1074.08	537.04	**580.02**	**290.01**	**430.38**	**215.19**
	107.00	987.66	105.58	1093.24	546.62	**590.56**	**295.28**	**439.00**	**219.50**
	108.00	1007.00	105.58	1112.58	556.29	**601.20**	**300.60**	**447.71**	**223.85**
	109.00	1026.52	105.58	1132.10	566.05	**611.93**	**305.97**	**456.49**	**228.25**
	110.00	1046.20	105.58	1151.78	575.89	**622.76**	**311.38**	**465.35**	**232.67**
	111.00	1066.04	105.58	1171.62	585.81	**633.67**	**316.83**	**474.27**	**237.14**
	112.00	1086.08	105.58	1191.66	595.83	**644.69**	**322.35**	**483.29**	**241.65**
	113.00	1106.26	105.58	1211.84	605.92	**655.79**	**327.89**	**492.37**	**246.19**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
42-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.40	0.40	0.20	0.20	0.10	0.00	0.00
	1.00	0.00	0.60	0.60	0.30	0.30	0.15	0.00	0.00
	2.00	0.00	0.80	0.80	0.40	0.40	0.20	0.00	0.00
	3.00	0.00	1.10	1.10	0.55	0.55	0.28	0.00	0.00
	4.00	0.00	1.30	1.30	0.65	0.65	0.33	0.00	0.00
	0.00	0.00	1.50	1.50	0.75	0.75	0.38	0.00	0.00
	1.00	1.12	15.96	17.08	8.54	8.60	4.30	0.50	0.25
	2.00	2.42	17.98	20.40	10.20	10.32	5.16	1.09	0.54
	3.00	3.90	19.80	23.70	11.85	12.05	6.02	1.76	0.88
Sand	4.00	5.58	21.38	26.96	13.48	13.76	6.88	2.51	1.26
	5.00	7.44	22.58	30.02	15.01	15.38	7.69	3.35	1.67
	6.00	9.50	23.28	32.78	16.39	16.87	8.43	4.28	2.14
	7.00	11.72	23.58	35.30	17.65	18.24	9.12	5.27	2.64
	8.00	14.14	23.58	37.72	18.86	19.57	9.78	6.36	3.18
	9.00	16.26	23.58	39.84	19.92	18.16	9.08	7.11	3.55
	10.00	18.38	23.58	41.96	20.98	19.12	9.56	7.85	3.92
	11.00	20.50	23.58	44.08	22.04	20.07	10.04	8.59	4.29
	12.00	22.62	23.58	46.20	23.10	21.03	10.51	9.33	4.67
	13.00	24.74	23.58	48.32	24.16	21.98	10.99	10.07	5.04
	14.00	26.84	23.58	50.42	25.21	22.92	11.46	10.81	5.40
	15.00	28.96	23.58	52.54	26.27	23.88	11.94	11.55	5.78
	16.00	31.08	23.58	54.66	27.33	24.83	12.42	12.29	6.15
	17.00	33.20	23.58	56.78	28.39	25.79	12.89	13.03	6.52
	18.00	35.32	23.58	58.90	29.45	26.74	13.37	13.78	6.89
Clay	19.00	37.44	23.58	61.02	30.51	27.69	13.85	14.52	7.26
	20.00	39.56	23.58	63.14	31.57	28.65	14.32	15.26	7.63
	21.00	41.66	23.58	65.24	32.62	29.59	14.80	16.00	8.00
	22.00	43.78	23.58	67.36	33.68	30.55	15.27	16.74	8.37
	23.00	45.90	23.58	69.48	34.74	31.50	15.75	17.48	8.74
	24.00	48.02	23.58	71.60	35.80	32.46	16.23	18.22	9.11
	25.00	50.14	23.58	73.72	36.86	33.41	16.70	18.96	9.48
	26.00	52.26	23.58	75.84	37.92	34.36	17.18	19.71	9.85
	27.00	54.36	23.58	77.94	38.97	35.31	17.65	20.44	10.22
	28.00	56.48	23.58	80.06	40.03	36.26	18.13	21.18	10.59
	29.00	58.60	23.58	82.18	41.09	37.22	18.61	21.92	10.96
	30.00	60.72	23.58	84.30	42.15	38.17	19.09	22.67	11.33
	31.00	62.84	23.58	86.42	43.21	39.12	19.56	23.41	11.70
	32.00	64.96	44.94	109.90	54.95	48.62	24.31	24.15	12.08
	33.00	67.08	68.96	136.04	68.02	59.18	29.59	24.89	12.45
	34.00	69.18	95.66	164.84	82.42	70.81	35.40	25.63	12.81
Clay	35.00	71.30	119.68	190.98	95.49	81.37	40.69	26.37	13.18
	36.00	73.42	135.70	209.12	104.56	88.73	44.37	27.11	13.56
	37.00	75.54	143.72	219.26	109.63	92.90	46.45	27.85	13.93
	38.00	77.66	143.72	221.38	110.69	93.85	46.92	28.60	14.30
Sand	39.00	86.44	143.72	230.16	115.08	113.05	56.53	32.55	16.27

Shaft Axial Resistance
B64-2 - Piers 1 and 2
42-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	95.42	143.72	239.14	119.57	**117.99**	**58.99**	**36.59**	**18.29**
	41.00	104.62	143.72	248.34	124.17	**123.05**	**61.52**	**40.73**	**20.36**
	42.00	114.00	143.72	257.72	128.86	**128.21**	**64.10**	**44.95**	**22.47**
	43.00	123.58	143.72	267.30	133.65	**133.48**	**66.74**	**49.26**	**24.63**
	44.00	133.36	143.72	277.08	138.54	**138.86**	**69.43**	**53.66**	**26.83**
	45.00	143.34	143.72	287.06	143.53	**144.35**	**72.17**	**58.15**	**29.08**
	46.00	153.52	143.72	297.24	148.62	**149.94**	**74.97**	**62.73**	**31.37**
	47.00	163.92	143.72	307.64	153.82	**155.66**	**77.83**	**67.41**	**33.71**
	48.00	174.50	143.72	318.22	159.11	**161.48**	**80.74**	**72.17**	**36.09**
	49.00	185.28	143.72	329.00	164.50	**167.41**	**83.71**	**77.02**	**38.51**
	50.00	196.26	143.72	339.98	169.99	**173.45**	**86.73**	**81.97**	**40.98**
	51.00	207.44	143.72	351.16	175.58	**179.60**	**89.80**	**87.00**	**43.50**
	52.00	218.82	143.72	362.54	181.27	**185.86**	**92.93**	**92.12**	**46.06**
	53.00	230.40	143.72	374.12	187.06	**192.23**	**96.11**	**97.33**	**48.66**
	54.00	242.18	143.72	385.90	192.95	**198.71**	**99.35**	**102.63**	**51.31**
	55.00	254.16	143.72	397.88	198.94	**205.30**	**102.65**	**108.02**	**54.01**
	56.00	266.34	143.72	410.06	205.03	**212.00**	**106.00**	**113.50**	**56.75**
Sand	**57.00**	278.72	143.72	422.44	211.22	**218.80**	**109.40**	**119.07**	**59.54**
	58.00	291.30	143.72	435.02	217.51	**225.72**	**112.86**	**124.73**	**62.37**
	59.00	304.08	143.72	447.80	223.90	**232.75**	**116.38**	**130.48**	**65.24**
	60.00	317.06	143.72	460.78	230.39	**239.89**	**119.95**	**136.33**	**68.16**
	61.00	330.24	143.72	473.96	236.98	**247.14**	**123.57**	**142.26**	**71.13**
	62.00	343.62	143.72	487.34	243.67	**254.50**	**127.25**	**148.28**	**74.14**
	63.00	357.20	143.72	500.92	250.46	**261.97**	**130.98**	**154.39**	**77.19**
	64.00	370.96	143.72	514.68	257.34	**269.54**	**134.77**	**160.58**	**80.29**
	65.00	384.94	143.72	528.66	264.33	**277.23**	**138.61**	**166.87**	**83.44**
	66.00	399.12	143.72	542.84	271.42	**285.02**	**142.51**	**173.25**	**86.63**
	67.00	413.50	143.72	557.22	278.61	**292.93**	**146.47**	**179.72**	**89.86**
	68.00	428.08	143.72	571.80	285.90	**300.95**	**150.48**	**186.28**	**93.14**
	69.00	442.84	143.72	586.56	293.28	**309.07**	**154.54**	**192.93**	**96.46**
	70.00	457.82	143.72	601.54	300.77	**317.31**	**158.65**	**199.67**	**99.83**
	71.00	473.00	143.72	616.72	308.36	**325.66**	**162.83**	**206.50**	**103.25**
	72.00	488.38	143.72	632.10	316.05	**334.12**	**167.06**	**213.42**	**106.71**
	73.00	503.94	143.72	647.66	323.83	**342.68**	**171.34**	**220.42**	**110.21**
	74.00	519.72	143.72	663.44	331.72	**351.35**	**175.68**	**227.52**	**113.76**
	75.00	535.70	143.72	679.42	339.71	**360.14**	**180.07**	**234.71**	**117.36**
	76.00	551.86	143.72	695.58	347.79	**369.03**	**184.52**	**241.99**	**120.99**
	77.00	568.24	143.72	711.96	355.98	**378.04**	**189.02**	**249.36**	**124.68**
	78.00	584.82	143.72	728.54	364.27	**387.16**	**193.58**	**256.82**	**128.41**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
42-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	79.00	601.58	143.72	745.30	372.65	**396.38**	**198.19**	**264.36**	**132.18**
	80.00	618.56	143.72	762.28	381.14	**405.72**	**202.86**	**272.00**	**136.00**
	81.00	635.72	143.72	779.44	389.72	**415.15**	**207.58**	**279.72**	**139.86**
	82.00	653.10	143.72	796.82	398.41	**424.71**	**212.36**	**287.54**	**143.77**
	83.00	670.68	143.72	814.40	407.20	**434.38**	**217.19**	**295.45**	**147.73**
	84.00	688.44	143.72	832.16	416.08	**444.15**	**222.08**	**303.45**	**151.72**
	85.00	706.42	143.72	850.14	425.07	**454.04**	**227.02**	**311.54**	**155.77**
	86.00	724.58	143.72	868.30	434.15	**464.03**	**232.01**	**319.71**	**159.85**
	87.00	742.96	143.72	886.68	443.34	**474.14**	**237.07**	**327.98**	**163.99**
	88.00	761.52	143.72	905.24	452.62	**484.34**	**242.17**	**336.33**	**168.17**
	89.00	780.28	143.72	924.00	462.00	**494.66**	**247.33**	**344.77**	**172.39**
	90.00	799.26	143.72	942.98	471.49	**505.10**	**252.55**	**353.32**	**176.66**
	91.00	818.42	143.72	962.14	481.07	**515.64**	**257.82**	**361.94**	**180.97**
	92.00	837.80	143.72	981.52	490.76	**526.30**	**263.15**	**370.66**	**185.33**
	93.00	857.36	143.72	1001.08	500.54	**537.06**	**268.53**	**379.46**	**189.73**
	94.00	877.12	143.72	1020.84	510.42	**547.92**	**273.96**	**388.35**	**194.18**
	95.00	897.10	143.72	1040.82	520.41	**558.91**	**279.46**	**397.34**	**198.67**
Sand	**96.00**	917.26	143.72	1060.98	530.49	**570.00**	**285.00**	**406.42**	**203.21**
	97.00	937.62	143.72	1081.34	540.67	**581.20**	**290.60**	**415.58**	**207.79**
	98.00	958.20	143.72	1101.92	550.96	**592.52**	**296.26**	**424.84**	**212.42**
	99.00	978.96	143.72	1122.68	561.34	**603.94**	**301.97**	**434.18**	**217.09**
	100.00	999.92	143.72	1143.64	571.82	**615.46**	**307.73**	**443.61**	**221.81**
	101.00	1021.08	143.72	1164.80	582.40	**627.10**	**313.55**	**453.13**	**226.57**
	102.00	1042.46	143.72	1186.18	593.09	**638.86**	**319.43**	**462.76**	**231.38**
	103.00	1064.02	143.72	1207.74	603.87	**650.72**	**325.36**	**472.46**	**236.23**
	104.00	1085.78	143.72	1229.50	614.75	**662.69**	**331.34**	**482.25**	**241.12**
	105.00	1107.74	143.72	1251.46	625.73	**674.77**	**337.38**	**492.13**	**246.07**
	106.00	1129.90	143.72	1273.62	636.81	**686.95**	**343.48**	**502.10**	**251.05**
	107.00	1152.28	143.72	1296.00	648.00	**699.26**	**349.63**	**512.17**	**256.09**
	108.00	1174.84	143.72	1318.56	659.28	**711.67**	**355.84**	**522.33**	**261.16**
	109.00	1197.60	143.72	1341.32	670.66	**724.19**	**362.09**	**532.57**	**266.28**
	110.00	1220.56	143.72	1364.28	682.14	**736.82**	**368.41**	**542.90**	**271.45**
	111.00	1243.72	143.72	1387.44	693.72	**749.55**	**374.78**	**553.32**	**276.66**
	112.00	1267.08	143.72	1410.80	705.40	**762.40**	**381.20**	**563.83**	**281.92**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
48-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	0.00	0.00	0.40	0.40	0.20	**0.20**	**0.10**	**0.00**	**0.00**
	1.00	0.00	0.60	0.60	0.30	**0.30**	**0.15**	**0.00**	**0.00**
	2.00	0.00	0.80	0.80	0.40	**0.40**	**0.20**	**0.00**	**0.00**
	3.00	0.00	1.10	1.10	0.55	**0.55**	**0.28**	**0.00**	**0.00**
	4.00	0.00	1.30	1.30	0.65	**0.65**	**0.33**	**0.00**	**0.00**
	0.00	0.00	1.50	1.50	0.75	**0.75**	**0.38**	**0.00**	**0.00**
Sand	**1.00**	1.28	20.32	21.60	10.80	**10.86**	**5.43**	**0.58**	**0.29**
	2.00	2.76	22.96	25.72	12.86	**13.00**	**6.50**	**1.24**	**0.62**
	3.00	4.46	25.46	29.92	14.96	**15.18**	**7.59**	**2.01**	**1.00**
	4.00	6.38	27.76	34.14	17.07	**17.39**	**8.69**	**2.87**	**1.44**
	5.00	8.52	29.36	37.88	18.94	**19.37**	**9.68**	**3.83**	**1.92**
	6.00	10.86	30.34	41.20	20.60	**21.14**	**10.57**	**4.89**	**2.44**
	7.00	13.40	30.80	44.20	22.10	**22.77**	**11.39**	**6.03**	**3.02**
	8.00	16.16	30.80	46.96	23.48	**24.29**	**12.14**	**7.27**	**3.64**
	9.00	18.58	30.80	49.38	24.69	**22.30**	**11.15**	**8.12**	**4.06**
	10.00	21.00	30.80	51.80	25.90	**23.39**	**11.69**	**8.97**	**4.48**
	11.00	23.42	30.80	54.22	27.11	**24.48**	**12.24**	**9.81**	**4.91**
	12.00	25.84	30.80	56.64	28.32	**25.56**	**12.78**	**10.66**	**5.33**
	13.00	28.26	30.80	59.06	29.53	**26.65**	**13.33**	**11.51**	**5.75**
	14.00	30.68	30.80	61.48	30.74	**27.74**	**13.87**	**12.35**	**6.18**
	15.00	33.10	30.80	63.90	31.95	**28.83**	**14.42**	**13.20**	**6.60**
	16.00	35.52	30.80	66.32	33.16	**29.92**	**14.96**	**14.05**	**7.02**
	17.00	37.94	30.80	68.74	34.37	**31.01**	**15.50**	**14.90**	**7.45**
	18.00	40.36	30.80	71.16	35.58	**32.10**	**16.05**	**15.74**	**7.87**
Clay	**19.00**	42.78	30.80	73.58	36.79	**33.19**	**16.59**	**16.59**	**8.29**
	20.00	45.20	30.80	76.00	38.00	**34.28**	**17.14**	**17.44**	**8.72**
	21.00	47.62	30.80	78.42	39.21	**35.37**	**17.68**	**18.28**	**9.14**
	22.00	50.04	30.80	80.84	40.42	**36.45**	**18.23**	**19.13**	**9.57**
	23.00	52.46	30.80	83.26	41.63	**37.54**	**18.77**	**19.98**	**9.99**
	24.00	54.88	30.80	85.68	42.84	**38.63**	**19.32**	**20.82**	**10.41**
	25.00	57.30	30.80	88.10	44.05	**39.72**	**19.86**	**21.67**	**10.84**
	26.00	59.72	30.80	90.52	45.26	**40.81**	**20.41**	**22.52**	**11.26**
	27.00	62.14	30.80	92.94	46.47	**41.90**	**20.95**	**23.37**	**11.68**
	28.00	64.56	30.80	95.36	47.68	**42.99**	**21.49**	**24.21**	**12.11**
	29.00	66.98	30.80	97.78	48.89	**44.08**	**22.04**	**25.06**	**12.53**
	30.00	69.40	30.80	100.20	50.10	**45.17**	**22.58**	**25.91**	**12.95**
	31.00	71.82	54.32	126.14	63.07	**55.66**	**27.83**	**26.75**	**13.38**
	32.00	74.24	80.48	154.72	77.36	**67.22**	**33.61**	**27.60**	**13.80**
	33.00	76.66	109.24	185.90	92.95	**79.81**	**39.90**	**28.45**	**14.22**
	34.00	79.08	140.64	219.72	109.86	**93.46**	**46.73**	**29.29**	**14.65**
Clay	**35.00**	81.50	164.16	245.66	122.83	**103.96**	**51.98**	**30.14**	**15.07**
	36.00	83.92	179.86	263.78	131.89	**111.32**	**55.66**	**30.99**	**15.49**
	37.00	86.34	187.70	274.04	137.02	**115.55**	**57.77**	**31.84**	**15.92**
	38.00	88.74	187.70	276.44	138.22	**116.63**	**58.31**	**32.68**	**16.34**
Sand	**39.00**	98.80	187.70	286.50	143.25	**140.93**	**70.47**	**37.20**	**18.60**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
48-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
	40.00	109.06	187.70	296.76	148.38	**146.58**	**73.29**	**41.82**	**20.91**
	41.00	119.56	187.70	307.26	153.63	**152.35**	**76.18**	**46.54**	**23.27**
	42.00	130.28	187.70	317.98	158.99	**158.25**	**79.12**	**51.37**	**25.68**
	43.00	141.24	187.70	328.94	164.47	**164.27**	**82.14**	**56.30**	**28.15**
	44.00	152.42	187.70	340.12	170.06	**170.42**	**85.21**	**61.33**	**30.67**
	45.00	163.82	187.70	351.52	175.76	**176.69**	**88.35**	**66.46**	**33.23**
	46.00	175.46	187.70	363.16	181.58	**183.10**	**91.55**	**71.70**	**35.85**
	47.00	187.32	187.70	375.02	187.51	**189.62**	**94.81**	**77.04**	**38.52**
	48.00	199.42	187.70	387.12	193.56	**196.27**	**98.14**	**82.48**	**41.24**
	49.00	211.74	187.70	399.44	199.72	**203.05**	**101.52**	**88.03**	**44.01**
	50.00	224.30	187.70	412.00	206.00	**209.96**	**104.98**	**93.68**	**46.84**
	51.00	237.08	187.70	424.78	212.39	**216.99**	**108.49**	**99.43**	**49.71**
	52.00	250.08	187.70	437.78	218.89	**224.14**	**112.07**	**105.28**	**52.64**
	53.00	263.32	187.70	451.02	225.51	**231.42**	**115.71**	**111.24**	**55.62**
	54.00	276.78	187.70	464.48	232.24	**238.82**	**119.41**	**117.29**	**58.65**
	55.00	290.48	187.70	478.18	239.09	**246.36**	**123.18**	**123.46**	**61.73**
	56.00	304.40	187.70	492.10	246.05	**254.01**	**127.01**	**129.72**	**64.86**
Sand	**57.00**	318.54	187.70	506.24	253.12	**261.79**	**130.89**	**136.09**	**68.04**
	58.00	332.92	187.70	520.62	260.31	**269.70**	**134.85**	**142.56**	**71.28**
	59.00	347.52	187.70	535.22	267.61	**277.73**	**138.86**	**149.13**	**74.56**
	60.00	362.36	187.70	550.06	275.03	**285.89**	**142.95**	**155.80**	**77.90**
	61.00	377.42	187.70	565.12	282.56	**294.17**	**147.09**	**162.58**	**81.29**
	62.00	392.70	187.70	580.40	290.20	**302.58**	**151.29**	**169.46**	**84.73**
	63.00	408.22	187.70	595.92	297.96	**311.11**	**155.56**	**176.44**	**88.22**
	64.00	423.96	187.70	611.66	305.83	**319.77**	**159.89**	**183.52**	**91.76**
	65.00	439.94	187.70	627.64	313.82	**328.56**	**164.28**	**190.72**	**95.36**
	66.00	456.14	187.70	643.84	321.92	**337.47**	**168.73**	**198.01**	**99.00**
	67.00	472.56	187.70	660.26	330.13	**346.50**	**173.25**	**205.39**	**102.70**
	68.00	489.22	187.70	676.92	338.46	**355.66**	**177.83**	**212.89**	**106.45**
	69.00	506.12	187.70	693.82	346.91	**364.96**	**182.48**	**220.50**	**110.25**
	70.00	523.22	187.70	710.92	355.46	**374.36**	**187.18**	**228.19**	**114.10**
	71.00	540.58	187.70	728.28	364.14	**383.91**	**191.96**	**236.00**	**118.00**
	72.00	558.14	187.70	745.84	372.92	**393.57**	**196.78**	**243.91**	**121.95**
	73.00	575.94	187.70	763.64	381.82	**403.36**	**201.68**	**251.92**	**125.96**
	74.00	593.96	187.70	781.66	390.83	**413.27**	**206.64**	**260.02**	**130.01**
	75.00	612.22	187.70	799.92	399.96	**423.31**	**211.66**	**268.24**	**134.12**
	76.00	630.70	187.70	818.40	409.20	**433.48**	**216.74**	**276.56**	**138.28**
	77.00	649.42	187.70	837.12	418.56	**443.77**	**221.89**	**284.98**	**142.49**
	78.00	668.36	187.70	856.06	428.03	**454.19**	**227.10**	**293.50**	**146.75**

Shaft Axial Resistance
B64-2 - Piers 1 and 2
48-Inch Diameter Shaft

Estimated Base of Pile Cap Elevation = 434.1 ft.
Water Table at Flood Elevation = 439.0 ft.

	Depth Below Pile Cap	Nominal Side Resistance	Nominal End Bearing	R_n Total Nominal Geotechnical Axial Resistance		ϕR_n Total Factored Geotechnical Axial Compressive Resistance		ϕR_n Total Factored Geotechnical Axial Uplift Resistance	
	(ft)	(kips)	(kips)	(kips)	(tons)	(kips)	(tons)	(kips)	(tons)
Sand	**79.00**	687.52	187.70	875.22	437.61	**464.73**	**232.36**	**302.13**	**151.06**
	80.00	706.92	187.70	894.62	447.31	**475.40**	**237.70**	**310.86**	**155.43**
	81.00	726.54	187.70	914.24	457.12	**486.19**	**243.09**	**319.69**	**159.84**
	82.00	746.40	187.70	934.10	467.05	**497.11**	**248.56**	**328.62**	**164.31**
	83.00	766.48	187.70	954.18	477.09	**508.16**	**254.08**	**337.66**	**168.83**
	84.00	786.80	187.70	974.50	487.25	**519.33**	**259.67**	**346.80**	**173.40**
	85.00	807.32	187.70	995.02	497.51	**530.62**	**265.31**	**356.04**	**178.02**
	86.00	828.10	187.70	1015.80	507.90	**542.05**	**271.02**	**365.39**	**182.69**
	87.00	849.08	187.70	1036.78	518.39	**553.59**	**276.79**	**374.83**	**187.41**
	88.00	870.30	187.70	1058.00	529.00	**565.26**	**282.63**	**384.38**	**192.19**
	89.00	891.76	187.70	1079.46	539.73	**577.06**	**288.53**	**394.03**	**197.02**
	90.00	913.44	187.70	1101.14	550.57	**588.98**	**294.49**	**403.79**	**201.90**
	91.00	935.34	187.70	1123.04	561.52	**601.03**	**300.51**	**413.65**	**206.82**
	92.00	957.48	187.70	1145.18	572.59	**613.21**	**306.60**	**423.61**	**211.80**
	93.00	979.84	187.70	1167.54	583.77	**625.50**	**312.75**	**433.67**	**216.84**
	94.00	1002.44	187.70	1190.14	595.07	**637.93**	**318.97**	**443.84**	**221.92**
	95.00	1025.26	187.70	1212.96	606.48	**650.49**	**325.24**	**454.11**	**227.05**
	96.00	1048.30	187.70	1236.00	618.00	**663.16**	**331.58**	**464.48**	**232.24**
	97.00	1071.58	187.70	1259.28	629.64	**675.96**	**337.98**	**474.95**	**237.48**
	98.00	1095.08	187.70	1282.78	641.39	**688.89**	**344.44**	**485.53**	**242.76**
	99.00	1118.82	187.70	1306.52	653.26	**701.94**	**350.97**	**496.21**	**248.11**
	100.00	1142.78	187.70	1330.48	665.24	**715.12**	**357.56**	**506.99**	**253.50**
	101.00	1166.96	187.70	1354.66	677.33	**728.42**	**364.21**	**517.87**	**258.94**
	102.00	1191.38	187.70	1379.08	689.54	**741.85**	**370.93**	**528.86**	**264.43**
	103.00	1216.02	187.70	1403.72	701.86	**755.40**	**377.70**	**539.95**	**269.98**
	104.00	1240.90	187.70	1428.60	714.30	**769.09**	**384.54**	**551.15**	**275.57**
	105.00	1266.00	187.70	1453.70	726.85	**782.89**	**391.45**	**562.44**	**281.22**
	106.00	1291.32	187.70	1479.02	739.51	**796.82**	**398.41**	**573.84**	**286.92**
	107.00	1316.88	187.70	1504.58	752.29	**810.88**	**405.44**	**585.34**	**292.67**
	108.00	1342.66	187.70	1530.36	765.18	**825.06**	**412.53**	**596.94**	**298.47**
	109.00	1368.68	187.70	1556.38	778.19	**839.37**	**419.68**	**608.65**	**304.32**
	110.00	1394.92	187.70	1582.62	791.31	**853.80**	**426.90**	**620.46**	**310.23**
	111.00	1421.40	187.70	1609.10	804.55	**868.36**	**434.18**	**632.37**	**316.19**

APPENDIX F
RECOMMENDED SOIL PARAMETERS FOR LATERAL LOAD ANALYSIS

Estimated Soil Parameters for Lateral Load Pile Analysis at Boring 4B-247
Kennedy Interchanges Project – Bridge B64-2
Structure S0160

Ground Water Level = 439 ft

Idealized Soil Profile	Soil Elevations (ft)	Average Saturated Unit Weight (pcf)	Estimated Corrected Friction Angle (degrees)	Estimated Undrained Shear Strength (psf)	Estimated Lateral Soil Modulus Paramter, k (pci)	Estimated Soil Strain Parameter, E_{50} (%)
Loose to Medium Dense Silty Sand (SM)	439.06-431.1	125	31	--	60	--
Soft Silty Clay	431.1-426.1	120	--	250	30	0.02
Soft to Medium Stiff Silty Clay	426.1-396.1	125	--	500	80	0.015
Medium Dense Sand with Silt (SW-SM)	396.1-371.1	125	32	--	60	--
Medium Dense to Dense Sand (SP)	371.1-349.1	125	33	--	125	--
Dense Gravelly Sand (SP)	349.1-345.5	130	37	--	125	--