STRUCTURE
GEOTECHNICAL REPORT

011-2518

Existing SN: 011-0013

IL 29 over Main Drainage Ditch

Route: FAP 75
Section: 2B-2
Christian County

D-96-039-13
Contract # 72G06

Prepared By:	Luke Murphy, PE IDOT Region 4 District 6 Geotechnical Unit 217-782-6709	**Checked By:**	LTM
		Approved By:	Luke Murphy, P.E. D-6 Geotechnical Engr. Lic. #062-071192
Date:	8/23/2022	**Date:**	1/20/2023
Revised Date:	12/15/2022		
Revised Date:	1/19/2023		
Prepared For:	Steve Negangard, SE Kuhn & Trello Consulting Engineers	**Attachments:**	Preliminary TSL Boring Log Subsurface Profile BBS 147 Pile Estimates Special Provisions

This Report has been prepared based on “Approved” Prefinal Plans dated November 2022. Contact the author if there are any questions regarding this Report or if there are modifications to structure location, size, geometry, or vertical alignment.

Electronic copies of boring logs are available upon request for inclusion in the plans. Calculations are also available upon request.

This Report has been prepared according to AASHTO Standard Specifications for Highway Bridges 9th Edition 2020, the 2012 IDOT BBS Bridge Manual, and 2017 IDOT BBS Culvert Manual.

Project Description and Proposed Structure Information

This project consists of the removal of the existing 40 ft two span bridge on closed abutments and replacing it with a triple 12’Hx12’W box culvert. Work will be performed under stage construction.

Proposed wingwalls are approximately 19 ft long and 17.5 ft high. The proposed pavement will sit directly on the box, change in roadway grade is not proposed.

Figure 1: Location Map

Existing Structure and Site Investigation

The existing two span bridge was constructed in 1924, that was widened in 1954. The existing structure is a reinforced concrete slab bridge founded on closed abutments on spread footings and a pile bent pier.

The existing structure is located on a shallow fill (~5ft) in otherwise level terrain, and the primary area land use is cultivated fields. The approach roadway is at or near grade. No existing settlement or stability problems were observed.

The channel banks are approximately 6ft in height and near 1H:2V slopes with no evidence of sloughing and visual evidence of channel meandering on the upstream end. The downstream end channel banks are approximately 5ft with slope ranging from 1V:1.5H to 1V:2H with no evidence of sloughing. Both up and down stream banks do exhibit minor erosion/scour typically found on similar structures.

New borings were advanced on the existing shoulder at the southwest and northeast corners of the existing structure. Borings were advanced 35± and 45± ft below the roadway, approximately 21± and 31± ft below the proposed culvert invert, by the District 6 drill crew according to AASHTO T 206 and the IDOT Geotechnical Manual.

Boring data indicates approximately 18 ft of silty clay over 5ft of soft silt to silt loam, over 5ft to 9 feet of medium stiff clay, over 3ft to 4 feet of silty clay before terminating in silt loam till to silty clay till, typical of the area. Borings on roadways are filled to prevent a hazard immediately after drilling. As a result, no 24-hour water elevation observations were made. The boring data indicates groundwater was encountered at 621.2 ft occurring within the silt loam till. For design and construction purposes, ground water should be anticipated to closely follow the creek elevation, with some lag given the lower permeability of the soils encountered.

Geotechnical Evaluation

Settlement. The proposed grade will match the existing grade and result in the pavement being placed directly on the top slab, implying very little fill materials, however part of the proposed structure will bare on previously unloaded creek bed soils, whereas part of the structure will bare on a partially removed abutment founded on a spread footing, implying that these soils have been previously loaded. Analysis using the BBS spreadsheet, the weight of the proposed box and pavement, shows the potential for 0.75" of differential settlement between loaded and unloaded areas, which is not anticipated to create structural issues for the box culvert. Two feet of removal and replacement reduces this to 0.57", which would result in a minor downdrag loss and load being applied to wingwall piles, if used. Settlement is not anticipated to be a problem.

Slope Stability. The stability of a 1:1 temporary construction slope has been analyzed including excavation to elevation 638 ft. The resulting factor-of-safety is 1.5. The final side slope are anticipated to be gentler or the same slope as before and 10 feet or less in height. No Slope Stability issues are anticipated.

Seismic Considerations. Seismic events are not a significant design consideration for culverts. No analysis is required.

Mining Activity. ISGS records indicate no mining beneath the proposed structure.

Foundation Evaluation

Culvert Barrel. Geotechnically speaking, a precast culvert could be used as differential settlement is not expected to be an issue, however per Section 2.1.4 of the Culvert Manual, a minimum of 6" of cover between the bottom of the pavement and the top slab is required for precast culverts. Therefore, the culvert should be cast in place.

The foundation soil immediately beneath the box is a Silty Clay with a Qu=1 tsf underlain with a Silty Clay with a Qu=0.2 tsf. Per the Subgrade Stability Manual the weaker silty clay would need 22.5" of cover for stability, the difference in elevation from the bottom of the slope to the top of this layer is approximately 9.4", not adequate for the stability during construction. We recommend removing 2 feet of soil beneath the box and replacing it with Rockfill.

Wingwalls.

T-Type:
The soils beneath the proposed footing elevation would prove too soft to provide adequate bearing capacity for a T-Type on a spread footing, with a Qu of 0.1 tsf and a Qu of 0.5 tsf 2 to 2.5 feet lower. A T-Type Wall would require a pile foundation for adequate performance. Given the borings did not encounter rock, we would recommend the use of metal shell piles with pile shoes. H-piles driven as friction piles generally have costly overruns and not ideal given the unknowns of the site. A pile table for the various pile sizes is provided below. The BBS 147's for each shape is attached to this report.

Pile	Estimated Length (ft)	Nominal Bearing (kips)	Factored Resistance Available (kips)	Downdrag Loss and Load (kips)	Max Nominal of Pile (kips)
MS 12" w/ 0.25" Walls	18*	65	34	2	392
	21	80	42	2	
	23	96	51	2	
	26	112	60	2	
MS 14" w/0.25" Walls	18*	78	41	2	459
	21	95	50	2	
	23	116	62	2	
	26	134	72	2	
MS 16" w/0.312" Walls	18*	91	47	3	654
	21	111	58	3	
	23	137	72	3	
	26	157	83	3	

*Bottom of boring 1-SW, layers afterwards are based on Boring 2-NE.

Analysis showed that Boring 1-SW provided a lower Factored Resistance than 2-NE, given the small project area, the pile capacity in the table was based on Boring 1-SW, except for depths below that boring. For depths below Boring 1-SW, Boring 2-NE was used as it was deeper than 1-SW.

Cantilevered Sheet Pile Wall:
A cantilevered sheet pile was also analyzed, but the embedment depth extended far beyond the boring depth and the section modulus required proved this wall type not practical. A concrete or sheet pile deadman anchor, placed a minimum of 18' away from the back of the wingwall could make a sheet pile wingwall design work. This would place the deadman close to the edge of the shoulder, meaning an excavation encroaching on the edge of pavement would be required to install tierods and other hardware onto the deadman anchor, which could complicate staging of traffic. If this option is selected, contact the author of this report for a Geotechnical Design Memorandum detailing design information required for this type of wall.

<u>Soldier Pile Wall:</u>
A cantilevered soldier pile wall was also analyzed. In the undrained condition, spacings between 3.75 and 5.25 feet where possible with available HP14 sections, and would require tip elevations ranging from 614.5 to 609. The drained condition showed tip elevations approaching 615 and either larger HP16 sections or W shapes. Based on conversations with structural steel suppliers, shapes larger than HP 14’s would require a large lead time given current supply chain issues, making them not desirable for the scope of the project, but technically feasible.

<u>Horizontal Cantilevered with Extension:</u>
Additional Considerations where given for Horizontal Cantilevered Wingwalls for a length of 16 feet, then an extension for the remaining 3 feet. In theory the drop in height, would allow wall types previously deemed not feasible, to be feasible for the extensions.

Utilizing a T-Type for the extension was investigated, by the bearing capacity of the foundation soils was too low, even with 2 feet of undercutting. This concept is only logical if the T-Type is on a spread footing, but in theory one could support the 3 foot extension on a single metal shell pile, we do not recommend exploring this option due to the construction sequencing troubles it would create and being uneconomical.

Utilizing a Permanent Sheet Pile Wall for the extension was also investigated and found to be feasible. The parameters in the table below were used in the feasibility analysis of the sheet pile wall, the Structural Engineer will have to do their own analysis using the properties from the same table. The new fill was assumed to be granular in nature. The cohesions in the table were based on the field Rimac test results. The drained or effective friction angles of cohesive materials were based on guidance given by the Bureau of Bridges and Structures Foundations Geotechnical Unit. The drained Ka and Kp were based on the effective friction angle and a wall friction of 1/3 of the effective friction angle.

Layer	Top Elev.	Bottom Elev.	Ymoist (pcf)	ϕ	Cohesion (psf)	Φ’	Drained Ka	Drained Kp
New Fill	Top of Wall	637.2	120	30	0	30	0.31	-
Silt/Silt Loam	637.2	632.2	105	0	375	26	0.36	3.29
Clay	632.2	627.2	118	0	1600	30	0.31	4.13
Silty Clay	627.2	624.2	116	0	600	26	0.36	3.29
Silty Clay	624.2	619.4	122	0	1150	26	0.36	3.29
Till	619.4	614.9	122	0	1200	30	0.31	4.13
Till	614.9	610.4	123	0	2200	30	0.31	4.13

The results of the preliminary analysis are shown below:

Retained Height	Strength Envelope	Tip Elevation	Section Modulus
11.5’ (to bottom of Toe Wall)	Undrained	625	10.7
	Drained	604	32.2
8.5' (to Culvert Invert Elevation)	Undrained	625	9.5
	Drained	616	14

In the table above there are two different retained heights, the 11.5’ assumes traditional construction practice of backfilling behind the wall prior to backfilling/ placing rip rap in front of the wall. Technically this option is feasible as the section modulus does not get out of hand and the embedment is only 6 feet below the deepest boring, not desirable, but technically feasible. Alternatively, the construction sequence could be altered to backfill/ riprap in front of the wall then work behind the wall, reducing the retained height in the analysis allowing for this option to be feasible.

Cast-in-Place End Section with Wingwalls Integrated into a Concrete Apron (CIP Apron):

The last wall type considered is a CIP Apron. This option would require the 2 feet of removal or replacement required underneath the box culvert be used underneath the entire apron. The factored bearing resistance of the apron would be limited by the silt loam soil underneath the 2 feet of removal and replacement this soil has a Qu of 0.5 tsf. From equation 10.6.3.1.2a-1 of AASHTO LRFD a factored bearing resistance of this soil is 1 ksf. This stems from using a resistance factor of 0.5 and an inclination factor of 0.8. For sliding computations a phi angle of 30 degrees should be used as the wall sits directly ontop of the CA-6 cap for rockfill. Using the required resistance factor of 0.8 this would yield an equation of Rs=0.462V where Rs is factored sliding resistance and V is vertical load. This information is summarized in the table below:

Cohesionless Foundation Soil Phi Angle:	30 degrees (assumes 2’ of rockfill)
Foundation Soil Unit Weight	110 pcf
Footing Embedment Depth	2 feet (for Silt Loam underneath) 0 otherwise
Groundwater Depth	0 feet
Retained Soil Phi Angle	28 degrees
Retained Soil Unit Weight	120 pcf
Factored Bearing Resistance (Allowable Bearing Capacity)	1 ksf (limited by Silt Loam underneath Rockfill)
Factored Sliding Resistance	0.462*Vertical Load

The CIP Apron has been used on other culverts within the District, most recently on SN 063-7035 (Contract 72F35), just finished construction July of 2022.

Final Recommendation:

Our final recommendation would be for the CIP Apron. If this option is not structurally feasible, then the consultant should consider horizontal cantilevered wingwalls with cantilevered sheet pile extensions with the backfill/riprap in front of the wall being placed prior to allowing the backfill behind the wall to be placed, contact the author of this report for more details, if this option is selected.

Construction Considerations

Stage Construction. This project will be constructed under stage construction.

Temporary Soil Retention. Temporary retention will be required to facilitate stage construction. The estimated maximum retained height is 17.25 ft. A preliminary analysis indicates a cantilevered sheet pile wall is not feasible. The contract should include a Temporary Soil Retention System.

Excavation. Existing abutments and pier bent should be removed to 2 ft below the proposed culvert barrel and should be backfilled with Rockfill-Foundation. The special provision is attached.

Backfill. Backfill should consist of Granular Culvert Backfill. The special provision is attached. A detail showing pay limits should be included. Pay limits include the temporary excavation limits in a section along the roadway and from edge of shoulder to edge of shoulder in a section along the culvert.

Ground Improvement. The designer should include 2' of soil be removed beneath the box and replaced with Rockfill- Foundation, as shown in the attached marked up TSL. A special provision is attached. The following note should be included in the TSL.

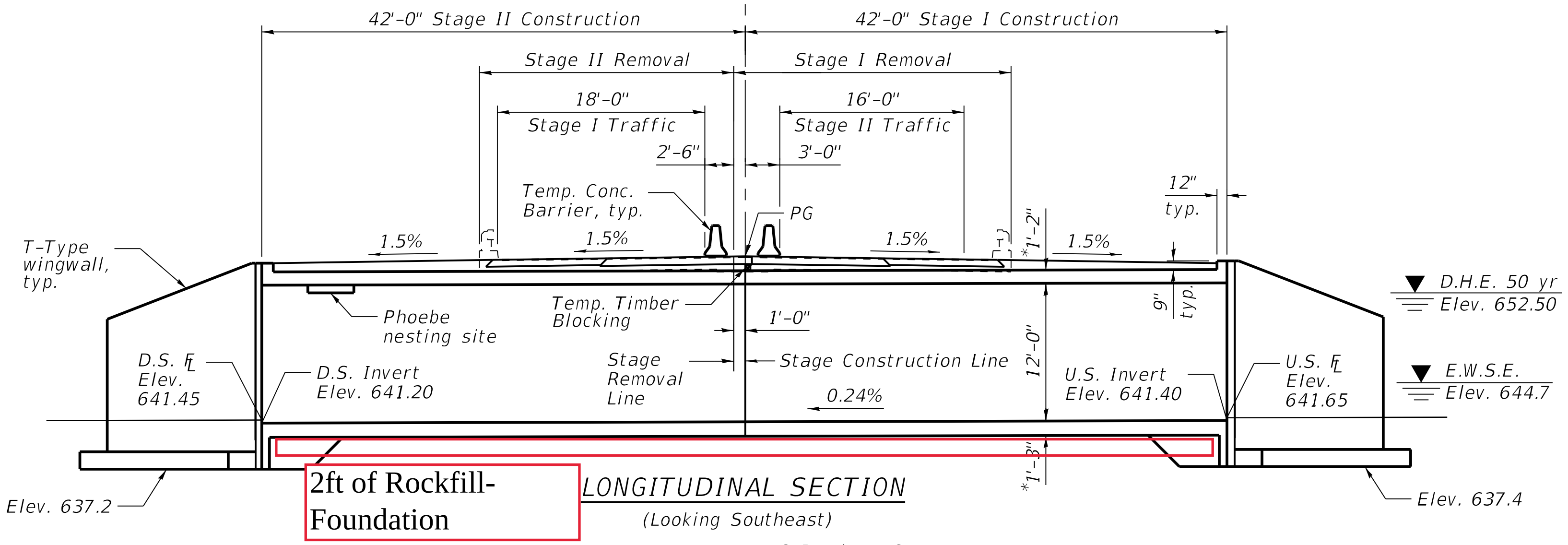
The limits and quantities of removal and replacement shown are based on the boring data and may be modified by the District Geotechnical and Field Engineers for variable subsurface conditions encountered in the field.

Benchmark: Chiseled "□" on top of northeast wingwall at abutment, Elev. 655.43

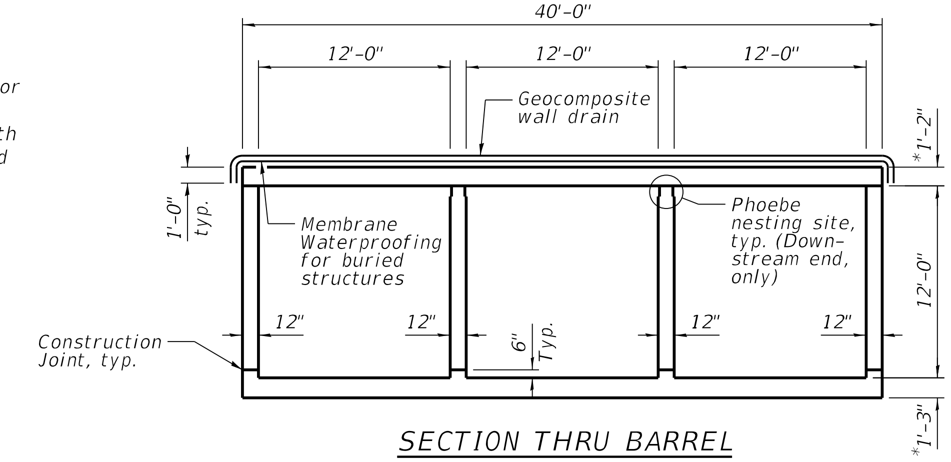
Existing Structure: SN 011-0013, built in 1924 as SBI 24, Section 2,3. The structure was widened in 1958. The existing structure is a 2 span reinforced concrete slab on a pile bent pier and closed abutments on spread footings. The existing structure is to be removed and replaced with a 12' x 12' triple barrel box culvert. One lane of traffic will be maintained utilizing stage construction.

No Salvage

Notes:
Excavate behind the existing abutment prior to superstructure removal.
Existing structure to be removed full depth within 2 feet of proposed culvert barrel and wingwall footprint.



LONGITUDINAL SECTION
(Looking Southeast)

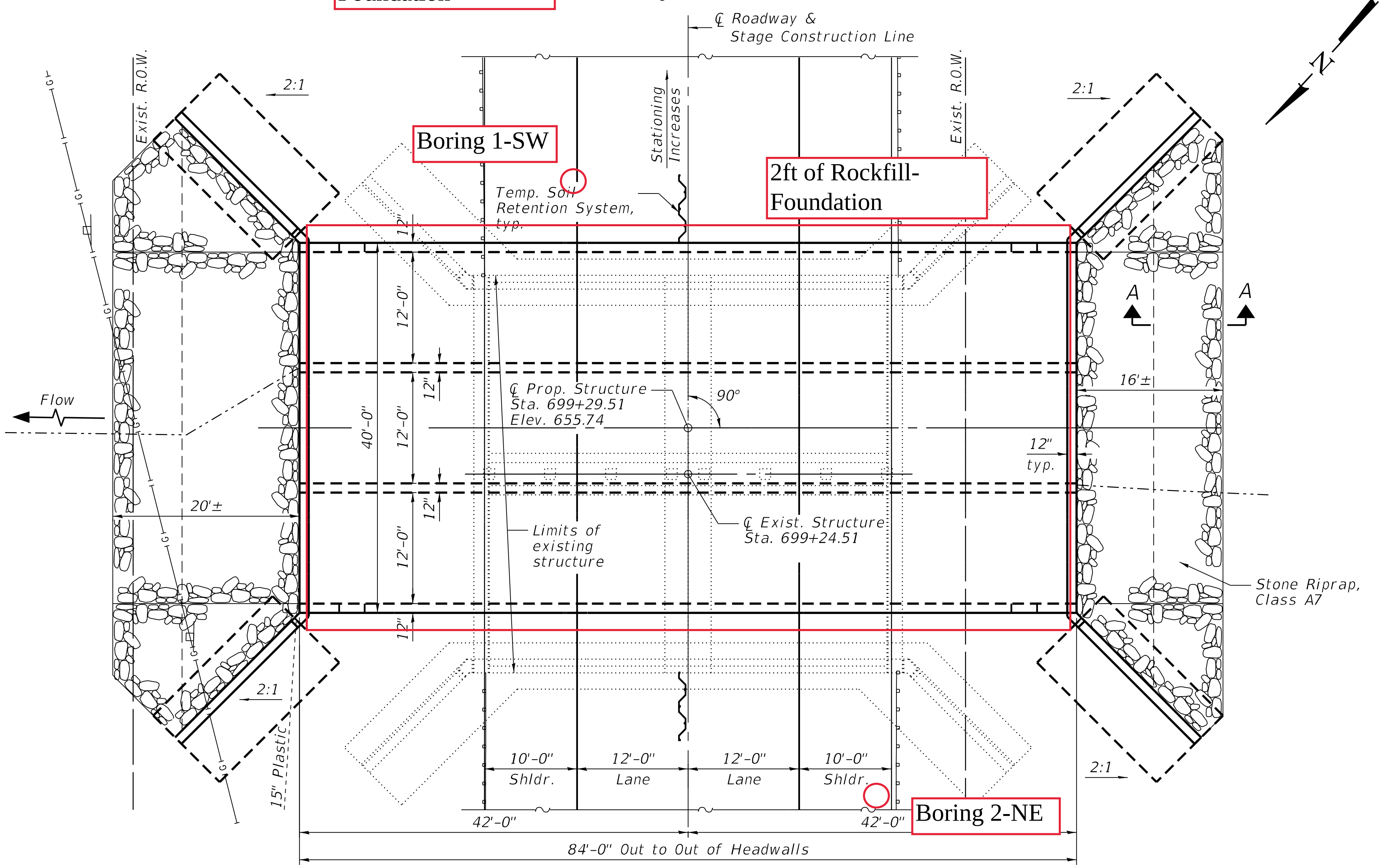


SECTION THRU BARREL

* Slab thickness may be refined in final design

WATERWAY INFORMATION

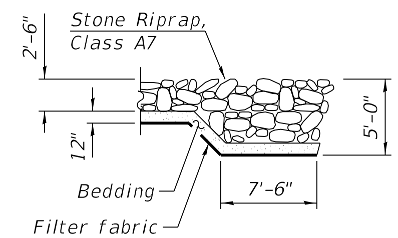
Flood Event	Freq. Yr.	Q C.F.S.	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
Drainage Area = 7 sq. mi.			Exist. Overtopping Elev. = 654.42 @ Sta. 673+00						
			Prop. Overtopping Elev. = 654.42 @ Sta. 673+00						
Ten-Year	10	1,290	256	243	651.5	0.3	0.0	651.8	651.5
Design	50	2,120	283	268	652.2	0.8	0.3	653.0	652.5
Base	100	2,490	294	279	652.5	1.0	0.4	653.5	652.9
Overtop Exist.	293	2,929	301	286	652.7	1.8	0.7	654.5	653.4
Max. Calc.	500	3,400	313	297	653.0	2.3	1.4	655.3	654.4



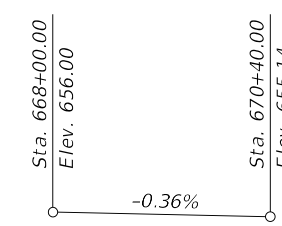
PLAN

DESIGN SCOUR ELEVATION TABLE

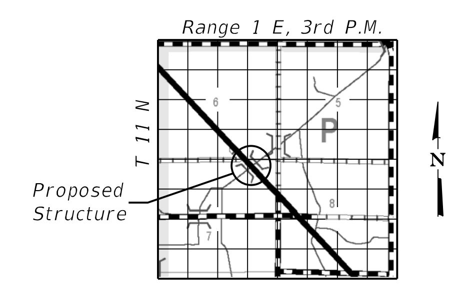
Design Scour Elevation (ft.)	Downstream	Upstream
	637.2	637.4



SECTION A-A



PROFILE GRADE



LOCATION SKETCH

HIGHWAY CLASSIFICATION

Rte. F.A.P. 75 - Rte. (IL 29)
Functional Class: Other principal arterial
ADT: 4300 (2021); 4751 (2041)
ADTT: 480 (2021); 530 (2041)
a.m. DHV: 366; p.m. DHV: 430
Design Speed: 55 m.p.h. (posted); 60 m.p.h. (design)
Posted Speed: 55 m.p.h.
Two-Way Traffic
Directional Distribution:

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design 9th edition

LOADING HL-93

Allow 50#/sq ft for future wearing surface

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi (concrete)
fy = 60,000 psi (reinforcement)

GENERAL PLAN AND ELEVATION
IL 29 OVER MAIN DRAINAGE DITCH
F.A.P. RTE. 75 SEC. (2)B-2
CHRISTIAN COUNTY
STATION 699+29.51
S.N. 011-2518

MODEL: Default
FILE NAME: J:\18040.09 IDOT D6 - PTB 187-011 - W09 - Christian County 72G06\CADData\CADsheets\0112518-72G06-TSL.dgn

KUHN & TRELLO CONSULTING ENGINEERS
A Limited Liability Company
109 N. 7th Street, 3rd Floor
Springfield, IL 62701
Phone: 217-679-0044
Professional Design Firm No. 184-006516

USER NAME =	DESIGNED - SPN	REVISED -	
	CHECKED - MJT	REVISED -	
PLOT SCALE =	DRAWN - MMY	REVISED -	
PLOT DATE =	CHECKED - SPN/MJT	REVISED -	

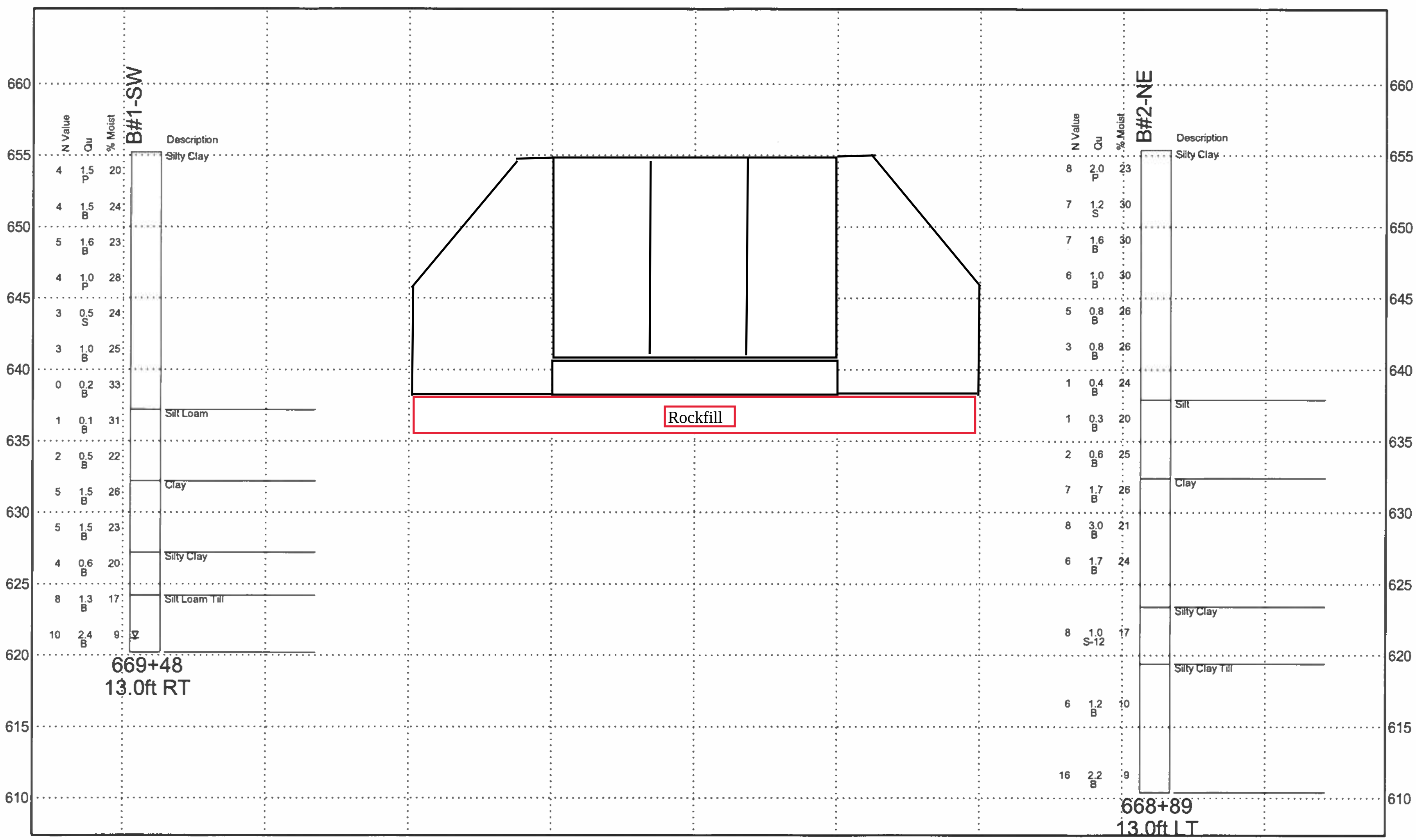
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 1 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
75	(2)B-2	CHRISTIAN	-	-
		CONTRACT NO. 72G06		
		ILLINOIS FED. AID PROJECT		

6/10/2022 4:57:20 PM

Structure Number 011-0013Ex Prop Box Culvert 1.8 miles N of Pana on IL 29
Located in the NW 1/4 of Section 7, Township 11 N, Range 1 E of the 3 P.M.



NOT TO HORIZONTAL SCALE

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation - D6

VARIATIONS IN SUBSURFACE CONDITIONS MAY EXIST BETWEEN BORINGS

Groundwater
First Encounter
Completion
after (refer to log) hours

Abbreviations
WOH - Sampler Advanced by Weight of Hammer, WOP - Weight of Pipe
B.S. - Before Seating

SUBSURFACE DATA PROFILE

Route: IL 29

Section: (2)B-2

County: Christian

SUBSURFACE DATA PROFILE 011-0013EX.GPJ D6TEMPLT.GDT 12/13/22

SUBSURFACE DATA PROFILE 011-0013EX.GPJ D6TEMPLT.GDT 12/13/22

Illinois Department of Transportation
Division of Highways
District 6

SOIL BORING LOG

Date 8/10/22

ROUTE IL 29 **DESCRIPTION** Prop Box Culvert 1.8 miles N of Pana on IL 29 **LOGGED BY** S. Burke

SECTION (2)B-2 **LOCATION** NW 1/4, **SEC.** 7, **TWP.** 11 N, **RNG.** 1 E, 3 **PM**

COUNTY Christian **DRILLING METHOD** HSA **HAMMER TYPE** 140# Auto

STRUCT. NO. 011-0013Ex
Station 699+24.51

BORING NO. 1-SW
Station 669+48
Offset 13.0ft RT
Ground Surface Elev. 655.19 ft

Surface Water Elev. 642.15 ft
Stream Bed Elev. ft

Groundwater Elev.:
∇ **First Encounter** 621.2 ft
▼ **Upon Completion** plugged ft
▼ **After** Hrs. plugged ft

Description	DEPTH (ft)	BLOWS /6"	UCS Qu (tsf)	MOIST (%)
Dk Gray Moist SILTY CLAY 0-9" cored thru HMA		0 / 2 / 2	1.5 P	20
	-5	1 / 2 / 2	1.5 B	24
		0 / 2 / 3	1.6 B	23
	-10	1 / 1 / 3	1.0 P	28
Dk and Lt Gray Moist SILTY CLAY		0 / 1 / 2	0.5 S	24
	-15	0 / 1 / 2	1.0 B	25
Gray Moist SILT to SILTY CLAY		0 / 0 / 0	0.2 B	33
637.19				
Gray V. Moist SILT LOAM	-20	0 / 0 / 1	0.1 B	31
Gray V. Moist SILT LOAM *(continued)*				
Lt Gray		0 / 1 / 1	0.5 B	22
632.19				
Lt Gray CLAY	-25	0 / 2 / 3	1.5 B	26
Lt Gray Clay w/ Silt Seams 1" Sand Seam at 27ft		1 / 2 / 3	1.5 B	23
627.19				
Lt Gray Moist SILTY CLAY w/ thin Sand Seams	-30	0 / 2 / 2	0.6 B	20
624.19				
Lt Gray V Moist SILT LOAM TILL		1 / 3 / 5	1.3 B	17
∇ Gray Moist SILT LOAM TILL FREE WATER	-35	1 / 4 / 6	2.4 B	9
620.19				
	-40			

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 S:\SOILS\GINT FILES\011 CHRISTIANCULVERT BORINGS\011-0013EX.GPJ Data Template D6TEMPLT.GDT Date Printed 12/13/22
Latitude Longitude Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 6

SOIL BORING LOG

Date 12/9/22

ROUTE IL 29 **DESCRIPTION** Prop Box Culvert 1.8 miles N of Pana on IL 29 **LOGGED BY** S. Burke

SECTION (2)B-2 **LOCATION** NW 1/4, **SEC.** 7, **TWP.** 11 N, **RNG.** 1 E, 3 **PM**

COUNTY Christian **DRILLING METHOD** HSA **HAMMER TYPE** 140# Auto

STRUCT. NO. 011-0013Ex
Station 699+24.51

BORING NO. 2-NE
Station 668+89
Offset 13.0ft LT
Ground Surface Elev. 655.39 ft

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

Groundwater Elev.:
▽ **First Encounter** No Encounter ft
▼ **Upon Completion** plugged ft
▼ **After** ____ **Hrs.** plugged ft

Description	DEPTH (ft)	BLOWS /6"	UCS Qu (tsf)	MOIST (%)
Dk Gray Moist SILTY CLAY cored thru shoulder, broken sample		0 4 4	 2.0 P	 23
	-5	1 3 4	 1.2 S	 30
		1 3 4	 1.6 B	 30
	-10	1 3 3	 1.0 B	 30
Dk Gray and Gray		0 2 3	 0.8 B	 26
	-15	0 0 3	 0.8 B	 26
Lt Gray V. Moist SILTY CLAY to SILT LOAM 637.89		0 0 1	 0.4 B	 24
Lt Gray V. Moist SILT	-20	0 0 1	 0.3 B	 20

Description	DEPTH (ft)	BLOWS /6"	UCS Qu (tsf)	MOIST (%)
Lt Gray V. Moist SILT *(continued)* 632.39		0 1 1	 0.6 B	 25
Lt Gray Moist CLAY	-25	0 3 4	 1.7 B	 26
		0 3 5	 3.0 B	 21
	-30	1 2 4	 1.7 B	 24
623.39				
Lt Gray Moist SILTY CLAY w/ some gravel trace sand @34ft	-35	0 2 6	 1.0 S-12	 17
619.39				
Lt Gray Moist SILTY CLAY (TILL)	-40	0 2 4	 1.2 B	 10

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 S:\SOILS\GINT FILES\011 CHRISTIANCULVERT BORINGS\011-0013EX.GPJ Data Template D6TEMPLT.GDT Date Printed 12/13/22
Latitude Longitude Datum NAD83 Job Number

Illinois Department of Transportation
Division of Highways
District 6

SOIL BORING LOG

Date 12/9/22

ROUTE IL 29 **DESCRIPTION** Prop Box Culvert 1.8 miles N of Pana on IL 29 **LOGGED BY** S. Burke

SECTION (2)B-2 **LOCATION** NW 1/4, **SEC.** 7, **TWP.** 11 N, **RNG.** 1 E, 3 PM

COUNTY Christian **DRILLING METHOD** HSA **HAMMER TYPE** 140# Auto

STRUCT. NO. 011-0013Ex
Station 699+24.51

BORING NO. 2-NE
Station 668+89
Offset 13.0ft LT
Ground Surface Elev. 655.39 ft

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

Groundwater Elev.:
First Encounter No Encounter ft
Upon Completion plugged ft
After ____ **Hrs.** plugged ft

Description	DEPTH (ft)	BLOWS /6"	UCS Qu (tsf)	MOIST (%)
Lt Gray Moist SILTY CLAY (TILL) *(continued)*				
		2		
		6	2.2	9
610.39	-45	10	B	
Boring Complete				
	-50			
	-55			
	-60			

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 Longitude Datum NAD83 Job Number

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

Illinois Department of Transportation

SUBSTRUCTURE==================================== Wingwalls
REFERENCE BORING ================================ 1-SW
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 638.20 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 637.20 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== DD
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD ============== 634.70 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 4000 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 102.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 2
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 155.95 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 58.48 KIPS

PILE TYPE AND SIZE ============= Metal Shell 12"Φ w/.25" walls
Pile Perimeter============================== 3.142 FT.
Pile End Bearing Area=========================== 0.785 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
392 KIPS	**124** KIPS	**66** KIPS	*** Below Boring

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL TOTAL RESIST. (KIPS)				NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
634.70	2.50	0.10			1.0		***5.3***				5	1	1	1	4
632.20	2.50	0.50			4.8	4.3	***18.7***				19	1	1	9	6
629.70	2.50	1.50			11.8	12.9	***30.6***				31	1	1	15	9
627.20	2.50	1.50			11.8	12.9	***34.6***				35	1	1	17	11
624.20	3.00	0.60			6.8	5.2	***47.4***				47	1	1	24	14
621.70	2.50	1.30			10.7	11.2	***67.6***				68	1	1	35	17
620.20	1.50	2.40			9.7	20.7	***65.2***				65	1	1	34	18
619.40	0.80	1.00			2.8	8.6	***69.7***				70	1	1	37	19
616.90	2.50	1.20			10.1	10.3	***79.8***				80	1	1	42	21
614.90	2.00	1.20			8.1	10.3	***96.5***				96	1	1	51	23
612.40	2.50	2.20			15.2	19.0	***111.7***				112	1	1	60	26
610.40	2.00	2.20			12.2	19.0	***123.9***				124	1	1	66	28
609.40	1.00	2.20				19.0									

Illinois Department of Transportation

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== Wingwalls
REFERENCE BORING ================================ 1-SW
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 638.20 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 637.20 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== DD
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =============== 634.70 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

TOTAL FACTORED SUBSTRUCTURE LOAD =============== 4000 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 102.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 2
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 155.95 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 58.48 KIPS

PILE TYPE AND SIZE ============= Metal Shell 14"Φ w/.25" walls
Pile Perimeter============================== 3.665 FT.
Pile End Bearing Area========================== 1.069 SQFT.

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
459 KIPS	**148** KIPS	**80** KIPS	*** Below Boring

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL TOTAL RESIST. (KIPS)				NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
634.70	2.50	0.10			1.2		***7.1***				7	1	1	2	4
632.20	2.50	0.50			5.6	5.9	***24.4***				24	1	1	11	6
629.70	2.50	1.50			13.8	17.6	***38.2***				38	1	1	19	9
627.20	2.50	1.50			13.8	17.6	***41.4***				41	1	1	21	11
624.20	3.00	0.60			7.9	7.0	***57.5***				58	1	1	30	14
621.70	2.50	1.30			12.5	15.2	***82.9***				83	1	1	44	17
620.20	1.50	2.40			11.3	28.1	***77.8***				78	1	1	41	18
619.40	0.80	1.00			3.3	11.7	***83.4***				83	1	1	44	19
616.90	2.50	1.20			11.8	14.1	***95.1***				95	1	1	50	21
614.90	2.00	1.20			9.4	14.1	***116.3***				116	1	1	62	23
612.40	2.50	2.20			17.7	25.8	***134.0***				134	1	1	72	26
610.40	2.00	2.20			14.2	25.8	***148.2***				148	1	1	80	28
609.40	1.00	2.20				25.8									

IDOT STATIC METHOD OF ESTIMATING PILE LENGTH

SUBSTRUCTURE==================================== Wingwalls
REFERENCE BORING ================================ 1-SW
LRFD or ASD or SEISMIC ============================== LRFD
PILE CUTOFF ELEV. ================================== 638.20 ft
GROUND SURFACE ELEV. AGAINST PILE DURING DRIVING = 637.20 ft
GEOTECHNICAL LOSS TYPE (None, Scour, Liquef., DD) ====== DD
BOTTOM ELEV. OF SCOUR, LIQUEF., or DD =============== 634.70 ft
TOP ELEV. OF LIQUEF. (so layers above apply DD) =============== ft

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

Maximum Nominal Req'd Bearing of Pile	Maximum Nominal Req.d Bearing of Boring	Maximum Factored Resistance Available in Boring	Maximum Pile Driveable Length in Boring
654 KIPS	**174** KIPS	**93** KIPS	*** Below Boring

TOTAL FACTORED SUBSTRUCTURE LOAD ============== 4000 kips
TOTAL LENGTH OF SUBSTRUCTURE (along skew)========== 102.60 ft
NUMBER OF ROWS OF PILES PER SUBSTRUCTURE ======= 2
Approx. Factored Loading Applied per pile at 8 ft. Cts ============ 155.95 KIPS
Approx. Factored Loading Applied per pile at 3 ft. Cts ============ 58.48 KIPS

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

BOT. OF LAYER ELEV. (FT.)	LAYER THICK. (FT.)	UNCONF. COMPR. STRENGTH (TSF.)	S.P.T. N VALUE (BLOWS)	GRANULAR OR ROCK LAYER DESCRIPTION	NOMINAL SIDE RESIST. (KIPS)	NOMINAL END BRG. RESIST. (KIPS)	NOMINAL TOTAL RESIST. (KIPS)				NOMINAL REQ'D BEARING (KIPS)	FACTORED GEOTECH. LOSS FROM SCOUR or DD (KIPS)	FACTORED GEOTECH. LOSS LOAD FROM DD (KIPS)	FACTORED RESISTANCE AVAILABLE (KIPS)	ESTIMATED PILE LENGTH (FT.)
634.70	2.50	0.10			1.4		***9.0***				9	1	2	3	4
632.20	2.50	0.50			6.4	7.7	***30.7***				31	1	2	15	6
629.70	2.50	1.50			15.8	23.0	***46.5***				46	1	2	23	9
627.20	2.50	1.50			15.8	23.0	***48.5***				48	1	2	24	11
624.20	3.00	0.60			9.0	9.2	***68.2***				68	1	2	35	14
621.70	2.50	1.30			14.3	19.9	***99.3***				99	1	2	52	17
620.20	1.50	2.40			12.9	36.8	***90.8***				91	1	2	48	18
619.40	0.80	1.00			3.7	15.3	***97.6***				98	1	2	51	19
616.90	2.50	1.20			13.4	18.4	***111.0***				111	1	2	59	21
614.90	2.00	1.20			10.7	18.4	***137.1***				137	1	2	73	23
612.40	2.50	2.20			20.3	33.7	***157.4***				157	1	2	84	26
610.40	2.00	2.20			16.2	33.7	***173.6***				174	1	2	93	28
609.40	1.00	2.20				33.7									

GRANULAR CULVERT BACKFILL **6M6 10/15/13**
Revised: April 14, 2020

Description. This work consists of backfilling box culverts or three-sided structures with granular materials. This work shall be performed at locations shown on the plans or as directed by the Engineer.

Materials. Backfilling shall be performed according to Article 502.10. The backfill material shall meet the requirements of Article 1004.05, except the gradation shall be CA-06 or CA-10.

This work satisfies select granular backfill (porous granular material) requirements of ASTM C 1577.

Method of Measurement. Granular culvert backfill will be measured for payment in cubic yards (cubic meters) compacted in place. Additional material required to backfill excavation outside the limits shown on the plans will not be measured for payment.

Basis of Payment. This work shall be paid for at the contract unit price per cubic yard (cubic meter) for GRANULAR CULVERT BACKFILL.

ROCKFILL - FOUNDATION **6M10 6/15/17**
Revised: April 14, 2020

Description. This work consists of constructing a layer of rockfill below culverts or spread footings having unstable or unsuitable soil conditions. When shown on the plans, the rockfill limits and thickness shall be confirmed by the Engineer prior to excavating below the theoretical top of rockfill line.

Materials. Rockfill materials shall meet the requirements of Article 1005.01 of the Standard Specifications. The gradation of rockfill shall be primary crusher run. The maximum dimension shall be 8 inches. Rockfill may contain broken pavement or rock excavation as defined in Article 205.04 and with the approval of the Engineer.

Materials shall meet the requirements of the following Articles of the Standard Specifications:

Bedding or Capping Material	1003.04 or 1004.05

Construction Requirements. The method of rockfill placement shall be approved by the Engineer. Rockfill shall be capped according to application as shown below:

Spread Footing	4 to 6 inches CA-6
Cast-In-Place Box Culverts	4 to 6 inches CA-7 or CA-11
Pre-Cast Box Culverts	Porous Granular Bedding Material (Article 540.02)
Pre-Cast Pipe Culverts	Coarse or Fine Aggregate Bedding (Article 542.04)

Excavation shall be performed according to Section 202 of the Standard Specifications.

In spread footing applications, the CA-6 cap shall be compacted to the satisfaction of the Engineer. No compaction of rockfill is required for culvert applications.

Method of Measurement. This work will be measured for payment in tons (metric tons).

Basis of Payment. This work will be paid for at the contract unit price per ton for ROCKFILL - FOUNDATION. The contract unit price for ROCKFILL-FOUNDATION shall include excavation, aggregate materials, aggregate material placement, and placement of excavated materials within right-of-way or disposal off right-of-way. *Excavation will not be measured or paid for separately or as part of EARTH EXCAVATION.* For precast concrete box culverts, porous granular bedding material and the excavation volume required for bedding will be paid for according to Article 540.08. For pipe culverts, the aggregate bedding material and excavation volume required for the aggregate bedding material will be paid for according to Article 542.11.