STRUCTURE GEOTECHNICAL REPORT

INTERSTATE I-74 OVER INTERSTATE I-57
(STATION 1061+40.60)

Existing SN: 010-0018 & 010-0019
Proposed SN: 010-1018 & 010-1019

F.A.I. RTE. 74/57
Section 10 (5-1-RS-1, 14-1,6) R
Champaign County

Contract No.: 70897
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Attachments:
Soil Boring Location Map
Preliminary TS&L
Subsurface Boring Logs
Boring Profile Sheet
Pile Capacity Tables
Integral Abut.Pile Selection Chart

1.0 Project Description

The purpose of this geotechnical study is to explore the existing subsurface conditions present at the existing structure location (SN 010-0018 & 010-0019) (Station 1061+40.60) carrying I-74 over I-57 in Section 10R, Township 20 North, Range 8 East of the 3rd PM in the city of Champaign, Champaign County, Illinois. These structures will be replaced by proposed structures SN 010-1018 & 010-1019. Based on the geotechnical data obtained, engineering properties of the subsurface soils were determined with design and construction recommendations being provided for the project.

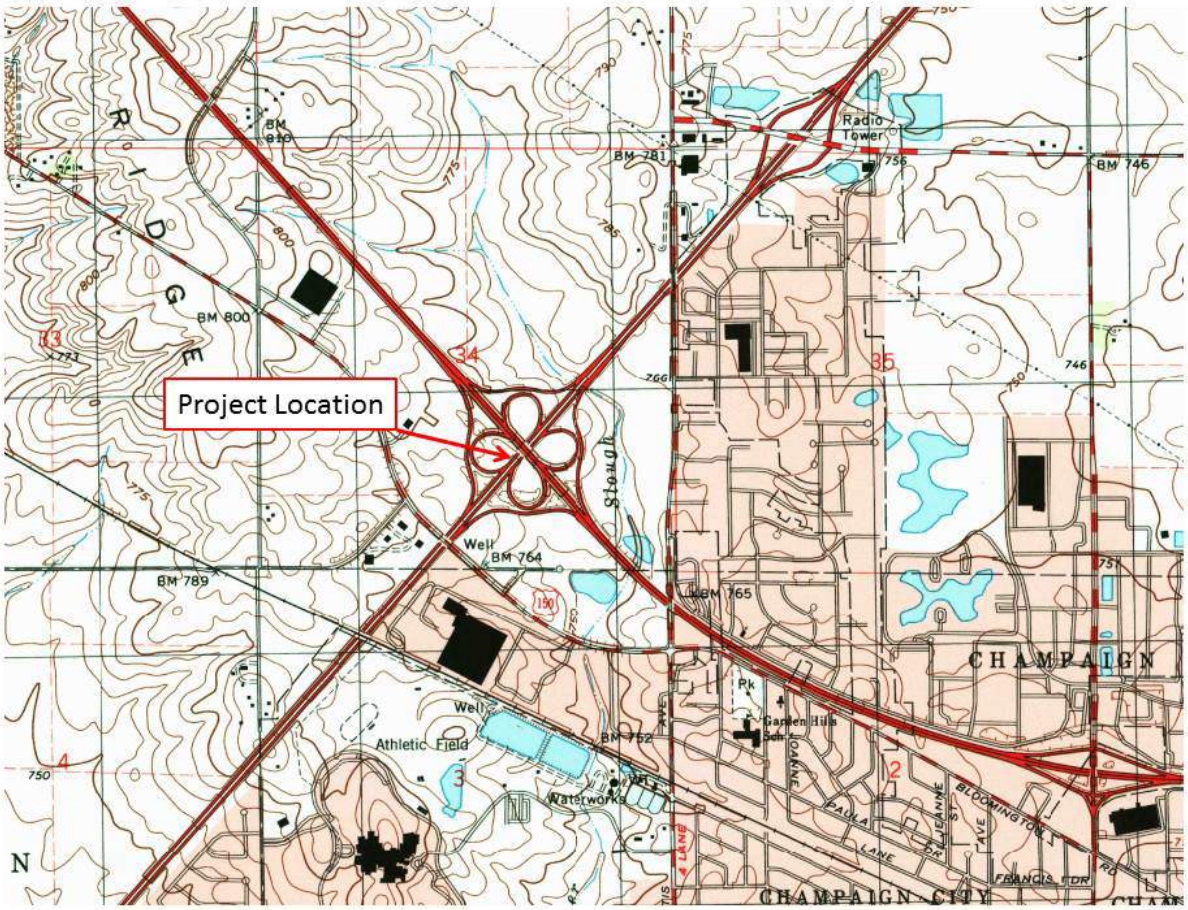


Exhibit 1: Project Location Map

2.0 Existing and Proposed Structure Information

Existing Structure (SN 010-0018 & 010-0019)

Based on information from the Bridge Condition Report (prepared by BFW, dated June 30, 2014), the existing structures were originally constructed in 1965 as four-span rolled steel beam structures with pin and link systems in the end spans. The abutments are open stub on concrete piles. The four column reinforced concrete piers with crash walls are supported on spread footings.

In 1989, the superstructure of each structure was replaced with rolled steel W36 beams composite in the positive moment regions only. The north fascia beam of the north bridge and south fascia beam of the south bridge is flared to carry the flared deck on each structure. The wingwalls were reconstructed, and the seat elevations were adjusted with concrete extensions. The overall length of the structures is 261'-2" back to back of abutments; the width ranges from 53'-3" to 57'-6.5" out to out; the structures have a right skew of 6°-45'-27".

Proposed Structure (SN 010-1018 & 010-1019)

Based on the preliminary TS&L, the I-74 over I-57 structures (SN 010-1018 & SN 010-1019) will consist of two-span bridges, each supported at the midpoint by a six-column hammerhead style pier with pile-supported concrete abutments at each end. The bridge decks will be supported by 54" web plate girders, consisting of an 8" thick slab. Total length of each structure will be 275'-0" back to back abutments. Total width of each structure will range from 69'-3¼" to 74'-8¾" back to back of edge barriers. The new structures will mirror the existing right skew of 6°-45'-11". The existing bridges will be replaced over a staged construction effort.

3.0 Existing Site Conditions

The locations of the proposed bridge structures extend I-74 across I-57, replacing existing structures SN 010-0018 & SN 010-0019. Existing site conditions include existing interstate roadways and grassy medians for both I-57 and I-74. Elevations range from 761.3' – 762.5' along the I-57 median and 783.74' – 784.84' near the I-74 bridge abutments.

3.1 Regional Geology

According to the Illinois State Geological Survey, "Bedrock Geology of Illinois" map, the site and surrounding area is situated in the Illinois Basin and is underlain by the Pennsylvanian-aged Tradewater Formation. The Illinois Basin is a Paleozoic depositional and structural basin centered in and underlying most of the state of Illinois. An Illinois Basin study reveals that the Tradewater Formation is composed of 70 to 80 percent shale and siltstone, 20 to 30 percent sandstone, and generally less than 5 percent coal and limestone. The Tradewater Formation is overlain by the Wedron Group, which is composed of mostly glacial till (an unsorted mixture of clay, silt, sand, and gravel) in broad ridges (last glaciation), and forms end moraines. The Wedron Group is finally capped by the Peoria and Roxana Silts, which are composed of windblown silt (loess) generally thicker than 20 feet blankets upland surfaces in these areas.

4.0 Subsurface Exploration and Generalized Subsurface Conditions

This section describes the subsurface exploration program and laboratory testing program completed as part of this Structure Geotechnical Report (SGR). The locations and subsurface data were provided by McCleary Engineering and were completed based on field conditions and accessibility. Therefore, no site observations have been made by BFW relative to existing conditions of the structure, roadway or of subsurface sample conditions. The locations of the soil borings are shown on the Boring Location Map located in Appendix A and were plotted based on location data obtained by Midland Engineering. The subsurface exploration program was performed in accordance with applicable IDOT geotechnical manuals and procedures.

4.1 Subsurface Exploration

The site subsurface exploration was conducted from February 6 through February 11, 2015 and included advancing one (1) standard penetration test (SPT) boring within the vicinity of the proposed abutment locations (abutment borings for each structure were combined) and one (1) SPT boring within the vicinity of each midspan pier location. The locations of the soil borings are shown on the **Boring Location Map** provided in Appendix A.

Table 1 – Summary of Subsurface Exploration I-74 over I-57

Boring ID	Location	Station	Offset	Depth (feet)	Surface Elevation (feet)
B-1/4	West Abutment	1060+08	2 LT	75	784.84
B-2/3	East Abutment	1063+03.80	3 LT	75	783.74
B-32	N. Pier I-74 over I-57	1061+31	95 LT	75	761.30
B-33	S. Pier I-74 over I-57	1061+45	76 RT	75	762.50

The soil borings were drilled using a track mounted drill rig. All of the borings were drilled using 3¼ - inch I.D. hollow stem augers. Soil sampling was performed according to AASHTO T 206, "Penetration Test and Split Barrel Sampling of Soils." Soil samples were obtained at 2.5 foot intervals to a minimum depth of 20 feet below existing grade and 5 foot intervals thereafter. McCleary Engineering field representative inspected, visually classified and logged the soil samples during the subsurface exploration activities, and performed unconfined compressive strength tests on cohesive soil samples using a calibrated Rimac compression tester and a calibrated hand penetrometer in accordance with IDOT procedures and requirements. Representative soil samples were collected from each sample interval, and were placed in jars and returned to the laboratory for further testing and evaluation.

4.2 Laboratory Testing

A field and laboratory testing program was undertaken by McCleary Engineering to characterize and determine engineering properties of the subsurface soils encountered in the area of the proposed bridge. The following laboratory tests were performed on representative soil samples:

The following laboratory tests were performed on representative soil samples:

- Moisture content ASTM D2216 / AASHTO T-265
- RIMAC Compression Test – IDOT Method
- Standard Penetration Test (SPT) and Split-Barrel Sampling – ASTM D1586 / T-206

The laboratory tests were performed in accordance with test procedures outlined in the IDOT Geotechnical Manual (1999) and per ASTM and AASHTO requirements. Based on the laboratory test results, the soils encountered were classified according to the AASHTO classification system. The results of the field and laboratory testing are shown on the Soil Boring Logs located in Appendix C.

4.3 Subsurface Conditions

This section provides a brief description of the soils encountered in the borings performed in the vicinity of the proposed improvements. Variations in the general subsurface soil profile were noted during the drilling activities. Detailed descriptions of the subsurface soils are provided in the Soil Boring Logs located in Appendix C and are shown graphically in the Subsurface Profiles located in Appendix D. The soil boring logs provide specific soil conditions encountered at each soil boring location. The soil boring logs include soil descriptions, stratifications, penetration resistance, elevations, location of the samples and laboratory test data. Unless otherwise noted, soil descriptions indicated on boring logs are visual identifications. The stratifications shown on the boring logs represent the conditions only at the actual boring locations, and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

Subsurface information was obtained during a geotechnical investigation conducted over the entire proposed I-57 / I-74 interchange modifications. Borings B-1/4, B-2/3, B-32, and B-33 were advanced in support of proposed I-74 over I-57 Structures (SN#010-1018/19) from February 6 through February 11, 2015 along the proposed roadway alignments. Borings 1 and 4 along with borings B-2 and B-3 were originally intended as separate abutment borings but were combined due to budget constraints.

Bridge Abutment Locations

Boring **B-1/4** was advanced between the proposed west abutments, located at Station 1060+08 (Elev. 784.30'). Originally planned to be two borings, boring **B-1/4** location was a field compromise due to project budget constraints. The boring was advanced in the median of I-74 with approximately 6 inches of topsoil at the surface. The soil profile underlying the topsoil in boring **B-1/4** is described as brown to dark brown, medium to very stiff, silty clay loam, which extends to approximately 22.5 feet deep (Elev. 762.34'), where the material transitions to a light brown very loose clayey sand. The upper silty clay loam had SPT N-values in the range of 13 to 18 and an unconfined compressive strength (Qu) from 1.9 to 3.5. The clayey sand continues with depth to approximately 27 feet deep (Elev. 757.84') where the soil transitions to a very stiff gray silty clay loam to till. The silty clay till soils continued to boring completion depth of 75 feet deep (Elev. 709.84') and exhibited SPT N-values in the range of 15 to 38 and unconfined compressive strengths (Qu) from 1.08 to 3.30.

Boring **B-2/3** was advanced between the proposed east abutments, located at Station 1063+03.80 (Elev. 783.74'). Originally planned to be two separate borings, boring **B-2/3** location was a field compromise due to project budget constraints. The boring was advanced in the median of I-74 with approximately 8 inches of topsoil at the surface. The soil profile underlying the topsoil in boring **B-2/3** is described as a fill material composed of dark brown to brownish gray silty clay, very stiff, with some limestone aggregate fragments, extending down to approximately 22.5 feet deep (Elev. 761.24'), where the material transitions to a brown/gray, stiff to very stiff silty clay. The upper soils had SPT N-values in the range of 12 to 23 and unconfined compressive strength (Qu) from 1.15 to 5.56. The silty clay continues deeper to approximately 32 feet deep (Elev. 751.74') where the soil changes to a gray hard silty clay loam till. The till extended to a depth of approximately 44 feet deep (Elev. 739.74') where the material transitioned into a gray, medium to coarse loose clean sand. The sand continues with depth to approximately 47.5 feet deep (Elev. 736.24') where the soil changes to a gray silty loam till, medium dense. The till continues to boring completion depths of 75 feet deep (Elev. 708.74'). The silty clay till soils had SPT N-values in the range of 11 to 26 and an unconfined compressive strength (Qu) from 0.99 to 3.6.

Pier Boring Locations

Borings **B-32 and B-33** were advanced near the proposed mid-span pier locations, Stations 1061+31 and 1061+45, respectively. In general, each boring was covered with approximately 8" to 2.5 feet of topsoil. Below the topsoil, a brown to gray silty clay to silty clay loam was encountered in each of the soil borings to a depth of 3 – 13 feet deep (Elev. 758.30' – 749.50'). The upper silty clay had SPT N-values ranging from 3 to 17 and unconfined compressive strengths (Qu) from 1.5 to 2.7. Below the silty clay and silty clay loams and silty clay loam till was encountered in each of the borings, with the exception of boring B-32, a very loose gray fine – medium sand layer was observed between approximately 26.5' and 39.5' (Elev. 734.80' – 721.80'). The silty clay loam till extended to boring completion depths of 75 feet deep (Elev. 686.30' – 687.50'). The silty clay loam till exhibited SPT N-values ranging from 7 to 46 and unconfined compressive strengths (Qu) from 1.4 to 3.7.

4.4 Groundwater Conditions

Water levels were checked in each boring to determine the general groundwater conditions present at the site and were measured while drilling and after each boring was completed.

Groundwater was identified in each boring as follows:

Table 2 – Groundwater Elevations

Boring	Groundwater Elevation (At time of drilling)	Groundwater Elevation (@ boring completion)
B-1/4 (West Abut)	754.8	- - -
B-32 (North Pier)	726.3	- - -
B-33 (South Pier)	Dry	Dry
B-2/3 (East Abut)	760.7	- - -

No 24-hour groundwater readings were noted. No streambed elevations or surface water elevations were noted.

Water level readings were made in the boreholes at times and under conditions shown on the boring logs and stated in the text of this report. However, it should be noted that fluctuations in groundwater level may occur due to variations in rainfall, other climatic conditions, or other factors not evident at the time measurements were made and reported.

5.0 Geotechnical Evaluations

The section provides geotechnical analysis and recommendations for the design of the proposed bridge based on the results of the field exploration, laboratory testing, and geotechnical analysis.

5.1 Derivation of Soil Parameters for Design

Unit weights, friction angles and shear strength parameters were estimated using soil shear strength values and standard penetration test (SPT) using published correlations for N values results. **Table 3** - presents generalized soil parameters to be used based for designs on the laboratory and in-situ testing data:

Table 3 – General Summary of Soil Parameters

Approximate Depth / Elevation (feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained	
			Cohesion c (psf)	Friction Angle Φ (degrees)	Cohesion c (psf)	Friction Angle Φ (degrees)
761' to 784'* (*approx. surface elev. at approaches)	Silty Clay Loam/Silty Clay (Fill)	115	2400	0	150	28
734' to 762'* (*approx. surface elev. near center piers)	Silty Clay Till	120	2,100	0	110	28

5.2 Settlement

Western and Eastern Approach Slabs / Abutments

The new approach slabs for both bridges will be supported by new engineered fill. It is anticipated that approximately 2.6 feet (at the west abutment) and 2.3 feet (at the east) will be placed along the new bridge approaches. To accommodate the proposed increase in approach and abutment heights, the abutment slopes will need to be regraded.

The design grading shows that the proposed abutment slope will be a 2H:1V. Based on preliminary settlement calculations, the increase in stress due to the increase in fill would produce only minor settlements in the range of less than 0.4-inch near the west and east abutments and should not adversely affect the approach pavements. Therefore, the anticipated settlement of the abutments due to the regarding activities is considered to be negligible.

5.3 Slope Stability – Bridge Abutments

The proposed construction of I-74 over I-57 involves the removal of the existing dual structures and the replacement of two new bridges with new abutments with concrete end slopes. The proposed abutments are integral with endslopes at 2 horizontal to 1 vertical (2H:1V). Slope stability of the bridge abutments was evaluated using a slope stability analysis software: *GSTABL7 with STEDwin.*

The proposed side slopes were analyzed based on the grading and the soils encountered during subsurface exploration. Three analyses were evaluated using the Bishop and Janbu analyses methods for the proposed slope geometry: end-of-construction (short term - undrained), long-term (drained) and a design seismic event. The analyses were performed using the soil parameters in Table 3 above. A critical factor of safety (FOS) was calculated for each condition. According to the current standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability and 1.0 for the design seismic event.

End-of-construction conditions was modeled using full cohesion with a friction angle of 0 degrees. Nominal values for cohesion were used with full friction angle to model the long-term and seismic conditions to analyze the condition where pore water pressure has dissipated. The results of the analysis are shown below in Table 4.

Based on the analysis performed, the proposed slopes meet the minimum required factor of safety of 1.5 (end-of-construction, long-term) and 1.0 (seismic).

Table 4 – Stability Analysis Results – Bridge Abutments

Boring Location	Slope	Calculated Critical FOS		
		End-of-Construction	Long Term	Seismic
B-1/4, West Abut	2H:1V	2.9	1.9	1.5
B-2/3, East Abut	2H:1V	2.9	1.9	1.5

5.4 Seismic Parameters

The seismic hazard for the site was analyzed per the IDOT Geotechnical Manual, IDOT Bridge Design Manual, and AASHTO LRDF Bride Design Specifications. The Seismic Soil Site Class was determined per the requirements of All Geotechnical Manual Users (AGMU) Memo 9.1, Design Guide for Seismic Site Class Determination, and the "Seismic Site Class Determination" Excel spreadsheet provided by IDOT.

Both proposed I-74 over I-57 bridges each have total lengths of 275 feet (back to back abutments). According to Table 3.10.3.1-1 (Site Class Definitions) of the AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition, 2014, with 2015 Interim Revisions, the project site soil profile is most accurately described as the AASHTO Soil Site Class D.

According to Table 3.10.6-1 "Seismic Performance Zones" (SPZ) of the AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition, 2014, with 2015 Interim Revisions, the site is most accurately described as (SPZ)=1 ($\mathbf{S_{D1}} \leq 0.15$g).

Liquefaction analysis was conducted using Design Guide AGMU Memo 10.1 – Liquefaction Analysis. As noted in the previous paragraph the Seismic Performance Zone (SPZ) is SPZ – 1 and the Peak Ground Acceleration (PGA) modified by the zero-period site factor, F_{pga} is less than 0.15. Therefore, no liquefaction of soil layers is anticipated to occur.

The following Seismic Coefficients should be used for design:

$\mathbf{S_s}$=0.146 g, $\mathbf{F_a}$=1.60; therefore Design Spectral Accelerations at 0.2 sec, ($\mathbf{S_{Ds}}$)=0.233g
$\mathbf{S_1}$=0.056 g, $\mathbf{F_v}$=2.40; therefore Design Spectral Accelerations at 1.0 sec, ($\mathbf{S_{D1}}$)=0.135g

Table 5 – Seismic Coefficients Summary Table

Seismic Performance Zone (SPZ)	1
Design Spectral Acceleration at 0.2 sec. ($\mathbf{S_{DS}}$)	0.234 g
Design Spectral Acceleration at 1.0 sec. ($\mathbf{S_{D1}}$)	0.135 g
Soil Site Class	D

Liquefaction analysis was conducted using Design Guide AGMU Memo 10.1 – Liquefaction Analysis. As noted in the previous paragraph the Seismic Performance Zone (SPZ) is SPZ – 1 and the Peak Ground Acceleration (PGA) modified by the zero-period site factor, F_{pga} is less than 0.15. Therefore, no liquefaction of soil layers is anticipated to occur.

5.5 Scour

The proposed dual bridge structures carrying I-74 will cross over I-57 and no waterways are in the vicinity of the proposed project; therefore, scour will not be a concern for this project.

5.6 Mining Activity

Based on a review of the Illinois State Geological Survey's on-line collection of County Coal Maps and Directories, the proposed structure is not located over a mine or mined out area.

5.7 Liquefaction

Based on the AGMU Memo 10.1 – Liquefaction Analysis Seismic Performance Zones 3 and 4 requires liquefaction analysis, as well as, SPZ 2 with a Peak Seismic Ground Surface Acceleration, As equal to or greater than 0.15. The subject site is in SPZ 1 with a A_s less than 0.15. Therefore, liquefaction is not considered as a reduction for the pile design capacity or other foundation considerations included herein.

5.8 Approach Slabs

Based on information from the structural engineer, the approach slabs are 30 feet in length and will be precast. The approach slabs will bear on the abutment on one side and an approach slab concrete pad on the other end. In accordance with the IDOT Bridge Manual, BFW evaluated the foundation soils at the approach slabs for bearing capacity and excessive settlement. With proper compaction of the approach subgrades, the bearing capacity and settlement requirements of the IDOT Bridge manual will be satisfied.

6.0 Foundation Type Evaluation and Design Recommendations

6.1 Foundation Type Feasibility

Based on the preliminary TS&L, the proposed dual structures (SN 010-1018 & 010-1019), Station 1061+40.60 will be constructed of 54" web plate girders (composite full length) on integral abutments with an estimated abutment length of 80'. The superstructure will consist skew alignment with back to back abutment distances of 275'-0". Abutments will bear on single row of vertical steel piles. Two new 30 feet long precast bridge approach slabs will be constructed on either end of the bridge.

For this project, the IDOT BBS requested that the proposed structures be based on an upcoming Supplement and pile selection chart (located in appendix) to the 2012 IDOT Integral Abutment Bridge policy which will allow the use of Metal Shell Piles with Integral Abutments. Based on IDOT BBS request the use of Metal Shell Piles is preferred at this location.

6.2 Driven Pile Supported Foundations

Piles considered for this site include HP-piles and metal shell piles. However, the use of metal shell piles is preferred whenever possible based on IDOT preference.

The designer should be aware that although H-piles are feasible, there are concerns with using H-Piles for some of the following reasons. 1) Friction H-piles are notorious for being the most difficult pile to accurately estimate the length at which bearing will be obtained during construction, 2) the estimated H-pile lengths provided within the SGR extend beyond the depths of the borings which make the pile length estimates more subject to error, 3) the borings were terminated per department policy, however; no indication of either a hard layer, which either crush a shell pile or adequate end bearing layer (such as hard pan or bedrock that would stop an H-pile was encountered, 4) H-piles are highly subject to being driven substantially longer than the estimated pile length. When this occurs in the field the equipment and crew are on hold until additional piling can be located, shipped and spliced, typically resulting in project delays and extra costs for all the splices, extra pile and working days. 5) Metal shell piles are IDOT Foundation and Geotechnical Unit's preferred foundation choice for the abutments because the pile lengths will be substantially shorter in comparison to HP-piles.

The Modified IDOT static method Excel spreadsheet was used to estimate the pile lengths at various axial geotechnical resistances for driven piles per AGMU Memo 10.2. The factored resistance includes reduction for the geotechnical resistance of 0.55 for the pile installation. Based on the results of the subsurface investigation no geotechnical losses due to down drag or liquefaction were included in the axial pile capacity calculations. The anticipated factored structural loadings were obtained from the structural engineer and are provided in Table 6 on the following page.

Tables 7, 8, 9, and 10 summarize the estimated pile lengths at various axial resistances for metal shell piles and HP-piles various sizes piles for the <u>integral</u> abutments for western and eastern abutments and for the center piers for the westbound and eastbound lanes. The complete IDOT Pile Design Tables for each substructure are included in Appendix E.

The Nominal Required Bearing (R_N) represents the resistance the pile will experience during driving as well as assists the contractor in selecting a proper hammer size. The Factored Resistance Available (RF) documents the net long-term axial factored pile capacity available at the top of the pile to support factored substructure loads.

The pile cutoff elevations used for analysis were Elev. 779.94 for both eastbound / westbound lanes west abutments and Elev. 778.82 and Elev. 778.86 for eastbound and westbound lanes for the east abutment, respectively. The pile cutoff elevation included a 2 feet embedment into the integral abutment as required by the Bridge Manual.

The presence of gravels and cobbles was noted in the soil boring logs below elevations of 753 in Boring, B-1/4. Therefore, pile shoes are recommended to be used for both metal shell and HP piles due to presence of cobbles within the general area.

Due to the differences in soil consistency between the soil test borings, one test pile should be advanced at each separate abutment locations and one test pile at both center pier locations. A test pile is performed prior to production driving so that actual, on-site field data can be gathered to further evaluate pile driving requirements for the project. This is also the time in which the contractor's proposed equipment and methodologies identified in their Pile Installation Plan can be assessed.

6.3 Shallow Foundations

Based on the soils encountered and the amount of embankment fill, shallow foundations are not a feasible option for the proposed substructures of the bridge. It is anticipated that shallow foundations designed for the loads provided will undergo settlement and therefore will not be a feasible option and are therefore not discussed in this report.

Design Capacity Limitations

There are no downdrag, liquefaction, scour, or settlement issues at this structure that would result in the loss of capacity of the piling. Therefore, no design capacity limitations are necessary.

6.4 Lateral Load Resistance

Section 3.10.1.10 of the 2012 IDOT Bridge manual requires performing detailed structure interaction analysis if the factored lateral loading per pile exceeds 3 kips. Lateral loadings applied to pile foundations are typically resisted by battering selected piles, the soil/structure interaction, pile flexure, or a combination of these factors. Based on information provided by the structural engineer the lateral loads were anticipated to be <u>less than 3 kips</u>.

6.5 Wingwall Foundation Recommendations

Based on information provided by the structural engineer and the preliminary TS&L the wing walls for the integral abutment option will be cantilever in design and will not rely on soil bearing.

Table 6: Structural Loadings

SUMMARY OF REACTIONS, Fy (kips):

	DC1	DC2	DW	*LL
W. Abut.	516.2	68.4	175.9	125.8
Pier 1	1937.9	237.0	609.2	155.0
Pier 2	0.0	0.0	0.0	0.0
Pier 3	0.0	0.0	0.0	0.0
Pier 4	0.0	0.0	0.0	0.0
E. Abut.	501.6	65.9	169.2	125.3

**One lane loaded (from CONSPAN)*

Total Substructure Weight

	DC1
W. Abut.	342.83
Pier 1	752
Pier 2	0
Pier 3	0
Pier 4	0
E. Abut.	342.83

Approach Slab Reaction = 217.5 kips

Load Factors	DC max	DW max	LL
Strength I	1.25	1.50	1.75

STRENGTH I Loads, Fy (kips):

	# of Lanes Loaded				STRENGTH I (max)
	1	2	3	4	
*MPF, m	1.20	1.00	0.85	0.65	
W. Abut.	1959.3	2135.4	2256.6	2267.6	2268
Pier 1	4898.0	5115.1	5264.3	5277.9	5278
Pier 2	0.0	0.0	0.0	0.0	0
Pier 3	0.0	0.0	0.0	0.0	0
Pier 4	0.0	0.0	0.0	0.0	0
E. Abut.	1926.6	2102.0	2222.6	2233.6	2234

*** Multiple Presence Factor (LRFD Table 3.6.1.1.2-1)**

7.0 Construction Considerations

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Road and Bridge Construction (2015) and the Supplemental Specifications and Recurring Special Provisions (2015) and-or its successor specifications. Any deviation from the requirements in the manuals above should be approved by IDOT.

7.1 Groundwater Management

Based on the depth of groundwater observed in the borings, significant groundwater management is not anticipated for bridge construction. The contactor should control groundwater and surface water infiltration to provide construction in dry condition. Temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment could be used to divert groundwater if significant seepage is encountered during construction. If water seepage occurs during footing or where wet conditions are encountered such that the water cannot be removed with conventional pumping, we recommend placing open grade stone similar to IDOT CA-7 to stabilize the bottom of the excavation.

The CA-7 stone should be placed to 12 inches above the water table, in 12-inch lifts, and should be compacted with the use of a heavy smooth drum roller or heavy vibratory plate compactor until stable. The remaining portion of the excavation beneath the footing should be backfilled using approved structural fill.

7.2 Temporary Sheeting and Soil Retention

The preliminary TS&L plans indicate that the construction of the proposed structures will require complete removal of the existing structure and abutments. Based on information provided by the structural engineer, the construction for the proposed structure will be phased maintaining one lane of traffic in each direction.

Pile Capacity Tables (Tables 7 & 8)

(54-Inch Web Plate Girder – Integral Abutment)

Table 7 – West Abutment

Piling Driven at West Abutment (B-1/4 data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
280	154	51
300	165	54
318	175	56
330	181	59
353*	194*	61
Metal Shell 14" Φ w/0.25" walls		
330	182	51
355	195	54
375	206	56
388	214	59
413*	227*	61
Metal Shell 14" Φ w/0.312 walls		
452	249	70
466	256	73
480	264	75
493	271	78
HP 12 x 53		
330	182	51
355	195	54
375	206	56
338	214	59
405	223	61
HP 12 x 74		
297	163	61
304	167	64
315	173	69
326	179	70
336	185	73
HP 14 x 73		
416	229	78
428	235	80
439	241	83
450	248	85
461	254	88

Table 8 – East Abutment

Piling Driven at South Abutment (B-2\3data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
268	147	46
299	164	49
320	176	51
340	187	54
353*	194*	56
Metal Shell 14" Φ w/0.25" walls		
314	173	46
354	195	49
380	209	51
402	221	54
413*	227*	56
Metal Shell 14" Φ w/0.312 walls		
449	247	59
472	260	61
498	274	64
513*	282*	66
HP 12 x 53		
345	190	61
364	200	64
381	210	66
387	213	69
402	221	70
HP 12 x 74		
412	227	70
428	235	73
444	244	75
461	253	78
477	262	80
HP 14 x 73		
486	268	70
505	278	73
524	288	75
543	299	78
562	309	80

*- Maximum Nominal Required Bearing

Pile Capacity Tables (Tables 9 & 10)
(54-Inch Web Plate Girder)

Table 9 – North Center Pier / Westbound Lanes

Piling Driven at Center Pier (B-32 data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
291	160	45
308	170	47
322	177	50
338	186	52
353*	194*	55
Metal Shell 14" Φ w/0.25" walls		
344	189	45
364	200	47
380	209	50
398	219	52
413*	227*	55
Metal Shell 14" Φ w/0.312 walls		
456	251	65
464	255	67
484	266	71
HP 12 x 53		
319	175	71
326	179	74
333	183	76
340	187	79
347	191	81
HP 12 x 74		
326	179	71
333	183	74
340	187	76
347	191	79
354	195	81
HP 14 x 73		
380	209	71
389	214	74
397	218	76
405	223	79
414	228	81

Table 10 – South Center Pier / Eastbound Lanes

Piling Driven at Center Pier (B-33 data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
288	158	46
302	166	49
315	173	51
328	181	54
353*	194*	56
Metal Shell 14" Φ w/0.25" walls		
339	187	46
355	195	49
371	204	51
386	212	54
413*	227*	56
Metal Shell 14" Φ w/0.312 walls		
460	253	66
477	263	69
485	267	70
HP 12 x 53		
375	206	78
385	212	80
395	217	83
406	223	85
416	229	88
HP 12 x 74		
394	217	80
404	222	83
415	228	85
425	234	88
435	239	90
HP 14 x 73		
461	254	80
473	260	83
486	267	85
498	274	88
510	280	90

*- Maximum Nominal Required Bearing

Temporary Sheeting and Soil Retention

In evaluating the use of temporary cantilever sheet piling, a maximum of about 11 feet of retaining height during stage construction of both structures. Using subsurface soils information encountered and on preliminary calculations for the depth of embedment as per IDOT Bridge Manual using the "Design Guide and Charts for Temporary Cantilever Sheet Piling", approximately embedment depths were determined. Based on the design charts, embedment depths of approximately 8.3 feet for both the western and eastern abutments for both structures were determined. Therefore, simple cantilever sheeting piles appear feasible to be used for both the western and eastern abutments.

8.0 Limitations

This report has been prepared for the exclusive use of the Illinois Department of Transportation and its structural consultant. The recommendations provided in this report are specific to the project described herein, and are based on the information obtained from the soil boring locations within the project limits. The analysis has been performed and the recommendations have been provided in this report are based on subsurface conditions determined at the location of the borings. This report may not reflect all variations that may occur between boring locations or at some other time, the nature and extend of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations provided herein in light of the new conditions.

Appendix A

Soil Boring Location Map

Appendix B

Preliminary TS&L

Appendix C

Subsurface Boring Logs

Appendix D

Boring Profile Sheet

Appendix D

Pile Capacity Tables

Appendix E

Integral Abutment Pile Selection Chart

1.0 Project Description

The purpose of this geotechnical study is to explore the existing subsurface conditions present at the existing structure location (SN 010-0018 & 010-0019) (Station 1061+40.60) carrying I-74 over I-57 in Section 10R, Township 20 North, Range 8 East of the 3rd PM in the city of Champaign, Champaign County, Illinois. These structures will be replaced by proposed structures SN 010-1018 & 010-1019. Based on the geotechnical data obtained, engineering properties of the subsurface soils were determined with design and construction recommendations being provided for the project.

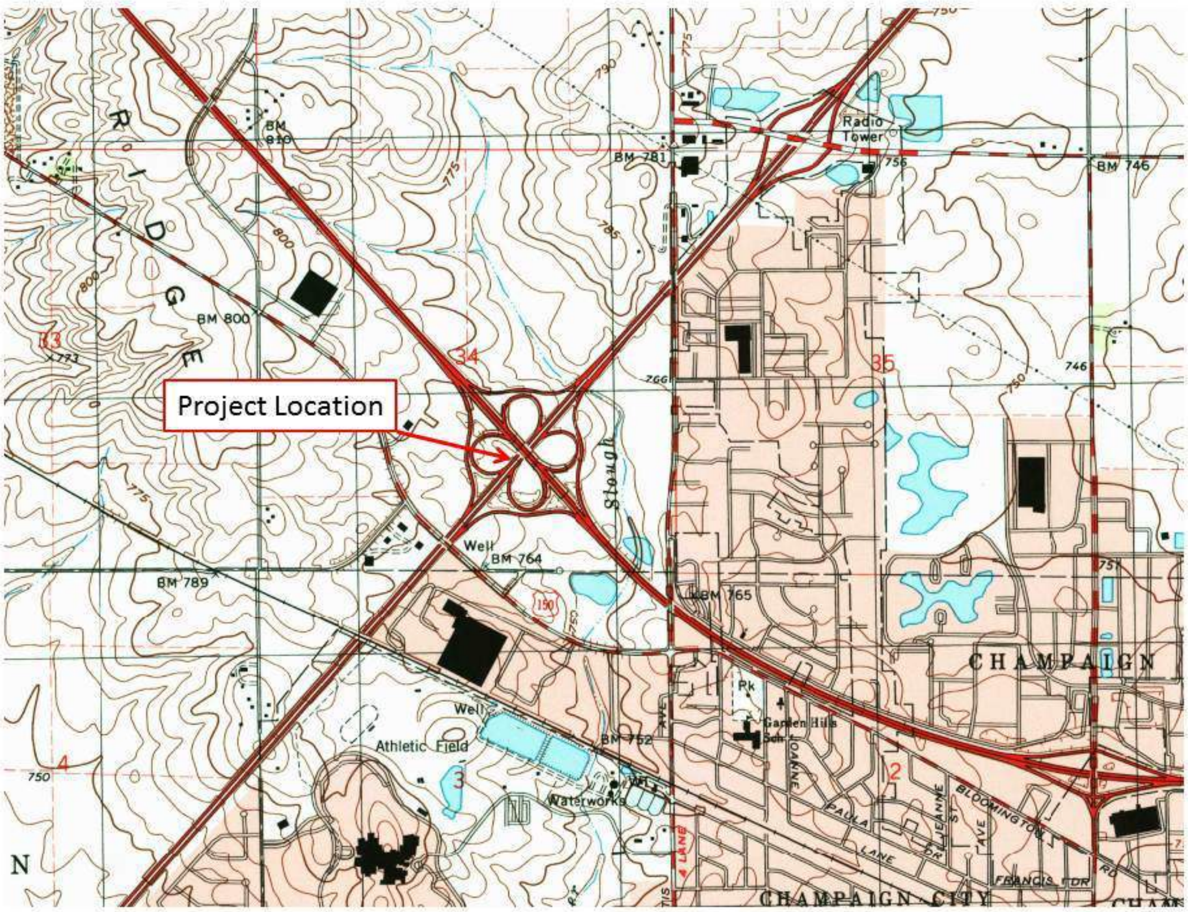


Exhibit 1: Project Location Map

2.0 Existing and Proposed Structure Information

Existing Structure (SN 010-0018 & 010-0019)

Based on information from the Bridge Condition Report (prepared by BFW, dated June 30, 2014), the existing structures were originally constructed in 1965 as four-span rolled steel beam structures with pin and link systems in the end spans. The abutments are open stub on concrete piles. The four column reinforced concrete piers with crash walls are supported on spread footings.

In 1989, the superstructure of each structure was replaced with rolled steel W36 beams composite in the positive moment regions only. The north fascia beam of the north bridge and south fascia beam of the south bridge is flared to carry the flared deck on each structure. The wingwalls were reconstructed, and the seat elevations were adjusted with concrete extensions. The overall length of the structures is 261'-2" back to back of abutments; the width ranges from 53'-3" to 57'-6.5" out to out; the structures have a right skew of 6°-45'-27".

Proposed Structure (SN 010-1018 & 010-1019)

Based on the preliminary TS&L, the I-74 over I-57 structures (SN 010-1018 & SN 010-1019) will consist of two-span bridges, each supported at the midpoint by a six-column hammerhead style pier with pile-supported concrete abutments at each end. The bridge decks will be supported by 54" web plate girders, consisting of an 8" thick slab. Total length of each structure will be 275'-0" back to back abutments. Total width of each structure will range from 69'-3¼" to 74'-8¾" back to back of edge barriers. The new structures will mirror the existing right skew of 6°-45'-11". The existing bridges will be replaced over a staged construction effort.

3.0 Existing Site Conditions

The locations of the proposed bridge structures extend I-74 across I-57, replacing existing structures SN 010-0018 & SN 010-0019. Existing site conditions include existing interstate roadways and grassy medians for both I-57 and I-74. Elevations range from 761.3' – 762.5' along the I-57 median and 783.74' – 784.84' near the I-74 bridge abutments.

3.1 Regional Geology

According to the Illinois State Geological Survey, "Bedrock Geology of Illinois" map, the site and surrounding area is situated in the Illinois Basin and is underlain by the Pennsylvanian-aged Tradewater Formation. The Illinois Basin is a Paleozoic depositional and structural basin centered in and underlying most of the state of Illinois. An Illinois Basin study reveals that the Tradewater Formation is composed of 70 to 80 percent shale and siltstone, 20 to 30 percent sandstone, and generally less than 5 percent coal and limestone. The Tradewater Formation is overlain by the Wedron Group, which is composed of mostly glacial till (an unsorted mixture of clay, silt, sand, and gravel) in broad ridges (last glaciation), and forms end moraines. The Wedron Group is finally capped by the Peoria and Roxana Silts, which are composed of windblown silt (loess) generally thicker than 20 feet blankets upland surfaces in these areas.

4.0 Subsurface Exploration and Generalized Subsurface Conditions

This section describes the subsurface exploration program and laboratory testing program completed as part of this Structure Geotechnical Report (SGR). The locations and subsurface data were provided by McCleary Engineering and were completed based on field conditions and accessibility. Therefore, no site observations have been made by BFW relative to existing conditions of the structure, roadway or of subsurface sample conditions. The locations of the soil borings are shown on the Boring Location Map located in Appendix A and were plotted based on location data obtained by Midland Engineering. The subsurface exploration program was performed in accordance with applicable IDOT geotechnical manuals and procedures.

4.1 Subsurface Exploration

The site subsurface exploration was conducted from February 6 through February 11, 2015 and included advancing one (1) standard penetration test (SPT) boring within the vicinity of the proposed abutment locations (abutment borings for each structure were combined) and one (1) SPT boring within the vicinity of each midspan pier location. The locations of the soil borings are shown on the **Boring Location Map** provided in Appendix A.

Table 1 – Summary of Subsurface Exploration I-74 over I-57

Boring ID	Location	Station	Offset	Depth (feet)	Surface Elevation (feet)
B-1/4	West Abutment	1060+08	2 LT	75	784.84
B-2/3	East Abutment	1063+03.80	3 LT	75	783.74
B-32	N. Pier I-74 over I-57	1061+31	95 LT	75	761.30
B-33	S. Pier I-74 over I-57	1061+45	76 RT	75	762.50

The soil borings were drilled using a track mounted drill rig. All of the borings were drilled using 3¼ - inch I.D. hollow stem augers. Soil sampling was performed according to AASHTO T 206, "Penetration Test and Split Barrel Sampling of Soils." Soil samples were obtained at 2.5 foot intervals to a minimum depth of 20 feet below existing grade and 5 foot intervals thereafter. McCleary Engineering field representative inspected, visually classified and logged the soil samples during the subsurface exploration activities, and performed unconfined compressive strength tests on cohesive soil samples using a calibrated Rimac compression tester and a calibrated hand penetrometer in accordance with IDOT procedures and requirements. Representative soil samples were collected from each sample interval, and were placed in jars and returned to the laboratory for further testing and evaluation.

4.2 Laboratory Testing

A field and laboratory testing program was undertaken by McCleary Engineering to characterize and determine engineering properties of the subsurface soils encountered in the area of the proposed bridge. The following laboratory tests were performed on representative soil samples:

The following laboratory tests were performed on representative soil samples:

- Moisture content ASTM D2216 / AASHTO T-265
- RIMAC Compression Test – IDOT Method
- Standard Penetration Test (SPT) and Split-Barrel Sampling – ASTM D1586 / T-206

The laboratory tests were performed in accordance with test procedures outlined in the IDOT Geotechnical Manual (1999) and per ASTM and AASHTO requirements. Based on the laboratory test results, the soils encountered were classified according to the AASHTO classification system. The results of the field and laboratory testing are shown on the Soil Boring Logs located in Appendix C.

4.3 Subsurface Conditions

This section provides a brief description of the soils encountered in the borings performed in the vicinity of the proposed improvements. Variations in the general subsurface soil profile were noted during the drilling activities. Detailed descriptions of the subsurface soils are provided in the Soil Boring Logs located in Appendix C and are shown graphically in the Subsurface Profiles located in Appendix D. The soil boring logs provide specific soil conditions encountered at each soil boring location. The soil boring logs include soil descriptions, stratifications, penetration resistance, elevations, location of the samples and laboratory test data. Unless otherwise noted, soil descriptions indicated on boring logs are visual identifications. The stratifications shown on the boring logs represent the conditions only at the actual boring locations, and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

Subsurface information was obtained during a geotechnical investigation conducted over the entire proposed I-57 / I-74 interchange modifications. Borings B-1/4, B-2/3, B-32, and B-33 were advanced in support of proposed I-74 over I-57 Structures (SN#010-1018/19) from February 6 through February 11, 2015 along the proposed roadway alignments. Borings 1 and 4 along with borings B-2 and B-3 were originally intended as separate abutment borings but were combined due to budget constraints.

Bridge Abutment Locations

Boring **B-1/4** was advanced between the proposed west abutments, located at Station 1060+08 (Elev. 784.30'). Originally planned to be two borings, boring **B-1/4** location was a field compromise due to project budget constraints. The boring was advanced in the median of I-74 with approximately 6 inches of topsoil at the surface. The soil profile underlying the topsoil in boring **B-1/4** is described as brown to dark brown, medium to very stiff, silty clay loam, which extends to approximately 22.5 feet deep (Elev. 762.34'), where the material transitions to a light brown very loose clayey sand. The upper silty clay loam had SPT N-values in the range of 13 to 18 and an unconfined compressive strength (Qu) from 1.9 to 3.5. The clayey sand continues with depth to approximately 27 feet deep (Elev. 757.84') where the soil transitions to a very stiff gray silty clay loam to till. The silty clay till soils continued to boring completion depth of 75 feet deep (Elev. 709.84') and exhibited SPT N-values in the range of 15 to 38 and unconfined compressive strengths (Qu) from 1.08 to 3.30.

Boring **B-2/3** was advanced between the proposed east abutments, located at Station 1063+03.80 (Elev. 783.74'). Originally planned to be two separate borings, boring **B-2/3** location was a field compromise due to project budget constraints. The boring was advanced in the median of I-74 with approximately 8 inches of topsoil at the surface. The soil profile underlying the topsoil in boring **B-2/3** is described as a fill material composed of dark brown to brownish gray silty clay, very stiff, with some limestone aggregate fragments, extending down to approximately 22.5 feet deep (Elev. 761.24'), where the material transitions to a brown/gray, stiff to very stiff silty clay. The upper soils had SPT N-values in the range of 12 to 23 and unconfined compressive strength (Qu) from 1.15 to 5.56. The silty clay continues deeper to approximately 32 feet deep (Elev. 751.74') where the soil changes to a gray hard silty clay loam till. The till extended to a depth of approximately 44 feet deep (Elev. 739.74') where the material transitioned into a gray, medium to coarse loose clean sand. The sand continues with depth to approximately 47.5 feet deep (Elev. 736.24') where the soil changes to a gray silty loam till, medium dense. The till continues to boring completion depths of 75 feet deep (Elev. 708.74'). The silty clay till soils had SPT N-values in the range of 11 to 26 and an unconfined compressive strength (Qu) from 0.99 to 3.6.

Pier Boring Locations

Borings **B-32 and B-33** were advanced near the proposed mid-span pier locations, Stations 1061+31 and 1061+45, respectively. In general, each boring was covered with approximately 8" to 2.5 feet of topsoil. Below the topsoil, a brown to gray silty clay to silty clay loam was encountered in each of the soil borings to a depth of 3 – 13 feet deep (Elev. 758.30' – 749.50'). The upper silty clay had SPT N-values ranging from 3 to 17 and unconfined compressive strengths (Qu) from 1.5 to 2.7. Below the silty clay and silty clay loams and silty clay loam till was encountered in each of the borings, with the exception of boring B-32, a very loose gray fine – medium sand layer was observed between approximately 26.5' and 39.5' (Elev. 734.80' – 721.80'). The silty clay loam till extended to boring completion depths of 75 feet deep (Elev. 686.30' – 687.50'). The silty clay loam till exhibited SPT N-values ranging from 7 to 46 and unconfined compressive strengths (Qu) from 1.4 to 3.7.

4.4 Groundwater Conditions

Water levels were checked in each boring to determine the general groundwater conditions present at the site and were measured while drilling and after each boring was completed.

Groundwater was identified in each boring as follows:

Table 2 – Groundwater Elevations

Boring	Groundwater Elevation (At time of drilling)	Groundwater Elevation (@ boring completion)
B-1/4 (West Abut)	754.8	- - -
B-32 (North Pier)	726.3	- - -
B-33 (South Pier)	Dry	Dry
B-2/3 (East Abut)	760.7	- - -

No 24-hour groundwater readings were noted. No streambed elevations or surface water elevations were noted.

Water level readings were made in the boreholes at times and under conditions shown on the boring logs and stated in the text of this report. However, it should be noted that fluctuations in groundwater level may occur due to variations in rainfall, other climatic conditions, or other factors not evident at the time measurements were made and reported.

5.0 Geotechnical Evaluations

The section provides geotechnical analysis and recommendations for the design of the proposed bridge based on the results of the field exploration, laboratory testing, and geotechnical analysis.

5.1 Derivation of Soil Parameters for Design

Unit weights, friction angles and shear strength parameters were estimated using soil shear strength values and standard penetration test (SPT) using published correlations for N values results. **Table 3** - presents generalized soil parameters to be used based for designs on the laboratory and in-situ testing data:

Table 3 – General Summary of Soil Parameters

Approximate Depth / Elevation (feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained	
			Cohesion c (psf)	Friction Angle Φ (degrees)	Cohesion c (psf)	Friction Angle Φ (degrees)
761' to 784'* (*approx. surface elev. at approaches)	Silty Clay Loam/Silty Clay (Fill)	115	2400	0	150	28
734' to 762'* (*approx. surface elev. near center piers)	Silty Clay Till	120	2,100	0	110	28

5.2 Settlement

Western and Eastern Approach Slabs / Abutments

The new approach slabs for both bridges will be supported by new engineered fill. It is anticipated that approximately 2.6 feet (at the west abutment) and 2.3 feet (at the east) will be placed along the new bridge approaches. To accommodate the proposed increase in approach and abutment heights, the abutment slopes will need to be regraded.

The design grading shows that the proposed abutment slope will be a 2H:1V. Based on preliminary settlement calculations, the increase in stress due to the increase in fill would produce only minor settlements in the range of less than 0.4-inch near the west and east abutments and should not adversely affect the approach pavements. Therefore, the anticipated settlement of the abutments due to the regarding activities is considered to be negligible.

5.3 Slope Stability – Bridge Abutments

The proposed construction of I-74 over I-57 involves the removal of the existing dual structures and the replacement of two new bridges with new abutments with concrete end slopes. The proposed abutments are integral with endslopes at 2 horizontal to 1 vertical (2H:1V). Slope stability of the bridge abutments was evaluated using a slope stability analysis software: *GSTABL7 with STEDwin.*

The proposed side slopes were analyzed based on the grading and the soils encountered during subsurface exploration. Three analyses were evaluated using the Bishop and Janbu analyses methods for the proposed slope geometry: end-of-construction (short term - undrained), long-term (drained) and a design seismic event. The analyses were performed using the soil parameters in Table 3 above. A critical factor of safety (FOS) was calculated for each condition. According to the current standard of practice, the target FOS is 1.5 for end-of-construction and long-term slope stability and 1.0 for the design seismic event.

End-of-construction conditions was modeled using full cohesion with a friction angle of 0 degrees. Nominal values for cohesion were used with full friction angle to model the long-term and seismic conditions to analyze the condition where pore water pressure has dissipated. The results of the analysis are shown below in Table 4.

Based on the analysis performed, the proposed slopes meet the minimum required factor of safety of 1.5 (end-of-construction, long-term) and 1.0 (seismic).

Table 4 – Stability Analysis Results – Bridge Abutments

Boring Location	Slope	Calculated Critical FOS		
		End-of-Construction	Long Term	Seismic
B-1/4, West Abut	2H:1V	2.9	1.9	1.5
B-2/3, East Abut	2H:1V	2.9	1.9	1.5

5.4 Seismic Parameters

The seismic hazard for the site was analyzed per the IDOT Geotechnical Manual, IDOT Bridge Design Manual, and AASHTO LRDF Bride Design Specifications. The Seismic Soil Site Class was determined per the requirements of All Geotechnical Manual Users (AGMU) Memo 9.1, Design Guide for Seismic Site Class Determination, and the "Seismic Site Class Determination" Excel spreadsheet provided by IDOT.

Both proposed I-74 over I-57 bridges each have total lengths of 275 feet (back to back abutments). According to Table 3.10.3.1-1 (Site Class Definitions) of the AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition, 2014, with 2015 Interim Revisions, the project site soil profile is most accurately described as the AASHTO Soil Site Class D.

According to Table 3.10.6-1 "Seismic Performance Zones" (SPZ) of the AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition, 2014, with 2015 Interim Revisions, the site is most accurately described as (SPZ)=1 ($\mathbf{S_{D1}} \leq 0.15g$).

Liquefaction analysis was conducted using Design Guide AGMU Memo 10.1 – Liquefaction Analysis. As noted in the previous paragraph the Seismic Performance Zone (SPZ) is SPZ – 1 and the Peak Ground Acceleration (PGA) modified by the zero-period site factor, F_{pga} is less than 0.15. Therefore, no liquefaction of soil layers is anticipated to occur.

The following Seismic Coefficients should be used for design:

$\mathbf{S_s}$=0.146 g, $\mathbf{F_a}$=1.60; therefore Design Spectral Accelerations at 0.2 sec, ($\mathbf{S_{Ds}}$)=0.233g
$\mathbf{S_1}$=0.056 g, $\mathbf{F_v}$=2.40; therefore Design Spectral Accelerations at 1.0 sec, ($\mathbf{S_{D1}}$)=0.135g

Table 5 – Seismic Coefficients Summary Table

Seismic Performance Zone (SPZ)	1
Design Spectral Acceleration at 0.2 sec. ($\mathbf{S_{DS}}$)	0.234 g
Design Spectral Acceleration at 1.0 sec. ($\mathbf{S_{D1}}$)	0.135 g
Soil Site Class	D

Liquefaction analysis was conducted using Design Guide AGMU Memo 10.1 – Liquefaction Analysis. As noted in the previous paragraph the Seismic Performance Zone (SPZ) is SPZ – 1 and the Peak Ground Acceleration (PGA) modified by the zero-period site factor, F_{pga} is less than 0.15. Therefore, no liquefaction of soil layers is anticipated to occur.

5.5 Scour

The proposed dual bridge structures carrying I-74 will cross over I-57 and no waterways are in the vicinity of the proposed project; therefore, scour will not be a concern for this project.

5.6 Mining Activity

Based on a review of the Illinois State Geological Survey's on-line collection of County Coal Maps and Directories, the proposed structure is not located over a mine or mined out area.

5.7 Liquefaction

Based on the AGMU Memo 10.1 – Liquefaction Analysis Seismic Performance Zones 3 and 4 requires liquefaction analysis, as well as, SPZ 2 with a Peak Seismic Ground Surface Acceleration, As equal to or greater than 0.15. The subject site is in SPZ 1 with a A_s less than 0.15. Therefore, liquefaction is not considered as a reduction for the pile design capacity or other foundation considerations included herein.

5.8 Approach Slabs

Based on information from the structural engineer, the approach slabs are 30 feet in length and will be precast. The approach slabs will bear on the abutment on one side and an approach slab concrete pad on the other end. In accordance with the IDOT Bridge Manual, BFW evaluated the foundation soils at the approach slabs for bearing capacity and excessive settlement. With proper compaction of the approach subgrades, the bearing capacity and settlement requirements of the IDOT Bridge manual will be satisfied.

6.0 Foundation Type Evaluation and Design Recommendations

6.1 Foundation Type Feasibility

Based on the preliminary TS&L, the proposed dual structures (SN 010-1018 & 010-1019), Station 1061+40.60 will be constructed of 54" web plate girders (composite full length) on integral abutments with an estimated abutment length of 80'. The superstructure will consist skew alignment with back to back abutment distances of 275'-0". Abutments will bear on single row of vertical steel piles. Two new 30 feet long precast bridge approach slabs will be constructed on either end of the bridge.

For this project, the IDOT BBS requested that the proposed structures be based on an upcoming Supplement and pile selection chart (located in appendix) to the 2012 IDOT Integral Abutment Bridge policy which will allow the use of Metal Shell Piles with Integral Abutments. Based on IDOT BBS request the use of Metal Shell Piles is preferred at this location.

6.2 Driven Pile Supported Foundations

Piles considered for this site include HP-piles and metal shell piles. However, the use of metal shell piles is preferred whenever possible based on IDOT preference.

The designer should be aware that although H-piles are feasible, there are concerns with using H-Piles for some of the following reasons. 1) Friction H-piles are notorious for being the most difficult pile to accurately estimate the length at which bearing will be obtained during construction, 2) the estimated H-pile lengths provided within the SGR extend beyond the depths of the borings which make the pile length estimates more subject to error, 3) the borings were terminated per department policy, however; no indication of either a hard layer, which either crush a shell pile or adequate end bearing layer (such as hard pan or bedrock that would stop an H-pile was encountered, 4) H-piles are highly subject to being driven substantially longer than the estimated pile length. When this occurs in the field the equipment and crew are on hold until additional piling can be located, shipped and spliced, typically resulting in project delays and extra costs for all the splices, extra pile and working days. 5) Metal shell piles are IDOT Foundation and Geotechnical Unit's preferred foundation choice for the abutments because the pile lengths will be substantially shorter in comparison to HP-piles.

The Modified IDOT static method Excel spreadsheet was used to estimate the pile lengths at various axial geotechnical resistances for driven piles per AGMU Memo 10.2. The factored resistance includes reduction for the geotechnical resistance of 0.55 for the pile installation. Based on the results of the subsurface investigation no geotechnical losses due to down drag or liquefaction were included in the axial pile capacity calculations. The anticipated factored structural loadings were obtained from the structural engineer and are provided in Table 6 on the following page.

Tables 7, 8, 9, and 10 summarize the estimated pile lengths at various axial resistances for metal shell piles and HP-piles various sizes piles for the integral abutments for western and eastern abutments and for the center piers for the westbound and eastbound lanes. The complete IDOT Pile Design Tables for each substructure are included in Appendix E.

The Nominal Required Bearing (R_N) represents the resistance the pile will experience during driving as well as assists the contractor in selecting a proper hammer size. The Factored Resistance Available (RF) documents the net long-term axial factored pile capacity available at the top of the pile to support factored substructure loads.

The pile cutoff elevations used for analysis were Elev. 779.94 for both eastbound / westbound lanes west abutments and Elev. 778.82 and Elev. 778.86 for eastbound and westbound lanes for the east abutment, respectively. The pile cutoff elevation included a 2 feet embedment into the integral abutment as required by the Bridge Manual.

The presence of gravels and cobbles was noted in the soil boring logs below elevations of 753 in Boring, B-1/4. Therefore, pile shoes are recommended to be used for both metal shell and HP piles due to presence of cobbles within the general area.

Due to the differences in soil consistency between the soil test borings, one test pile should be advanced at each separate abutment locations and one test pile at both center pier locations. A test pile is performed prior to production driving so that actual, on-site field data can be gathered to further evaluate pile driving requirements for the project. This is also the time in which the contractor's proposed equipment and methodologies identified in their Pile Installation Plan can be assessed.

6.3 Shallow Foundations

Based on the soils encountered and the amount of embankment fill, shallow foundations are not a feasible option for the proposed substructures of the bridge. It is anticipated that shallow foundations designed for the loads provided will undergo settlement and therefore will not be a feasible option and are therefore not discussed in this report.

Design Capacity Limitations

There are no downdrag, liquefaction, scour, or settlement issues at this structure that would result in the loss of capacity of the piling. Therefore, no design capacity limitations are necessary.

6.4 Lateral Load Resistance

Section 3.10.1.10 of the 2012 IDOT Bridge manual requires performing detailed structure interaction analysis if the factored lateral loading per pile exceeds 3 kips. Lateral loadings applied to pile foundations are typically resisted by battering selected piles, the soil/structure interaction, pile flexure, or a combination of these factors. Based on information provided by the structural engineer the lateral loads were anticipated to be less than 3 kips.

6.5 Wingwall Foundation Recommendations

Based on information provided by the structural engineer and the preliminary TS&L the wing walls for the integral abutment option will be cantilever in design and will not rely on soil bearing.

Table 6: Structural Loadings

SUMMARY OF REACTIONS, Fy (kips):

	DC1	DC2	DW	*LL
W. Abut.	516.2	68.4	175.9	125.8
Pier 1	1937.9	237.0	609.2	155.0
Pier 2	0.0	0.0	0.0	0.0
Pier 3	0.0	0.0	0.0	0.0
Pier 4	0.0	0.0	0.0	0.0
E. Abut.	501.6	65.9	169.2	125.3

*One lane loaded (from CONSPAN)

Total Substructure Weight

	DC1
W. Abut.	342.83
Pier 1	752
Pier 2	0
Pier 3	0
Pier 4	0
E. Abut.	342.83

Approach Slab Reaction = 217.5 kips

Load Factors	DC max	DW max	LL
Strength I	1.25	1.50	1.75

STRENGTH I Loads, Fy (kips):

	# of Lanes Loaded				STRENGTH I (max)
	1	2	3	4	
*MPF, m	1.20	1.00	0.85	0.65	
W. Abut.	1959.3	2135.4	2256.6	2267.6	2268
Pier 1	4898.0	5115.1	5264.3	5277.9	5278
Pier 2	0.0	0.0	0.0	0.0	0
Pier 3	0.0	0.0	0.0	0.0	0
Pier 4	0.0	0.0	0.0	0.0	0
E. Abut.	1926.6	2102.0	2222.6	2233.6	2234

*** Multiple Presence Factor (LRFD Table 3.6.1.1.2-1)**

7.0 Construction Considerations

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Road and Bridge Construction (2015) and the Supplemental Specifications and Recurring Special Provisions (2015) and-or its successor specifications. Any deviation from the requirements in the manuals above should be approved by IDOT.

7.1 Groundwater Management

Based on the depth of groundwater observed in the borings, significant groundwater management is not anticipated for bridge construction. The contactor should control groundwater and surface water infiltration to provide construction in dry condition. Temporary ditches, sumps, granular drainage blankets, stone ditch protection, or hand-laid riprap with geotextile underlayment could be used to divert groundwater if significant seepage is encountered during construction. If water seepage occurs during footing or where wet conditions are encountered such that the water cannot be removed with conventional pumping, we recommend placing open grade stone similar to IDOT CA-7 to stabilize the bottom of the excavation.

The CA-7 stone should be placed to 12 inches above the water table, in 12-inch lifts, and should be compacted with the use of a heavy smooth drum roller or heavy vibratory plate compactor until stable. The remaining portion of the excavation beneath the footing should be backfilled using approved structural fill.

7.2 Temporary Sheeting and Soil Retention

The preliminary TS&L plans indicate that the construction of the proposed structures will require complete removal of the existing structure and abutments. Based on information provided by the structural engineer, the construction for the proposed structure will be phased maintaining one lane of traffic in each direction.

Pile Capacity Tables (Tables 7 & 8)
(54-Inch Web Plate Girder – Integral Abutment)

Table 7 – West Abutment

Piling Driven at West Abutment (B-1/4 data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
280	154	51
300	165	54
318	175	56
330	181	59
353*	194*	61
Metal Shell 14" Φ w/0.25" walls		
330	182	51
355	195	54
375	206	56
388	214	59
413*	227*	61
Metal Shell 14" Φ w/0.312 walls		
452	249	70
466	256	73
480	264	75
493	271	78
HP 12 x 53		
330	182	51
355	195	54
375	206	56
338	214	59
405	223	61
HP 12 x 74		
297	163	61
304	167	64
315	173	69
326	179	70
336	185	73
HP 14 x 73		
416	229	78
428	235	80
439	241	83
450	248	85
461	254	88

Table 8 – East Abutment

Piling Driven at South Abutment (B-2\3data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
268	147	46
299	164	49
320	176	51
340	187	54
353*	194*	56
Metal Shell 14" Φ w/0.25" walls		
314	173	46
354	195	49
380	209	51
402	221	54
413*	227*	56
Metal Shell 14" Φ w/0.312 walls		
449	247	59
472	260	61
498	274	64
513*	282*	66
HP 12 x 53		
345	190	61
364	200	64
381	210	66
387	213	69
402	221	70
HP 12 x 74		
412	227	70
428	235	73
444	244	75
461	253	78
477	262	80
HP 14 x 73		
486	268	70
505	278	73
524	288	75
543	299	78
562	309	80

*- Maximum Nominal Required Bearing

Pile Capacity Tables (Tables 9 & 10)
(54-Inch Web Plate Girder)

Table 9 – North Center Pier / Westbound Lanes

Piling Driven at Center Pier (B-32 data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
291	160	45
308	170	47
322	177	50
338	186	52
353*	194*	55
Metal Shell 14" Φ w/0.25" walls		
344	189	45
364	200	47
380	209	50
398	219	52
413*	227*	55
Metal Shell 14" Φ w/0.312 walls		
456	251	65
464	255	67
484	266	71
HP 12 x 53		
319	175	71
326	179	74
333	183	76
340	187	79
347	191	81
HP 12 x 74		
326	179	71
333	183	74
340	187	76
347	191	79
354	195	81
HP 14 x 73		
380	209	71
389	214	74
397	218	76
405	223	79
414	228	81

Table 10 – South Center Pier / Eastbound Lanes

Piling Driven at Center Pier (B-33 data)		
Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft)
Metal Shell 12" Φ w/0.25 walls		
288	158	46
302	166	49
315	173	51
328	181	54
353*	194*	56
Metal Shell 14" Φ w/0.25" walls		
339	187	46
355	195	49
371	204	51
386	212	54
413*	227*	56
Metal Shell 14" Φ w/0.312 walls		
460	253	66
477	263	69
485	267	70
HP 12 x 53		
375	206	78
385	212	80
395	217	83
406	223	85
416	229	88
HP 12 x 74		
394	217	80
404	222	83
415	228	85
425	234	88
435	239	90
HP 14 x 73		
461	254	80
473	260	83
486	267	85
498	274	88
510	280	90

*- Maximum Nominal Required Bearing

Temporary Sheeting and Soil Retention

In evaluating the use of temporary cantilever sheet piling, a maximum of about 11 feet of retaining height during stage construction of both structures. Using subsurface soils information encountered and on preliminary calculations for the depth of embedment as per IDOT Bridge Manual using the "Design Guide and Charts for Temporary Cantilever Sheet Piling", approximately embedment depths were determined. Based on the design charts, embedment depths of approximately 8.3 feet for both the western and eastern abutments for both structures were determined. Therefore, simple cantilever sheeting piles appear feasible to be used for both the western and eastern abutments.

8.0 Limitations

This report has been prepared for the exclusive use of the Illinois Department of Transportation and its structural consultant. The recommendations provided in this report are specific to the project described herein, and are based on the information obtained from the soil boring locations within the project limits. The analysis has been performed and the recommendations have been provided in this report are based on subsurface conditions determined at the location of the borings. This report may not reflect all variations that may occur between boring locations or at some other time, the nature and extend of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations provided herein in light of the new conditions.

Appendix A

Soil Boring Location Map

Boring Number	Location	Station	Offset	Elevation	Latitude	Longitude
B-1/4	West Abut I-74 over I-57	1060+08	2 LT	784.84	40.146299	-88.284334
B-2/B-3	East Abut I-74 over I-57	1063+03.80	3 LT	783.74	40.145826	-88.283446
B-32	N. Boring Pier I-74 over I-57	1061+31	95 LT	761.3	40.146341	-88.283629
B-33	S. Pier I-74 over I-57	1061+45	76 RT	762.5	40.146005	-88.284013

FILE NAME = $FILEL$ $MODELNAME$	USER NAME = $USER$	DESIGNED -	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	I-74 (I-57/I-74 INTERCHANGE)
		DRAWN -	REVISED -		
	PLOT SCALE = $SCALE$	CHECKED -	REVISED -		
	PLOT DATE = $DATE$	DATE -	REVISED -		SCALE: SHEET OF SHEETS STA. TO STA.

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
57/74	10(5-1-RS-1, 14-1, 6)R	CHAMPAIGN		
		CONTRACT NO. 70897		
	ILLINOIS FED. AID PROJECT			

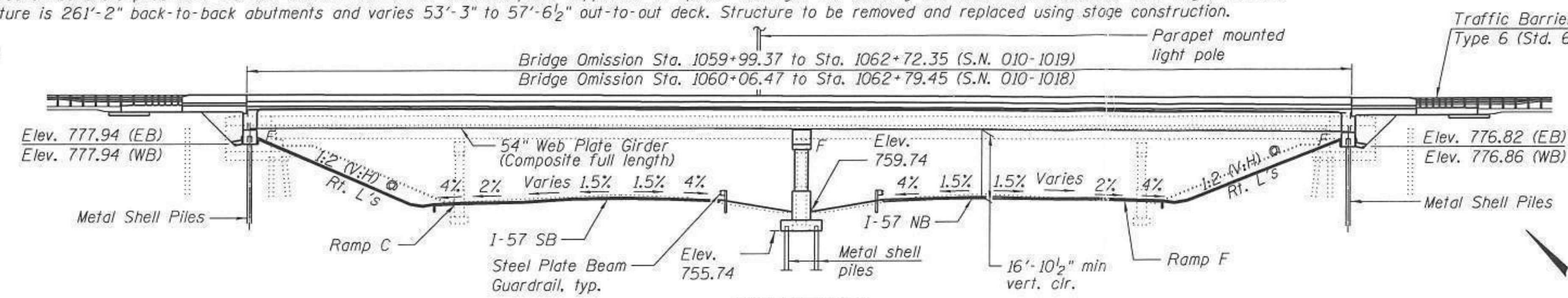
Appendix B

Preliminary TS&L

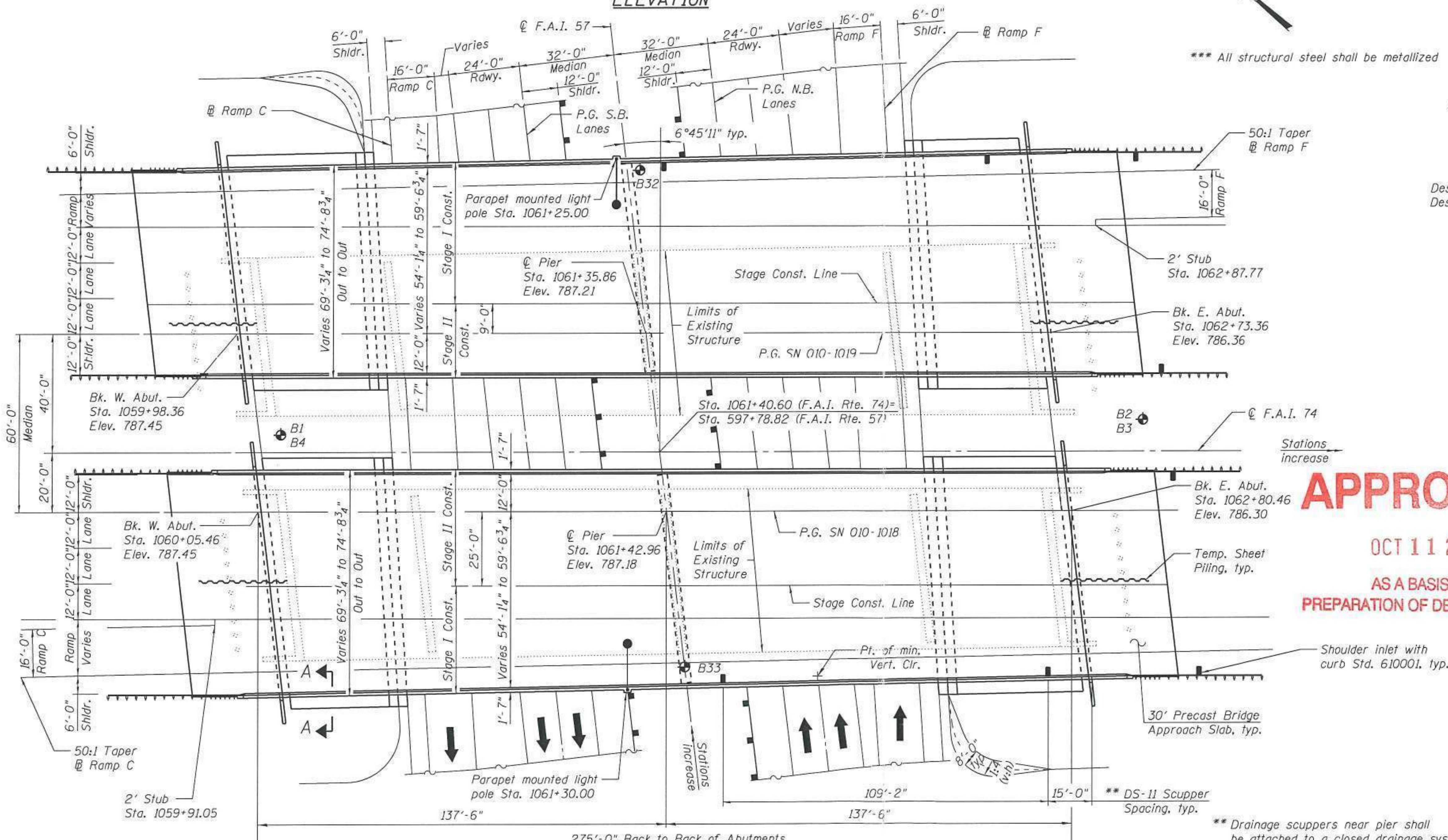
Bench Mark: Chisled "□" on top of the SW corner of the SW wingwall of the westbound bridge. Sta. 1059+99.73, 12.54' LT. Elev. 787.79.

Existing Structures: S.N. 010-0018(19) built in 1965 as F.A.I. 57 Section 10-34HB-1. In 1989, the superstructure, wingwalls, and bearings were replaced on both structures. Each structure is a composite (positive moment regions only) four-span continuous rolled W36 steel beam bridge with a reinforced concrete deck. The open stub abutments are supported on concrete piles with the four column reinforced concrete piers supported on spread footings. The existing structures are skewed 6°45'11" right forward. Each structure is 261'-2" back-to-back abutments and varies 53'-3" to 57'-6½" out-to-out deck. Structure to be removed and replaced using stage construction.

No Salvage



ELEVATION



PLAN

** Drainage scuppers near pier shall be attached to a closed drainage system.

*** All structural steel shall be metallized

HIGHWAY CLASSIFICATION

F.A.I. Rte. 74	F.A.I. 57
Functional Class: Interstate	Functional Class: Interstate
ADT: 38,900 (2013); 59,900 (2040)	ADT: 32,400 (2013); 49,900 (2040)
ADTT: 7,350 (2013); 13,720 (2040)	ADTT: 9,450 (2013); 14,170 (2040)
DHV: 3,961 (2040)	DHV: 2,146 (2040)
Design Speed: 75 m.p.h.	Design Speed: 75 m.p.h.
Posted Speed: 70 m.p.h.	Posted Speed: 70 m.p.h.
2 -Way Traffic	2-Way Traffic
Directional Distribution: 50:50	Directional Distribution: 50:50

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi
f'c = 4,000 psi (superstructure concrete)
fy = 60,000 psi (Reinforcement)
*** fy = 50,000 psi (M270 Grade 50)

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

SEISMIC DATA

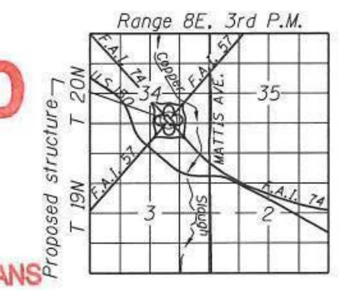
Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.135 g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.234g
Soil Site Class = D

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition with 2016 Interims.

Note:
Up to ¼ inch may be ground off the bridge deck and the bridge approach slabs.

APPROVED
OCT 1 1 2019
AS A BASIS FOR PREPARATION OF DETAILED PLANS



LOCATION SKETCH

GENERAL PLAN & ELEVATION
F.A.I. RTE. 74 OVER F.A.I. RTE. 57
SECTION (10-34)BR, BR-1 & (10-5-1)BR-1
CHAMPAIGN COUNTY
STATION 1061+40.60
STRUCTURE NO. 010-1018 & 010-1019

* (10-34)BR, BR-1 & (10-5-1)BR-1

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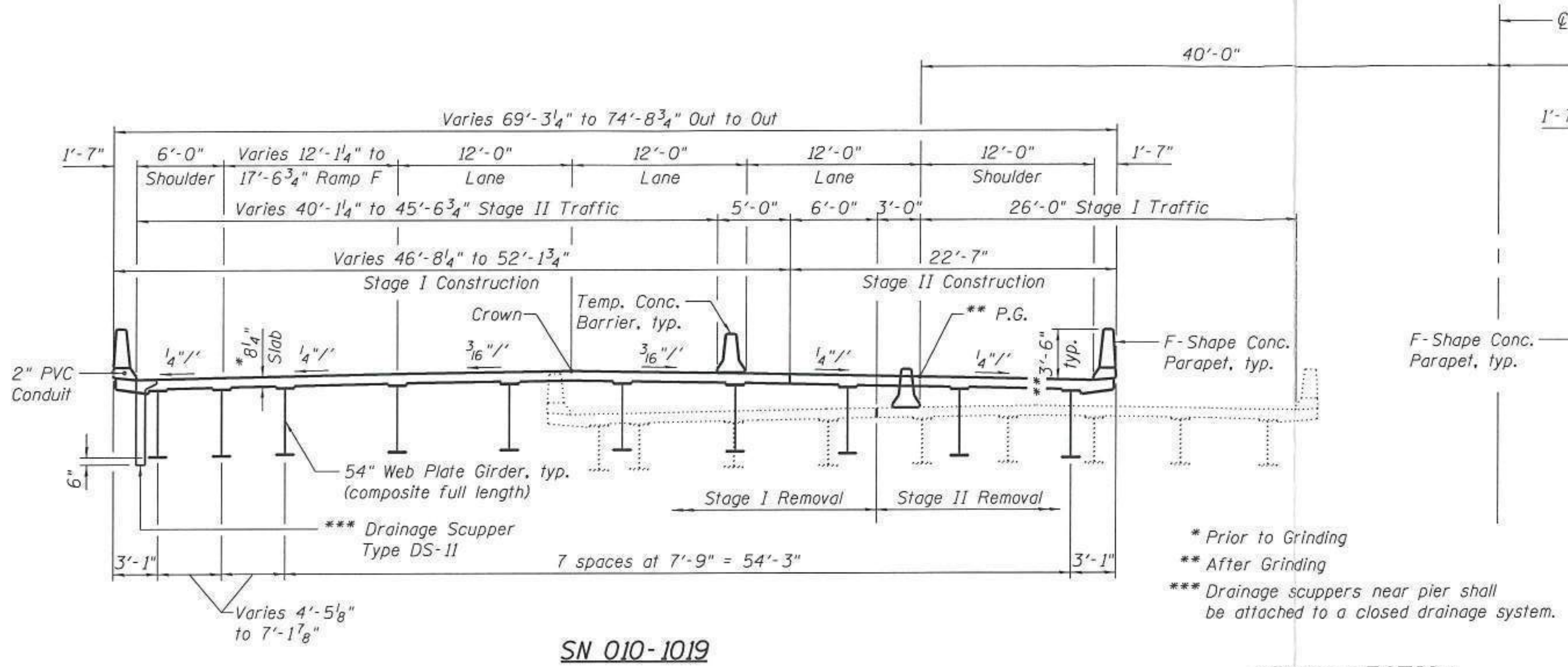
	PLOT SCALE =	DRAWN - BJV	REVISED -
	PLOT DATE = 3/31/2017	CHECKED - BWP	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

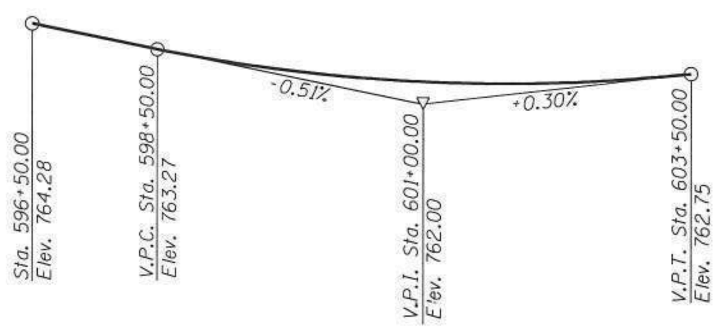
SHEET NO. 1 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
74	*	CHAMPAIGN		
		CONTRACT NO. 70B38		
		ILLINOIS FED. AID PROJECT		

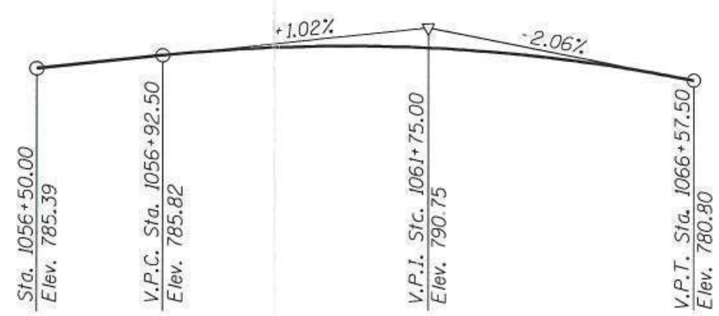


CROSS SECTION

(Looking East)

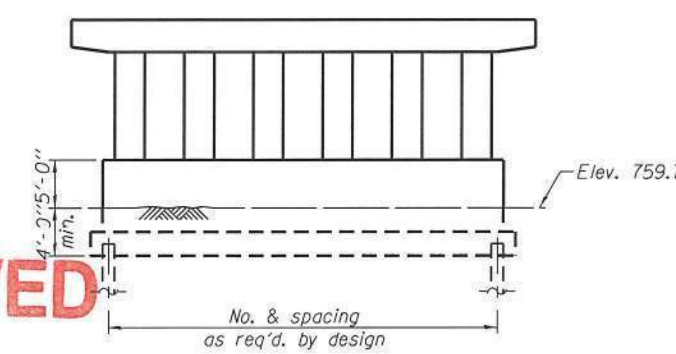


PROFILE GRADE F.A.I. 57



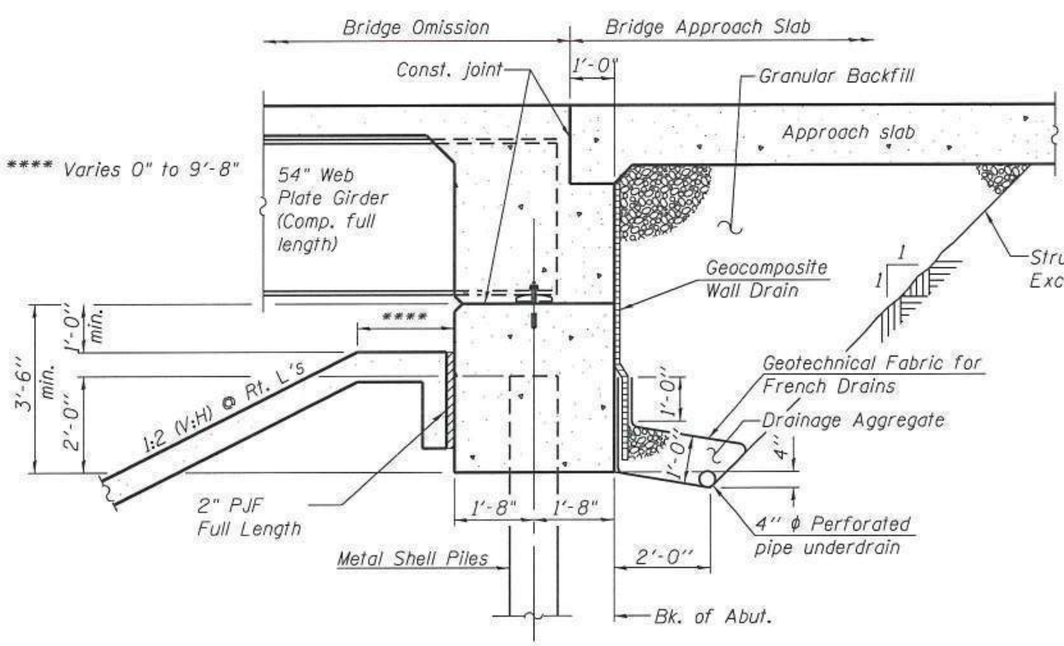
PROFILE GRADE F.A.I. 74

(The profile grade shows the final elevations after grinding)



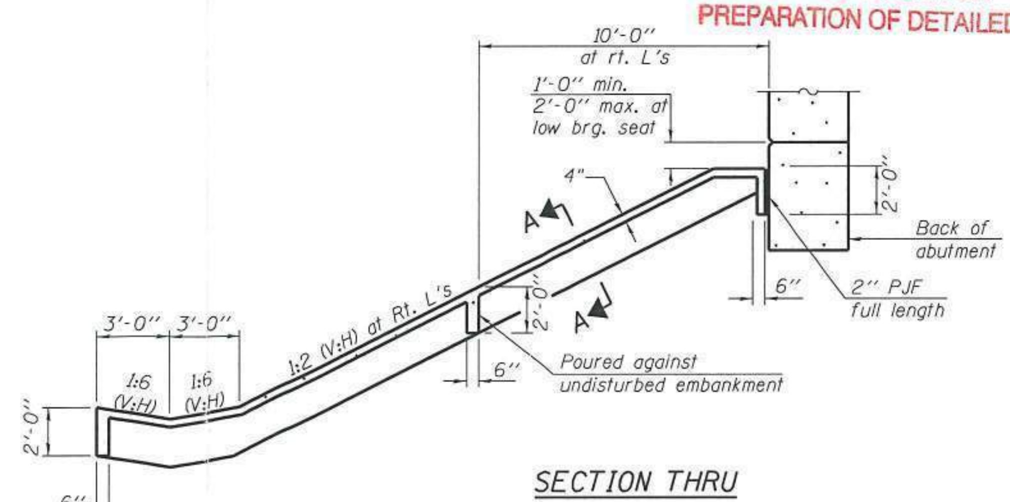
PIER SKETCH

APPROVED
OCT 11 2019
AS A BASIS FOR PREPARATION OF DETAILED PLANS

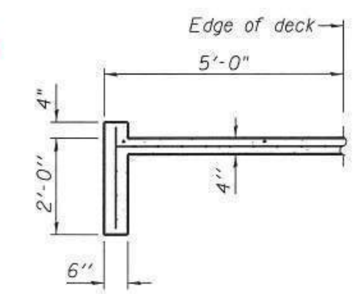


SECTION THRU INTEGRAL ABUTMENT

(Horizontal Dimensions @ Rt. L's)



SECTION THRU CONCRETE SLOPEWALL



SECTION A-A

STAGING & DETAILS
F.A.I. RTE. 74 OVER F.A.I. RTE. 57
SECTION (10-34)BR, BR-1 & (10-5-1)BR-1
CHAMPAIGN COUNTY
STATION 1061+40.60
STRUCTURE NO. 010-1018 & 010-1019

* (10-34)BR, BR-1 & (10-5-1)BR-1

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BFW BACON | FARMER | WORKMAN ENGINEERING & TESTING, INC		CHECKED - BWP	REVISED -
	PLOT SCALE =	DRAWN - BJV	REVISED -
	PLOT DATE = 3/31/2017	CHECKED - BWP	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. 2 OF 2 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
74	*	CHAMPAIGN		
		CONTRACT NO. 70B38		
		ILLINOIS FED. AID PROJECT		

Appendix C

Subsurface Boring Logs

Illinois Department of Transportation

Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/6/15

ROUTE I-57/74 **DESCRIPTION** West Abut I-74 over I-57 **LOGGED BY** TC, MLL

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO.
Station

BORING NO. B-1/4
Station 1060+08
Offset 2.0ft Left
Ground Surface Elev. 784.84 ft

Surface Water Elev. n/a ft
Stream Bed Elev. ft

Groundwater Elev.:
▽ **First Encounter** 754.8 ft
▼ **Upon Completion** ft
▼ **After** Hrs. ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
6" TOPSOIL	784.34				
SILTY CLAY LOAM: Dark Brown, very stiff			3 7 8	3.5 B	18.7
		-5	3 6 9	2.68 B	19.3
SILTY CLAY LOAM: Brown, very stiff	779.34		3 7 11	2.75 B	21.9
SILTY LOAM: Brown, medium	776.84	-10	3 8 8	0.62 S	18.0
SILTY LOAM: Brown, very stiff	774.34		5 9 8	2.47 S	16.8
SILTY LOAM: Dark Brown, very stiff	771.84	-15	4 7 8	2.06 S	20.7
SILTY CLAY LOAM: Brown, stiff	769.34		3 6 7	1.90 B	19.3
SILTY CLAY LOAM: Brown, very stiff	766.84	-20	3 6 7	2.47 B	23.6

Description	Elev. (ft)	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY LOAM: Brown, very stiff *(continued)*					
CLAYEY SAND: Light Brown, very loose	762.34	-25	1 1 2		24.1
SILTY CLAY LOAM: Gray, very stiff Brown last 6" ▽	757.84	-30	3 8 8	3.30 B	12.7
SILTY CLAY TILL: Gray, stiff cobble/gravel @ 32 ft.	753.84	-35	4 7 8	1.65 B	11.1
SILTY CLAY TILL: Gray, very stiff	747.84	-40	4 6 9	2.47 B	12.2

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

File Name P:\GINT\PROJECTS\I 57 74 CHAMPAIGN COUNTY.GPJ Data Template D6TEMPLT.GDT Date Printed 3/2/15
Latitude 40.146299 Longitude -88.284334 Datum Job Number MCE-14044

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/6/15

ROUTE I-57/74 **DESCRIPTION** West Abut I-74 over I-57 **LOGGED BY** TC, MLL

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO.
Station

BORING NO. B-1/4
Station 1060+08
Offset 2.0ft Left
Ground Surface Elev. 784.84 ft

Surface Water Elev. n/a ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 754.8 ft
Upon Completion ft
After Hrs. ft

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY TILL: Gray, very stiff *(continued)*				
	-45	4 7 10	2.27 B	10.8
737.84				
SILTY CLAY TILL: Gray, stiff				
	-50	3 5 12	1.48 B	11.1
very little recovery, some clayey gravel	-55	7 24 14		17.9
727.84				
SILTY CLAY TILL: Gray, very stiff, wet				
	-60	6 10 13	2.68 B	13.1

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY TILL: Gray, very stiff, wet *(continued)*				
	-65	6 8 10	2.06 B	12.7
717.84				
SILTY CLAY TILL: Gray, stiff				
	-70	6 10 11	1.73 B	13.3
709.84	-75	5 11 15	1.03 B	13.9
End of Boring				
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/6/15

ROUTE I-57/74 **DESCRIPTION** East Abut I-74 over I-57 **LOGGED BY** TLM

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO.
Station

BORING NO. B-2/B-3
Station 1063+03.80
Offset 3.0ft Left
Ground Surface Elev. 783.74 ft

Surface Water Elev. n/a ft
Stream Bed Elev. ft

Groundwater Elev.:
▽ **First Encounter** 760.7 ft
▼ **Upon Completion** ft
▼ **After** Hrs. ft

Description	Elev.	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
8" TOPSOIL: Dark Brown, silty clay	783.04				
FILL: Silty Clay, brown/gray, very stiff			4 4 11	3.3 B	13.3
		-5	3 5 7	2.10 B	16.6
FILL: Silty Clay, brown, stiff, with limestone aggregate pieces	778.24		5 7 6	1.15 B	21.4
		-10	4 6 6	1.65 B	14.6
FILL: Silty Clay, dark brown/black and brown, very stiff	773.24		5 7 7	2.68 B	19.7
FILL: Silty Clay, dark brown/black and brown, stiff	770.74	-15	4 8 8	1.90 B	18.5
FILL: Silty Clay, dark brown to black, some organics, hard	768.24		5 11 12	5.56 B	20.1
FILL: Silty Clay, brown and dark brown, very stiff cobbles @ 18 ft.	765.74	-20	4 7 9	2.5 P	21.7

Description	Elev.	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
FILL: Silty Clay, brown and dark brown, very stiff *(continued)*					
SILTY CLAY: Brown/Gray, stiff ▽ (likely original ground)	761.24	-25	3 4 4	1.65 B	25.6
SILTY CLAY: Brown, very stiff, trace gravel	756.24	-30	4 8 10	2.89 B	13.9
SILTY CLAY LOAM TILL: Gray, hard LL: 15 PL: 12 PI: 3	751.74	-35	7 9 11	4.12 B	11.1
		-40	4 7 9		11.2

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

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Latitude 40.145826 Longitude -88.283446 Datum Job Number MCE-14044

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/6/15

ROUTE I-57/74 **DESCRIPTION** East Abut I-74 over I-57 **LOGGED BY** TLM

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO.
Station

BORING NO. B-2/B-3
Station 1063+03.80
Offset 3.0ft Left
Ground Surface Elev. 783.74 ft

Surface Water Elev. n/a ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter 760.7 ft
Upon Completion ft
After Hrs. ft

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY LOAM TILL: Gray, hard *(continued)*				
739.74		4	2.5	12.8
SAND: Gray, loose, medium to coarse		4	P	
	-45	3		16.8
736.24				
SILTY LOAM TILL: Medium dense *Clay portion significantly reduced from that seen between 32' and 44'		5		
		6	0.99	10.5
	-50	5	B	
731.74				
SILTY CLAY LOAM TILL: Brown, very stiff		5		
		10	3.6	11.7
	-55	11	S	
726.74				
SILTY CLAY LOAM TILL: Gray, very stiff		7		
		9	3.35	12.2
	-60	15	B	

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY LOAM TILL: Gray, very stiff *(continued)*				
721.74				
SILTY CLAY TILL: Gray, very stiff		5		
		11	3.3	11.6
	-65	15	B	
		6		
		10	3.55	12.2
	-70	12	B	
		5		
		10	2.68	11.8
708.74	-75	15	B	
End of Boring				
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/11/15

ROUTE I-57/74 **DESCRIPTION** N. Boring Pier I-74 over I-57 **LOGGED BY** TC

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. ____
Station ____

BORING NO. B-32
Station 1061+31
Offset 95.0ft Left
Ground Surface Elev. 761.30 ft

Surface Water Elev. ____ ft
Stream Bed Elev. ____ ft

Groundwater Elev.:
▽ **First Encounter** 726.3 ft
▼ **Upon Completion** ____ ft
▼ **After** ____ **Hrs.** ____ ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
8" TOPSOIL	760.63				
SILTY CLAY: Brown, stiff			4		
			7	1.85	14.5
			10	B	
	758.30				
SILTY CLAY TILL: Gray, very stiff			5		
			8	3.92	11.3
		-5	8	B	
			4		
			6	2.06	11.6
			8	B	
			4		
			9	3.60	11.3
		-10	9	B	
			4		
			7	3.10	10.4
			10	B	
	748.30				
SILTY CLAY TILL: Gray, stiff			4		
			6	1.73	11.6
		-15	7	B	
			4		
			5	1.65	11.9
			8	S	
	743.30				
SILTY CLAY LOAM TILL: Gray, very stiff			4		
			6	2.06	11.5
		-20	10	B	
SILTY CLAY LOAM TILL: Gray, very stiff *(continued)*					
	739.30				
SILTY CLAY TILL: Gray, stiff			2		
			4	1.40	16.1
		-25	6	B	
	734.80				
SAND: Gray, very loose, fine			WOH		
			WOH		17.3
		-30	WOH		
	729.30				
SAND: Gray, medium, fine			5		
			13		10.8
▽		-35	15		
			8		
	721.80		9	4.5+	12.3
SANDY CLAY: Gray, hard		-40	13	P	

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/11/15

ROUTE I-57/74 **DESCRIPTION** N. Boring Pier I-74 over I-57 **LOGGED BY** TC

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. ______
Station ______

BORING NO. B-32
Station 1061+31
Offset 95.0ft Left
Ground Surface Elev. 761.30 ft

Surface Water Elev. ______ ft
Stream Bed Elev. ______ ft

Groundwater Elev.:
▽ **First Encounter** 726.3 ft
▼ **Upon Completion** ______ ft
▼ **After** ______ **Hrs.** ______ ft

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SANDY CLAY: Gray, hard *(continued)*				
719.80				
SILTY CLAY TILL: Gray, very stiff		5		
		8	3.92	11.4
	-45	13	B	
		5		
		7	2.68	15.5
	-50	13	B	
		3		
		7	2.27	12.0
	-55	14	B	
704.30				
SILTY CLAY TILL: Gray, stiff, trace gravel		6		
		8	1.32	12.7
	-60	11	B	

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY TILL: Gray, stiff, trace gravel *(continued)*		8		
		10	1.98	12.4
	-65	14	B	
694.30				
CLAY TILL: Gray, medium		13		
		17	0.75	15.1
	-70	23	P	
689.30				
SILTY CLAY TILL: Gray, stiff		7		
		11	1.65	12.3
686.30	-75	13	B	
End of Boring				
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/10/15

ROUTE I-57/74 **DESCRIPTION** S. Pier I-74 over I-57 **LOGGED BY** TLM

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO.
Station

BORING NO. B-33
Station 1061+45
Offset 76.0ft Right
Ground Surface Elev. 762.50 ft

Surface Water Elev. n/a ft
Stream Bed Elev. ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion Dry ft
After Hrs. ft

Description	Elev.	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
TOPSOIL: Silty Clay, dark brown to black, very stiff	760.00		4 5 5	2.7 B	30.0
SILTY CLAY: Brown, stiff		-5	4 3 4	1.57 B	26.7
	754.50		1 2 1	1.25 P	21.3
SILTY CLAY: Brown/Gray, stiff, trace gravel		-10	2 5 5	1.81 B	14.8
	749.50		4 9 7	1.57 B	12.5
SILTY CLAY TILL: Gray, very stiff		-15	2 4 6	2.06 B	11.9
			2 5 7	2.27 B	11.2
		-20	3 6 7	2.92 B	11.2

Description	Elev.	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY TILL: Gray, very stiff *(continued)*	740.50				
SILTY CLAY TILL: Gray, very stiff, with thin sand seams	735.50	-25	3 5 6	2.1 B	10.8
SILTY CLAY LOAM TILL: Gray, stiff	731.00	-30	3 5 6	1.85 B	11.5
SILTY CLAY LOAM TILL: Gray, very stiff		-35	8 8 9	3.71 B	12.6
		-40	6 8 12	3.30 B	11.6

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Kaskaskia Engineering Group

SOIL BORING LOG

Date 2/10/15

ROUTE I-57/74 **DESCRIPTION** S. Pier I-74 over I-57 **LOGGED BY** TLM

SECTION 10(5-1-RS-1, 14-1,6)R **LOCATION** , **SEC.** 34, **TWP.** 20N, **RNG.** 8E, 3 **PM**

COUNTY Champaign **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. ______
Station ______

BORING NO. B-33
Station 1061+45
Offset 76.0ft Right
Ground Surface Elev. 762.50 ft

Surface Water Elev. n/a ft
Stream Bed Elev. ______ ft

Groundwater Elev.:
First Encounter Dry ft
Upon Completion Dry ft
After ______ **Hrs.** ______ ft

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY LOAM TILL: Gray, very stiff *(continued)*				
720.50				
SILTY CLAY TILL: Gray, stiff		4		
		5	1.90	12.8
	-45	7	B	
715.50				
SILTY CLAY TILL: Very stiff		3		
		5	1.81	13.7
Thin sand seam at 49.5 ft.	-50	7	B	
		2		
>1" thick silt seam at 54 ft.		4	1.81	13.1
	-55	7	B	
		3		
		4	1.81	12.3
	-60	7	B	

Description	DEPTH (ft)	BLOWS	UCS Qu (tsf)	MOIST (%)
SILTY CLAY TILL: Very stiff *(continued)*				
		4		
		3	1.81	12.5
	-65	4	B	
		6		
		7	1.57	12.6
	-70	6	B	
		5		
		5	1.81	12.5
687.50	-75	5	B	
End of Boring				
	-80			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer, E-Estimated)
Abbreviations W.O.H - Sampler Advanced By Weight of Hammer, W.O.P - Advanced by Weight of Pipe, B.S. - Before Seating
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206) BBS, from 137 (Rev. 8-99)

Appendix D

Boring Profile Sheet

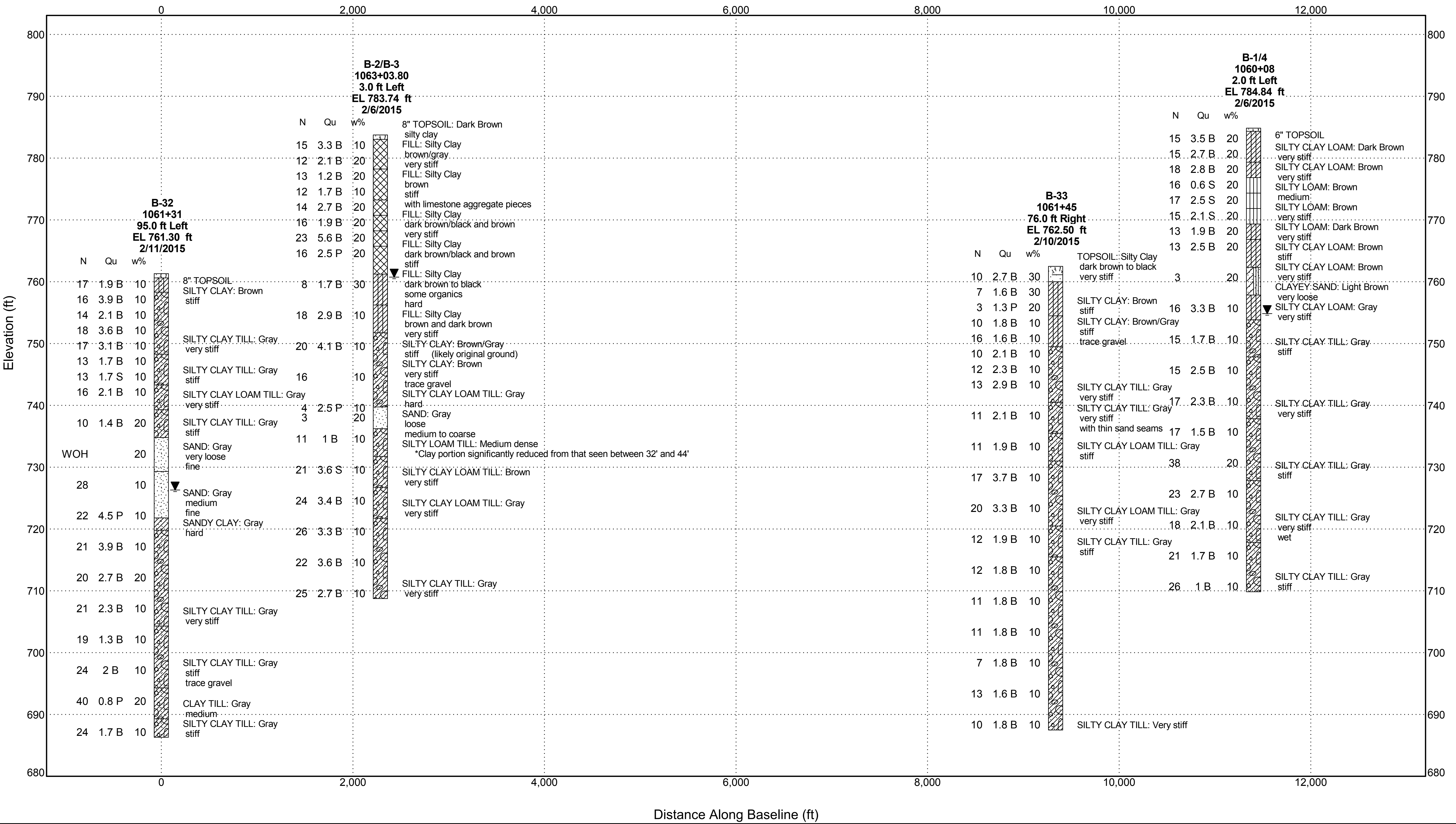
Illinois Department of Transportation
Division of Highways
BFW Engineering & Testing Inc.

ROUTE I-57/74
SECTION 10(5-1-RS-1, 14-1,6)R
COUNTY Champaign
PROJECT LOCATION

SUBSURFACE PROFILE
SN 010-0018/19

LEGEND
EL = Elevation (ft)
D = Depth Below Existing Ground Surface (ft)
N = SPT N-Value (AASHTO T206)
Qu = Unconfined compressive Strength (tsf)
Failure Mode (B= Bulge, S= shear, P= penetrometer)
w% = Moisture Content Percentage

WATER TABLE LEGEND
▼ = First Encountered
▽ = Upon Completion
▼ = After __ hours



ROADWAY PROFILE - BETA I 57 74 CHAMPAIGN COUNTY.GPJ IL_DOT_D4_9-15-10.GDT 3/23/15

Appendix D

Pile Capacity Tables

Pile Design Table for WEST ABUT utilizing Boring #1&4

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	150	83	29
	163	90	31
	183	100	34
	199	110	36
	214	118	39
	229	126	41
	238	131	44
	250	137	46
Metal Shell 12"Φ w/.25" walls			
	150	83	29
	163	90	31
	183	100	34
	199	110	36
	214	118	39
	229	126	41
	238	131	44
	250	137	46
	266	146	49
	280	154	51
	300	165	54
	318	175	56
	330	181	59
	344	189	61
Metal Shell 14"Φ w/.25" walls			
	150	83	24
	172	95	26
	178	98	29
	193	106	31
	217	119	34
	236	130	36
	253	139	39
	271	149	41
	280	154	44
	294	162	46
	314	173	49
	330	182	51
	355	195	54
	375	206	56
	388	214	59
	405	223	61
Metal Shell 14"Φ w/.312" walls			
	150	83	24
	172	95	26
	178	98	29
	193	106	31
	217	119	34
	236	130	36
	253	139	39
	271	149	41

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	154	85	39
	164	90	41
	167	92	44
	175	96	46
	188	104	49
	198	109	51
	215	118	54
	226	125	56
	232	128	59
	242	133	61
	249	137	64
	258	142	66
	260	143	69
	268	147	70
	276	152	73
	284	156	75
	292	161	78
	300	165	80
	308	170	83
	316	174	85
	324	178	88
Steel HP 12 X 53			
	141	77	31
	162	89	34
	175	96	36
	186	102	39
	198	109	41
	200	110	44
	210	115	46
	226	124	49
	238	131	51
	259	142	54
	273	150	56
	278	153	59
	290	159	61
	297	163	64
	308	169	66
	308	170	69
	319	175	70
	329	181	73
	338	186	75
	348	191	78
	357	196	80
	367	202	83
	376	207	85
	386	212	88
Steel HP 12 X 63			
	142	78	31
	164	90	34

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	142	78	24
	160	88	29
	172	94	31
	200	110	34
	215	118	36
	227	125	39
	241	133	44
	253	139	46
	274	151	49
	288	158	51
	314	173	54
	331	182	56
	336	185	59
	350	192	61
	357	196	64
	369	203	69
	383	210	70
	394	217	73
	405	223	75
	416	229	78
	428	235	80
	439	241	83
	450	248	85
	461	254	88
Steel HP 14 X 89			
	145	80	24
	162	89	29
	174	96	31
	202	111	34
	218	120	36
	230	126	39
	244	134	44
	256	141	46
	277	152	49
	291	160	51
	318	175	54
	335	184	56
	340	187	59
	354	195	61
	361	199	64
	373	205	69
	387	213	70
	398	219	73
	410	225	75
	421	232	78
	432	238	80
	444	244	83
	455	250	85
	467	257	88

280	154	44
294	162	46
314	173	49
330	182	51
355	195	54
375	206	56
388	214	59
405	223	61
418	230	64
434	238	66
441	242	69
452	249	70
466	256	73
480	264	75
493	271	78
507	279	80
Steel HP 8 X 36		
148	81	49
155	86	51
168	92	54
177	97	56
183	101	59
191	105	61
197	108	64
204	112	66
206	114	69
212	117	70
219	120	73
225	124	75
232	127	78
238	131	80
245	135	83
251	138	85
257	142	88
Steel HP 10 X 42		
150	83	39
161	88	41
164	90	44
171	94	46
184	101	49
194	107	51
177	97	36
188	103	39
200	110	41
202	111	44
211	116	46
228	126	49
240	132	51
261	144	54
275	151	56
281	154	59
293	161	61
300	165	64
310	171	66
311	171	69
322	177	70
332	182	73
341	188	75
351	193	78
360	198	80
370	203	83
379	209	85
389	214	88
Steel HP 12 X 74		
144	79	31
166	91	34
180	99	36
190	105	39
203	112	41
205	113	44
214	118	46
231	127	49
243	134	51
265	146	54
279	154	56
285	156	59
297	163	61
304	167	64
315	173	66
315	173	69
326	179	70
336	185	73
Steel HP 14 X 102		
147	81	24
164	90	29
176	97	31
205	113	34
221	121	36
233	128	39
247	136	44
259	142	46
281	154	49
295	162	51
322	177	54
339	187	56
344	189	59
358	197	61
365	201	64
377	207	69
391	215	70
403	222	73
414	228	75
426	234	78
437	240	80
449	247	83
460	253	85
472	259	88
Steel HP 14 X 117		
149	82	24
166	91	29
178	98	31
208	114	34
224	123	36
236	130	39
250	138	44
262	144	46
284	156	49
298	164	51
326	179	54
343	189	56
348	191	59
362	199	61
370	203	64

Pile Design Table for EAST ABUT utilizing Boring #2&3

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	136	75	21
	159	87	24
	177	97	26
	205	113	29
	228	126	31
Metal Shell 12"Φ w/.25" walls			
	136	75	21
	159	87	24
	177	97	26
	205	113	29
	228	126	31
	239	131	39
	255	140	41
	259	142	44
	268	147	46
	299	164	49
	320	176	51
	340	187	54
Metal Shell 14"Φ w/.25" walls			
	146	80	19
	161	88	21
	190	105	24
	212	116	26
	246	135	29
	273	150	31
	283	155	39
	302	166	41
	304	167	44
	314	173	46
	354	195	49
	380	209	51
	402	221	54
Metal Shell 14"Φ w/.312" walls			
	146	80	19
	161	88	21
	190	105	24
	212	116	26
	246	135	29
	273	150	31
	283	155	39
	302	166	41
	304	167	44
	314	173	46
	354	195	49
	380	209	51
	402	221	54
	425	234	56
	449	247	59
	472	260	61

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	133	73	26
	156	86	29
	170	93	34
	170	93	36
	173	95	39
	181	100	44
	187	103	46
	219	120	49
	234	128	51
	246	135	54
	260	143	56
	273	150	59
	287	158	61
	303	167	64
	317	174	66
	323	178	69
	336	185	70
	349	192	73
	363	199	75
	376	207	78
	390	214	80
Steel HP 12 X 53			
	148	81	24
	163	89	26
	193	106	29
	205	113	34
	205	113	36
	210	115	39
	216	119	44
	223	122	46
	265	146	49
	283	156	51
	297	163	54
	313	172	56
	329	181	59
	345	190	61
	364	200	64
	381	210	66
	387	213	69
	402	221	70
Steel HP 12 X 63			
	149	82	24
	164	90	26
	195	107	29
	207	114	34
	207	114	36
	212	116	39
	217	120	44
	225	123	46

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	148	81	21
	184	101	24
	201	111	26
	240	132	29
	249	137	34
	249	137	36
	256	141	39
	258	142	44
	267	147	46
	325	179	49
	346	190	51
	362	199	54
	381	210	56
	400	220	59
	419	230	61
	442	243	64
	462	254	66
	466	257	69
	486	268	70
	505	278	73
	524	288	75
	543	299	78
	562	309	80
Steel HP 14 X 89			
	150	82	21
	186	103	24
	204	112	26
	244	134	29
	252	139	34
	252	139	36
	259	143	39
	261	144	44
	270	148	46
	330	181	49
	350	193	51
	366	201	54
	386	212	56
	405	223	59
	424	233	61
	447	246	64
	468	257	66
	472	260	69
	492	271	70
	511	281	73
	530	292	75
	549	302	78
	568	313	80
Steel HP 14 X 102			
	152	83	21

498	274	64
Steel HP 8 X 36		
148	82	46
170	93	49
181	100	51
192	105	54
203	112	56
214	117	59
225	124	61
237	130	64
248	137	66
255	140	69
264	145	70
275	151	73
285	157	75
Steel HP 10 X 42		
130	71	26
153	84	29
166	91	34
166	91	36
170	93	39
177	98	44
183	101	46
214	118	49
228	126	51
240	132	54
254	140	56
267	147	59
281	154	61
296	163	64
310	171	66
317	174	69
329	181	70
268	147	49
286	157	51
300	165	54
316	174	56
332	183	59
348	192	61
368	202	64
385	212	66
390	215	69
406	223	70
422	232	73
438	241	75
454	250	78
470	259	80
Steel HP 12 X 74		
152	84	24
167	92	26
198	109	29
210	115	34
210	115	36
215	118	39
220	121	44
228	125	46
272	150	49
290	159	51
304	167	54
321	176	56
337	185	59
353	194	61
373	205	64
390	215	66
396	218	69
412	227	70
428	235	73
444	244	75
461	253	78
477	262	80
Steel HP 12 X 84		
125	69	21
154	85	24
170	93	26
189	104	24
207	114	26
247	136	29
255	140	34
255	140	36
262	144	39
264	145	44
273	150	46
334	184	49
355	195	51
371	204	54
391	215	56
410	225	59
429	236	61
453	249	64
474	260	66
478	263	69
498	274	70
517	285	73
537	295	75
556	306	78
575	316	80
Steel HP 14 X 117		
141	78	19
154	85	21
192	105	24
210	115	26
251	138	29
258	142	34
258	142	36
266	146	39
267	147	44
276	152	46
338	186	49
359	198	51
375	206	54
395	218	56
415	228	59
434	239	61
458	252	64
479	264	66

Pile Design Table for EASTBOUND LANE PIER utilizing Boring #33

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	159	87	26
	182	100	29
	201	110	31
	220	121	34
	238	131	36
	248	136	39
Metal Shell 12"Φ w/.25" walls			
	159	87	26
	182	100	29
	201	110	31
	220	121	34
	238	131	36
	248	136	39
	262	144	41
	275	151	44
	288	158	46
	302	166	49
	315	173	51
	328	181	54
	342	188	56
Metal Shell 14"Φ w/.25" walls			
	172	95	24
	188	103	26
	217	120	29
	239	132	31
	261	144	34
	283	156	36
	292	161	39
	308	170	41
	324	178	44
	339	187	46
	355	195	49
	371	204	51
	386	212	54
	402	221	56
Metal Shell 14"Φ w/.312" walls			
	172	95	24
	188	103	26
	217	120	29
	239	132	31
	261	144	34
	283	156	36
	292	161	39
	308	170	41
	324	178	44
	339	187	46
	355	195	49
	371	204	51
	386	212	54

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	177	97	39
	187	103	41
	195	107	44
	204	112	46
	214	118	49
	223	123	51
	232	128	54
	241	133	56
	250	138	59
	260	143	61
	266	146	64
	275	151	66
	285	157	69
	289	159	70
	298	164	73
	307	169	75
	315	173	78
	324	178	80
	333	183	83
	341	188	85
	350	192	88
	358	197	90
Steel HP 12 X 53			
	167	92	29
	183	100	31
	198	109	34
	213	117	36
	213	117	39
	224	123	41
	234	129	44
	245	135	46
	256	141	49
	266	147	51
	277	153	54
	288	158	56
	299	164	59
	310	170	61
	317	174	64
	327	180	66
	340	187	69
	345	190	70
	355	195	73
	365	201	75
	375	206	78
	385	212	80
	395	217	83
	406	223	85
	416	229	88
Steel HP 12 X 63			

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	172	95	26
	207	114	29
	225	124	31
	243	134	34
	258	142	39
	271	149	41
	283	155	44
	295	163	46
	308	170	49
	321	177	51
	334	184	54
	347	191	56
	360	198	59
	372	205	61
	381	209	64
	392	216	66
	409	225	69
	413	227	70
	425	234	73
	437	241	75
	449	247	78
	461	254	80
	473	260	83
	486	267	85
	498	274	88
	510	280	90
Steel HP 14 X 89			
	174	96	26
	210	116	29
	228	126	31
	246	136	34
	261	144	39
	274	151	41
	286	157	44
	299	164	46
	312	172	49
	325	179	51
	338	186	54
	351	193	56
	364	200	59
	377	207	61
	385	212	64
	397	218	66
	413	227	69
	418	230	70
	430	237	73
	442	243	75
	455	250	78
	467	257	80

402	221	56
418	230	59
433	238	61
446	245	64
460	253	66
477	263	69
485	267	70
500	275	73
Steel HP 8 X 36		
176	97	51
183	101	54
190	105	56
198	109	59
205	113	61
211	116	64
218	120	66
226	124	69
229	126	70
236	130	73
243	134	75
250	137	78
257	141	80
264	145	83
271	149	85
278	153	88
284	156	90
Steel HP 10 X 42		
173	95	39
183	101	41
191	105	44
200	110	46
209	115	49
218	120	51
227	125	54
236	130	56
245	135	59
254	140	61
261	144	64
269	148	66
280	154	69
283	156	70
169	93	29
184	101	31
200	110	34
215	118	39
226	124	41
236	130	44
247	136	46
258	142	49
269	148	51
280	154	54
291	160	56
302	166	59
313	172	61
320	176	64
330	182	66
343	189	69
348	191	70
358	197	73
368	202	75
378	208	78
389	214	80
399	219	83
409	225	85
419	231	88
430	236	90
Steel HP 12 X 74		
172	94	29
187	103	31
203	112	34
218	120	39
229	126	41
239	132	44
250	138	46
262	144	49
273	150	51
284	156	54
295	162	56
306	168	59
317	174	61
324	178	64
334	184	66
479	263	83
491	270	85
503	277	88
515	283	90
Steel HP 14 X 102		
177	97	26
213	117	29
231	127	31
250	137	34
264	145	39
278	153	41
289	159	44
303	166	46
316	174	49
329	181	51
342	188	54
355	195	56
368	202	59
381	210	61
389	214	64
401	221	66
418	230	69
423	232	70
435	239	73
447	246	75
460	253	78
472	260	80
484	266	83
497	273	85
509	280	88
521	287	90
Steel HP 14 X 117		
179	98	26
216	119	29
234	129	31
253	139	34
267	147	39
281	155	41
293	161	44
306	168	46
319	176	49

Pile Design Table for WESTBOUND LANES PIER utilizing Boring #32

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.179" walls			
	137	75	27
Metal Shell 12"Φ w/.25" walls			
	137	75	27
	210	115	35
	235	129	37
	256	141	40
	279	153	42
	291	160	45
	308	170	47
	322	177	50
	338	186	52
	345	190	55
Metal Shell 14"Φ w/.25" walls			
	161	89	27
	252	139	35
	282	155	37
	305	168	40
	332	182	42
	344	189	45
	364	200	47
	380	209	50
	398	219	52
	405	223	55
Metal Shell 14"Φ w/.312" walls			
	161	89	27
	252	139	35
	282	155	37
	305	168	40
	332	182	42
	344	189	45
	364	200	47
	380	209	50
	398	219	52
	405	223	55
	417	230	57
	438	241	60
	454	250	62
	456	251	65
	464	255	67
	483	266	70
	484	266	71
	494	272	74
	505	278	76
Steel HP 8 X 36			
	192	106	60
	200	110	65
	204	112	67
	213	117	70
	213	117	71

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 10 X 57			
	191	105	45
	203	112	47
	211	116	50
	222	122	52
	223	123	55
	230	127	57
	244	134	60
	251	138	65
	256	141	67
	268	148	71
	274	151	74
	280	154	76
	286	158	79
	292	161	81
Steel HP 12 X 53			
	176	97	35
	199	109	37
	211	116	40
	229	126	42
	231	127	45
	245	135	47
	253	139	50
	265	146	55
	274	151	57
	292	161	60
	298	164	65
	303	167	67
	319	175	71
	326	179	74
	333	183	76
	340	187	79
	347	191	81
Steel HP 12 X 63			
	180	99	35
	201	110	37
	213	117	40
	232	127	42
	233	128	45
	247	136	47
	256	141	50
	268	147	55
	277	152	57
	295	162	60
	300	165	65
	306	168	67
	321	177	71
	328	181	74
	336	185	76
	343	188	79

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Steel HP 14 X 73			
	129	71	27
	198	109	30
	206	113	32
	213	117	35
	249	137	37
	262	144	40
	282	155	45
	298	164	47
	307	169	50
	318	175	55
	329	181	57
	352	193	60
	355	195	65
	362	199	67
	380	209	71
	389	214	74
	397	218	76
	405	223	79
	414	228	81
Steel HP 14 X 89			
	131	72	27
	201	111	30
	210	115	32
	217	119	35
	252	139	37
	265	146	40
	285	157	45
	302	166	47
	311	171	50
	322	177	55
	332	183	57
	356	196	60
	359	198	65
	366	201	67
	385	212	71
	393	216	74
	402	221	76
	410	225	79
	418	230	81
Steel HP 14 X 102			
	132	73	27
	204	112	30
	212	117	32
	220	121	35
	256	141	37
	269	148	40
	289	159	45
	306	168	47
	315	173	50

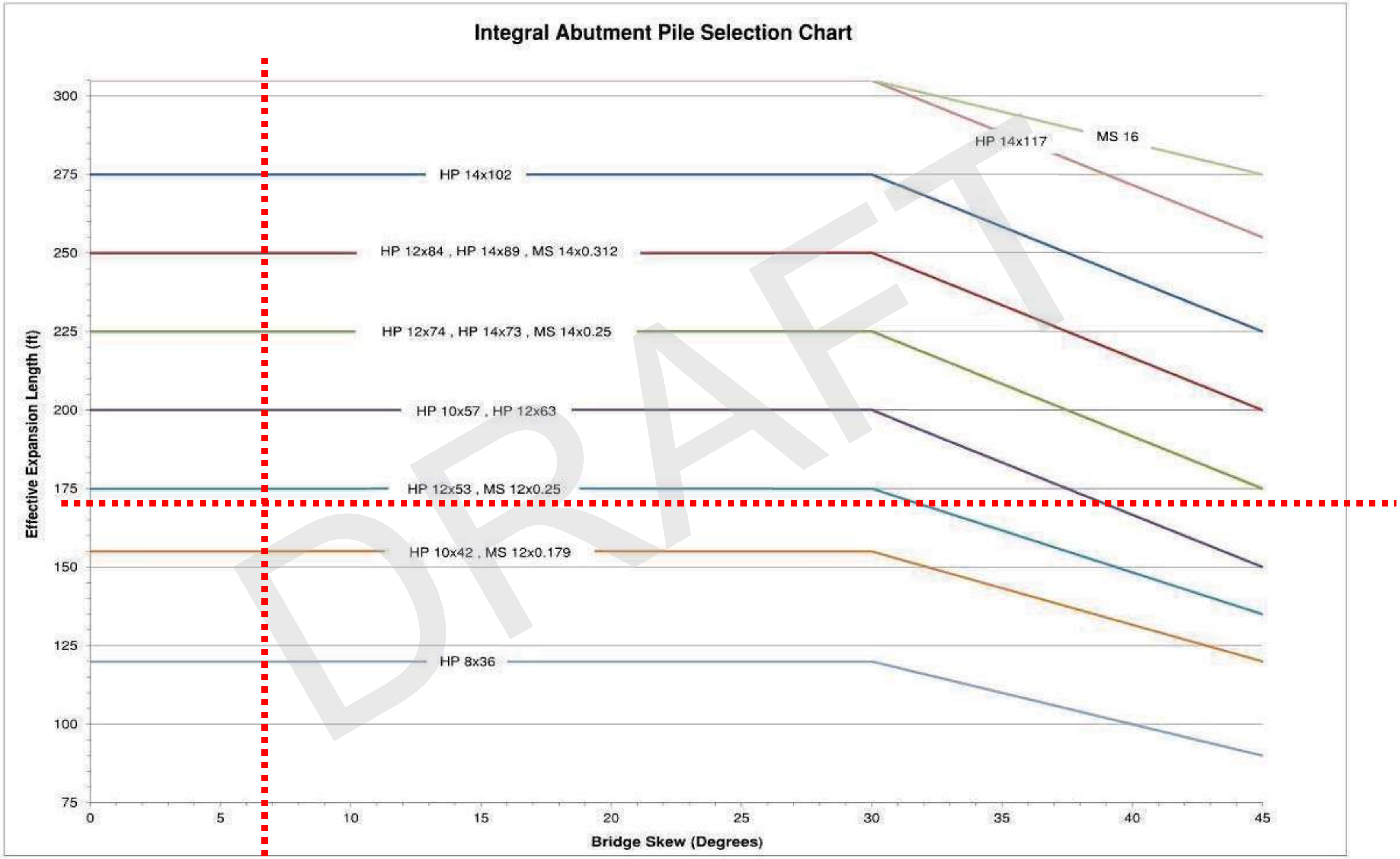
218	120	74
223	123	76
228	125	79
233	128	81
Steel HP 10 X 42		
187	103	45
199	109	47
206	114	50
217	119	52
218	120	55
225	124	57
239	131	60
246	136	65
251	138	67
263	145	71
269	148	74
275	151	76
281	154	79
287	158	81

350	192	81
Steel HP 12 X 74		
182	100	35
204	112	37
217	119	40
235	129	42
237	130	45
251	138	47
259	143	50
271	149	55
280	154	57
299	164	60
304	167	65
310	171	67
326	179	71
333	183	74
340	187	76
347	191	79
354	195	81
Steel HP 12 X 84		
185	101	35
207	114	37
220	121	40
239	131	42
240	132	45
255	140	47
263	145	50
275	151	55
284	156	57
303	166	60
308	170	65
314	173	67
330	181	71
337	185	74
344	189	76
352	193	79
359	197	81

326	179	55
336	185	57
360	198	60
363	200	65
370	203	67
389	214	71
397	219	74
406	223	76
415	228	79
423	233	81
Steel HP 14 X 117		
134	74	27
208	114	30
216	119	32
223	123	35
260	143	37
273	150	40
293	161	45
310	170	47
318	175	50
329	181	55
340	187	57
364	200	60
367	202	65
374	206	67
393	216	71
402	221	74
410	226	76
419	230	79
428	235	81
Precast 14"x 14"		
183	101	20
200	110	22
204	112	25
205	113	27
Timber Pile		
134	74	27

Appendix E

Integral Abutment Pile Selection Chart



Integral Abutment Pile Selection Chart
HP 14x117
MS 16
HP 14x102
HP 12x84 , HP 14x89 , MS 14x0.312
HP 12x74 , HP 14x73 , MS 14x0.25
HP 10x57 , HP 12x63
HP 12x53 , MS 12x0.25
HP 10x42 , MS 12x0.179
HP 8x36
Effective Expansion Length (ft)
Bridge Skew (Degrees)
DRAFT