STRUCTURE GEOTECHNICAL REPORT

Proposed Retaining Wall

S.N. 043-7011

IL Route 84/U.S. Route 20
(Summit Street)
FAP Route 301
Section 29R-1
Jo Daviess County

PTB 155 - Item 029
IDOT Job No. P92-088-92
Contract No. 64880

Prepared By: Michael T. Haley, P.E., S.E.
Lin Engineering, Ltd.
3261 S. Meadowbrook Rd.
Suite 500
Springfield, IL 62711
(217) 679-2928
mhaley@lineng.com

Date Prepared: 03/20/2015
Date Revised: 06/10/2020

Prepared For: Vincent P. Tabor, P.E., S.E.
Lin Engineering, Ltd.
3261 S. Meadowbrook Rd.
Suite 500
Springfield, IL 62711
(217) 679-2928
vtabor@lineng.com

Exhibits:
A) Location Map
B) Boring Locations
C) Boring Logs
D) Rock Depth Probes
E) Subsurface Data Profile
F) Slope Stability Output
G) Approved TSL

Project Description and Proposed Structure Information

The geotechnical study summarized in this report was performed for the proposed structure number 043-7011 along Summit Street from station 110+74 to station 111+83 in Jo Daviess County, Illinois. The proposed alignment will be used for all stations in the narrative, but the borings and rock depth probes have existing alignment stationing. The retaining wall is part of the reconstruction project for IL Route 84/U.S. Route 20. The purpose of this report is to investigate the subsurface conditions and present design and construction recommendations for the proposed structure. On the USGS Galena quadrangle map, the project site lies in Section 13, Range 1W, Township 28N, in the 4th Principal Meridian. A *Location Map* is presented in Exhibit A.

The proposed structure is located approximately 0.7 miles northwest of the Galena River. The retaining wall ranges from 25 to 39 feet left of the centerline of Summit Street and will be 127'-6" in length. The proposed wall will retain the new embankment resulting from reconstruction of Summit Street to accommodate the local parking lot. The estimated maximum retained height for the structure is 14.6 feet with an average retained height of 9.5 feet. The proposed structure design will follow the LRFD design specifications. In order to construct the retaining wall, lane closure or shoulder closure may be required if the parking lot cannot provide the necessary required work area for construction. A Type B concrete gutter will be provided to ensure proper drainage for the proposed structure.

Existing Information

Lin Engineering conducted a field visit to investigate the existing wall. The retaining wall is located from station 110+65 to 112+14 along existing Summit Street. The structure is retaining soil to provide space for the existing parking lot. The estimated maximum retained height for the structure is 8.0 feet with an average retained height of 5.3 feet. No additional information was provided for the existing retaining wall. Stationing increases from south to north.

Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

This site is located in a historic district in Galena, IL. The combination of residential, commercial, and historic structures in the immediate vicinity may reduce design options in order to limit noise levels and vibrations. Utilities in the vicinity of the proposed retaining wall include, but are not limited to, an underground water main approximately 25 feet southeast of the wall that runs parallel to Summit Street; a manhole whose center is approximately 4.8 feet from the proposed wall and an underground watermain heading southeast from the manhole which connects with the previously mentioned underground water main; and an underground watermain that heads southeast through the wall and connects to the previously mentioned manhole. The subsurface investigation consisted of 3 borings (B-1e, B-2e, and B-3e) drilled by IDOT District 2 personnel in January of 2012 along with an additional subsurface investigation in July of 2015 which consisted of rock depth probing at three locations. The borings were drilled west of the centerline of Summit Street at offset distances ranging from 7 to 40 feet left. A rock core was taken at boring location B-3e.

Beginning at the ground surface, standard penetration tests (SPT) were conducted every 2.5 feet according to AASHTO T 206 using a hollow stem auger drill. Boring B-1e consisted of a silty loam with blow counts ranging from 7 to 44 blows per foot, a Qu value ranging from 0.3 to 2.7 tsf, and a moisture content range from 21 to 30%. Boring B-2e encountered weathered limestone directly beneath the surface and was drilled for 2 feet until refusal. Boring B-3e encountered a thin layer of loam with a blow count of 1 and a Qu value of 0.3 tsf. Directly below the thin layer of loam, dolomite was encountered. Because of the varying offsets and rock elevations encountered, it is recommended to assume that the rock elevation and station are as shown in Table 1 and linear interpolation is recommended for the stations in between.

Station	Elevation
110+81.49	674.1
111+33.96	692.0
111+77.01	697.0

Table 1

According to borings B-2e and B-3e, the rock line elevation ranged from 688.80 to 691.80 feet. Boring B-3e had rock core recoveries of 45% for the first five feet, 75% for the second five feet, and 60% for the third and final five feet. The rock line for boring B-1e was unable to be determined from the January 2012 subsurface investigation with the termination of the boring before reaching any rock, but from the rock depth probing the auger refusal depth was found to be 673.6. Termination of the boring depths ranged from 2 to 16.5 feet below the ground surface. The depth to auger refusal ranged from 2 to 12 ft.

According to the boring logs provided, no groundwater was encountered at the time the drilling took place or 24 hours after completion.

Further descriptions of the soil conditions encountered in the borings and a rock core log for Boring B-3e are presented in the *Boring Logs* attached in Exhibit C and the *Subsurface Data Profile* in Exhibit E. The *Rock Depth Probes* can be found in Exhibit D. Rock depth probe and boring locations can be found in Exhibit B.

Geotechnical Evaluations

Settlement. Primary settlement analysis was performed for concrete cantilever and MSE wall types for various boring locations. The estimated settlements were found to be less than a half inch due to similar existing and proposed embankment heights. The analysis was done assuming preliminary footing elevations, a 10 foot wide footing, and 120 pcf back fill for concrete cantilever wall. If the actual dimensions vary from those assumed for this analysis, settlements shall be checked using actual values.

Slope Stability. Preliminary stability analyses using Bishop's Method were performed using temporary excavation 1:1 (V:H) slope model at multiple locations along the wall using different borings. According to the IDOT Geotechnical Manual, the required factor of safety is 1.7 for cut slopes. Stability checks were performed at various boring locations and the minimum factor of safety was found to be over 6 at all locations. No slope stability issues are expected for the proposed retaining wall. *Slope Stability Output* is presented in Exhibit F.

Liquefaction. Per the IDOT AGMU Memo and Design Guide 10.1 (LRFD Liquefaction Analysis), a liquefaction analysis is not required for Seismic Performance Zone 1.

Retaining Wall Evaluations and Design Recommendations

The maximum retained height is to be approximately 14.6 feet (from bottom-of-wall grade to top-of-wall grade). The soil retained will be a cut area for an expanded parking lot. Feasible wall types include a T-type cantilever wall supported by a spread footing, a soldier pile wall, and a mechanically stabilized earth (MSE) wall. The following considers the feasibility of each retaining wall due to construction constraints of the proposed retaining wall. Considering the soil conditions, wall heights, fill situation and that there is an existing roadway behind the proposed wall, it is expected that the soldier pile wall will be the most appropriate option for construction. However, economic, construction and scheduling factors should be evaluated for the decision of retaining wall design

T-type Concrete Cantilever. A conventional reinforced concrete retaining wall supported on a spread footing appears to be a feasible option for the proposed wall. Preliminary analysis showed that the soil below the footing provided adequate bearing resistance with minimum bearing capacity being approximately 11 ksf. Additionally, settlements of less than a half inch are expected for this wall type, so differential settlement is not expected. However, a cantilever T-type wall will require a temporary soil retention system to accommodate the construction of the wall due to the fact that the sloped excavation would extend beyond the centerline of Summit Street at some locations along the wall. The need for a temporary soil retention system will result in increased costs. The bottom of the footings would need to be placed at a minimum depth of 4 feet below final lowest adjacent grade for frost protection or bear on rock. Rock ranges from depths of 0.0 to 13.8 feet below the proposed ground line at the front face of wall and the wall is 127’-6” feet in length. The footing could bear on rock or soil as long as there is adequate bearing pressure in the soil beneath the footing. The footing should be sized to provide sufficient weight to resist sliding and overturning.

Lateral loads on the wall may be resisted by the frictional resistance between the footings and supporting soil. A Geocomposite Wall Drain should be placed over the entire length of the back face of the wall and either connected to a perforated drain pipe in accordance with IDOT Bridge Manual or weep holes should be added and spaced at 8 foot centers.

Mechanically Stabilized Earth (MSE) Wall. The MSE wall does not appear to be a viable option. An MSE wall will require a temporary soil retention system to accommodate the construction of the wall due to the fact that the sloped excavation would extend beyond the centerline of Summit Street at some locations along the wall. This will result in increased costs.

Soldier Pile Wall. A soldier pile wall appears to be the most suitable option because of the cut situation. The soil parameters shown in Table 2 are recommended for the design of the soldier pile wall. The parameters were determined based on the soil conditions encountered in the soil borings. The design of the soldier pile wall should disregard the top 3 feet of soil in front of the wall to account for excavation required for concrete facing and drainage system. The drainage behind the wall should be designed in accordance with 2012 IDOT Bridge Manual. A Geotechnical Design Memorandum will be required in the design phase if the solider pile wall option is chosen. If the solider pile option is

chosen, drilled soldier piles are recommended due to the close proximity of historical structures and shallow rock depth.

Soil Type	Moist Unit Weight (pcf)	Cohesion Cu (psf)	Friction Angle, φ (deg)	Estimated Soil Modulus k (pci)	Estimated Soil Strain Parameter, E50
Soft Sandy Loam	108	300	24.6	30	0.02
Soft Silty Loam	108	300	29.9	30	0.02
Medium Silty Loam	120	900	38.5	100	0.01
Medium Silty Clay Loam	121	1000	29.9	100	0.01
Stiff Silty Clay Loam	127	1700	27.0	500	0.007
Weathered Limestone	144	-	44.0	-	-

Table 2

Construction Considerations

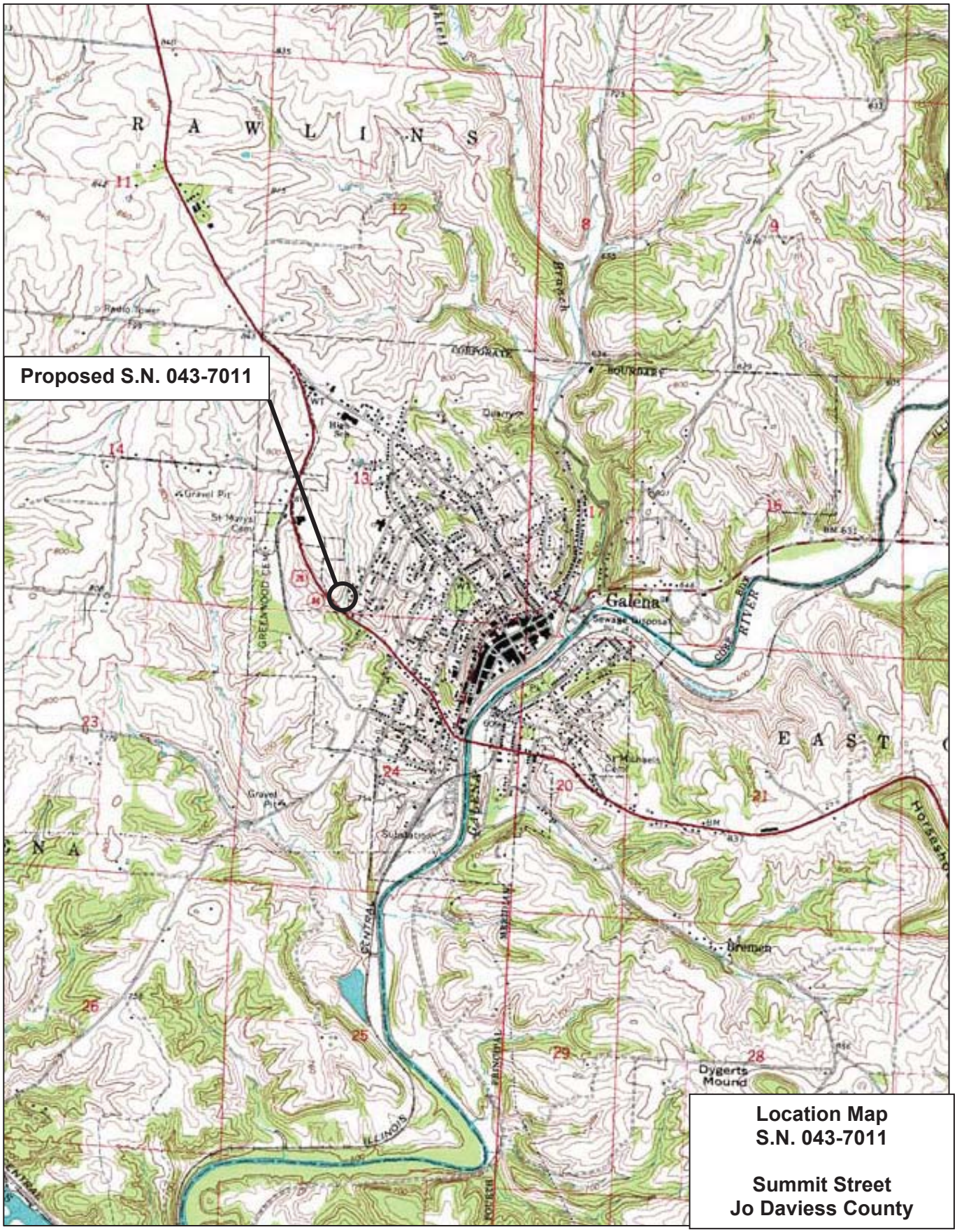
Excavation. If excavation for the proposed improvements is in excess of 4 feet, a 1:1 (V:H) temporary excavation slope has an adequate factor of safety. A steeper slope should not be used. If there is not enough room to provide a 1:1 (V:H) due to the proximity of the centerline of Summit Street, a temporary soil retention system would be required. Movement of adjacent soils near the edge of and into excavation areas should be prevented. All excavations should be performed in accordance with the latest Occupational Safety and Health Administration (OSHA) requirements. If precipitation or perched water is allowed to enter the excavated area, it should be immediately removed via sump-pump. Any soil allowed to soften in standing water should be removed and replaced with structural fill material.

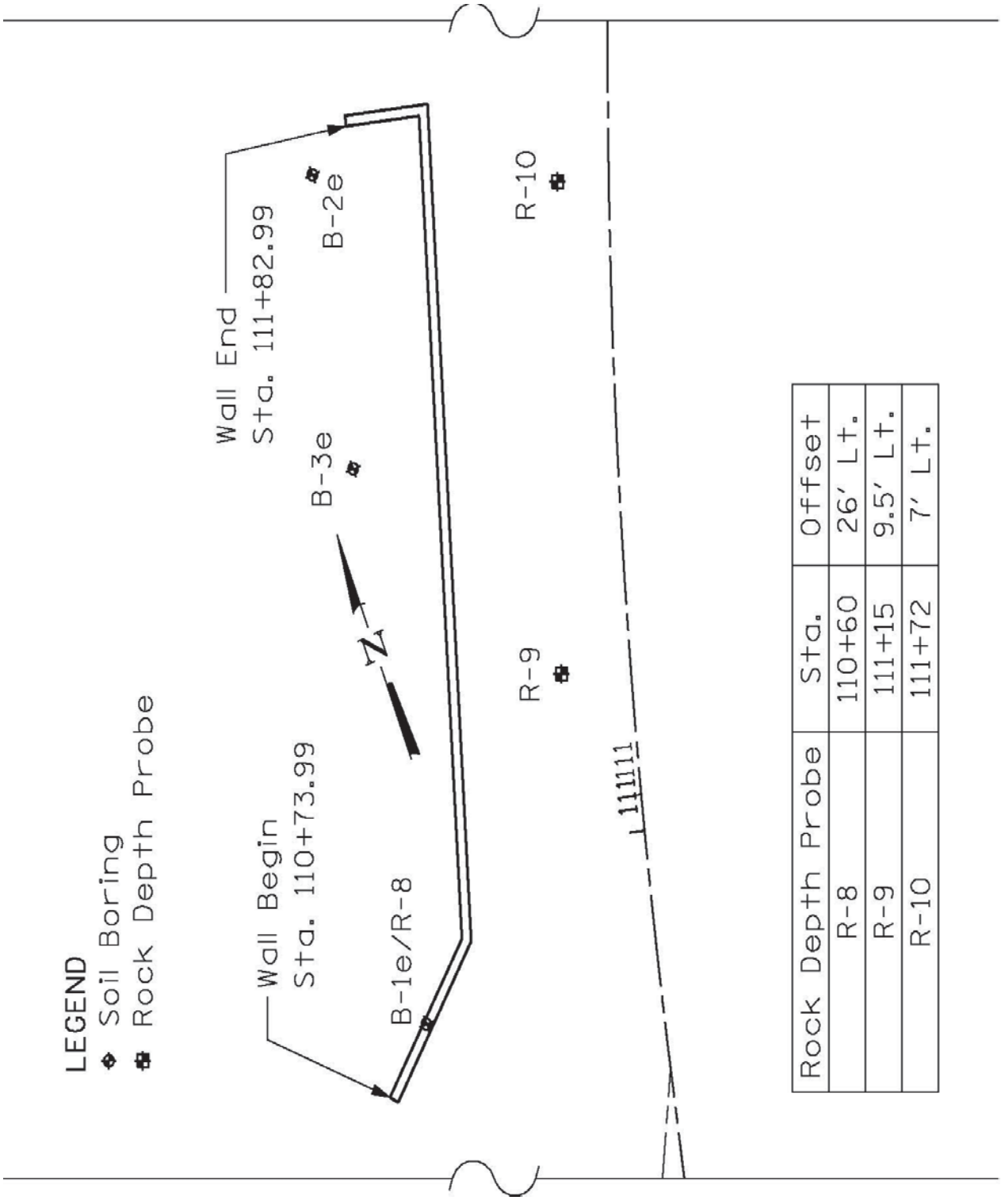
Backfill. If backfill materials are required, they must be pre-approved by the Resident Engineer. To backfill the retaining walls, we recommend Porous Granular Embankment in accordance with the IDOT Standard Specifications Section 207. Back fill material should be placed and compacted in accordance with the specification.

Ground Improvement. No ground improvement is anticipated at this location.

Limitations

The recommendations provided herein are for the exclusive use of IDOT and Lin Engineering, Ltd. They are specific only to the project described, and are based on subsurface information obtained at boring locations within the retaining wall area, our understanding of the project as described herein, and geotechnical engineering practice consistent with the standard of care. No other warranty is expressed or implied. Lin Engineering, Ltd. should be contacted if conditions encountered during construction are not consistent with those described.


Proposed S.N. 043-7011
R A W L I N S
Galena
E A S T
Dygerts Mound
Location Map
S.N. 043-7011
Summit Street
Jo Daviess County



Rock Depth Probe	Sta.	Offset
R-8	110+60	26' Lt.
R-9	111+15	9.5' Lt.
R-10	111+72	7' Lt.

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation/D-2

SOIL BORING LOG

Page 1 of 1

Date 1/12/12

ROUTE FA 301 DESCRIPTION P92-088-92 Retaining Wall #3: Summit Street, Gear Street to High Street LOGGED BY Be. Wetzell

SECTION 29X-T LOCATION W. Galena Twp. - 13NW, SEC. , TWP. 28N, RNG. 1W

COUNTY JoDaviess DRILLING METHOD Hollow Stem Auger HAMMER TYPE CME-45 Automatic

STRUCT. NO.
Station 111+25

BORING NO. B-1e
Station 110+60
Offset 26.00ft Lt
Ground Surface Elev. 685.60 ft

Surface Water Elev. ft
Stream Bed Elev. ft

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

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
STIFF brown SILTY CLAY LOAM			1.1 P	24.0
683.60		3		
STIFF brown SILTY CLAY LOAM		3 5	2.7 P	24.0
682.10				
MEDIUM brown SILTY CLAY LOAM	-5	3		
		3 4	1.0 P	28.0
679.60				
SOFT brown SILTY LOAM		1		
		2 5	0.3 P	30.0
677.10				
MEDIUM tan SILTY LOAM	-10	1		
		9 35	0.9 P	21.0
674.60				
End of Boring	-15			
	-20			

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

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation/D-2

SOIL BORING LOG

Page 1 of 1

Date 1/12/12

ROUTE FA 301 DESCRIPTION P92-088-92 Retaining Wall #3: Summit Street, Gear Street to High Street LOGGED BY Be. Wetzell

SECTION 29X-T LOCATION W. Galena Twp. - 13NW, SEC. , TWP. 28N, RNG. 1W

COUNTY JoDaviess DRILLING METHOD Hollow Stem Auger HAMMER TYPE CME-45 Automatic

STRUCT. NO.
Station 111+25

BORING NO. B-2e
Station 111+75
Offset 40.00ft Lt
Ground Surface Elev. 691.80 ft

Surface Water Elev. ft
Stream Bed Elev. ft

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

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	
				Weathered LIMESTONE
				Auger Refusal @ 2'
				689.80 End of Boring
-5				
-10				
-15				
-20				

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

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation/D-2

SOIL BORING LOG

Page 1 of 1

Date 1/17/12

ROUTE FA 301 DESCRIPTION P92-088-92 Retaining Wall #3: Summit Street, Gear Street to High Street LOGGED BY By. Wetzell

SECTION 29X-T LOCATION W. Galena Twp. - 13NW, SEC. , TWP. 28N, RNG. 1W

COUNTY JoDaviess DRILLING METHOD Hollow Stem Auger HAMMER TYPE CME-45 Automatic

STRUCT. NO.
Station 111+25

BORING NO. B-3e
Station 111+40
Offset 35.00ft Lt
Ground Surface Elev. 690.30 ft

Surface Water Elev. ft
Stream Bed Elev. ft

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

DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)	
SOFT brown SANDY LOAM				
688.80		0.3 P		
Borehole continued with rock coring.				
-5				
-10				
-15				
-20				

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

BBS, from 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
Illinois Department of Transportation/D-2

ROCK CORE LOG

Page 1 of 1

Date 1/17/12

ROUTE FA 301 DESCRIPTION P92-088-92 Retaining Wall #3: Summit Street, Gear Street to High Street LOGGED BY By. Wetzell

SECTION 29X-T LOCATION W. Galena Twp. - 13NW, SEC. , TWP. 28N, RNG. 1W

COUNTY JoDaviess CORING METHOD

STRUCT. NO.
Station 111+25

CORING BARREL TYPE & SIZE

Core Diameter 2 in
Top of Rock Elev. 688.80 ft
Begin Core Elev. 688.80 ft

BORING NO. B-3e
Station 111+40
Offset 35.00ft Lt
Ground Surface Elev. 690.30 ft

	DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Dolomite: tan-buff, mostly pitted, sometimes vuggy, very finely crystalline, dense, severely fractured. No testable segments.	688.80	1	45	8	1.2	
	-5					
Dolomite: as above. T.S.F.: 683.8 to 681.8	683.80	2	75	17	2	642.0
	-10					
Dolomite: as above. T.S.F.: 676.3 to 673.8	678.80	3	60	22	1.2	469.0
	-15					
End of Boring	673.80					
	-20					

Color pictures of the cores
Cores will be stored for examination until
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

Illinois Department of Transportation

Soil Survey Data

Project:
Route: US 20
Section: 29R-1
County Jo Daviess

Logged By: Wally Garza

Date: 7/30/15		**Sta.:** 1219+45 (Elev. 661.5)				**Offset:** 22' Lt of CL
Depth	**Sample No.**	**Soil Type**	**Water**	**Can No.**	**Qu**	**Description of Soil Layer** (Color, Moisture, Strength, Etc.)
1						
2						1st Encounter – 659.5
3						
4						Auger Refusal @ 659.5
5						
6						
7						
8						
9						
10						

Date: 7/31/15 B-1e		**Sta.:** B-1e (Elev. 685.6)				**Offset:** Same Hole
Depth	**Sample No.**	**Soil Type**	**Water**	**Can No.**	**Qu**	**Description of Soil Layer** (Color, Moisture, Strength, Etc.)
1						
2						1st Encounter – 674.1
3						
4						Auger Refusal @ 673.6
5						
6						
7						
8						
9						
10						

Date: 7/30/15		**Sta.:** 111+15 (Elev. 696.7)				**Offset:** 9.5' Lt
Depth	**Sample No.**	**Soil Type**	**Water**	**Can No.**	**Qu**	**Description of Soil Layer** (Color, Moisture, Strength, Etc.)
1						
2						1st Encounter @ 695.2
3						
4						Auger Refusal @ 694.2
5						
6						
7						8" Asphalt
8						
9						
10						

Qu: 0-.25 Very Soft; .25-.5 Soft; .5-1.0 Medium; 1.0-2.0 Stiff; 2.0-4.0 Very Stiff; >4.0 Hard jt9-1-15-1

Page 3

Illinois Department of Transportation

Soil Survey Data

Project:
Route: US 20
Section: 29R-1
County Jo Daviess

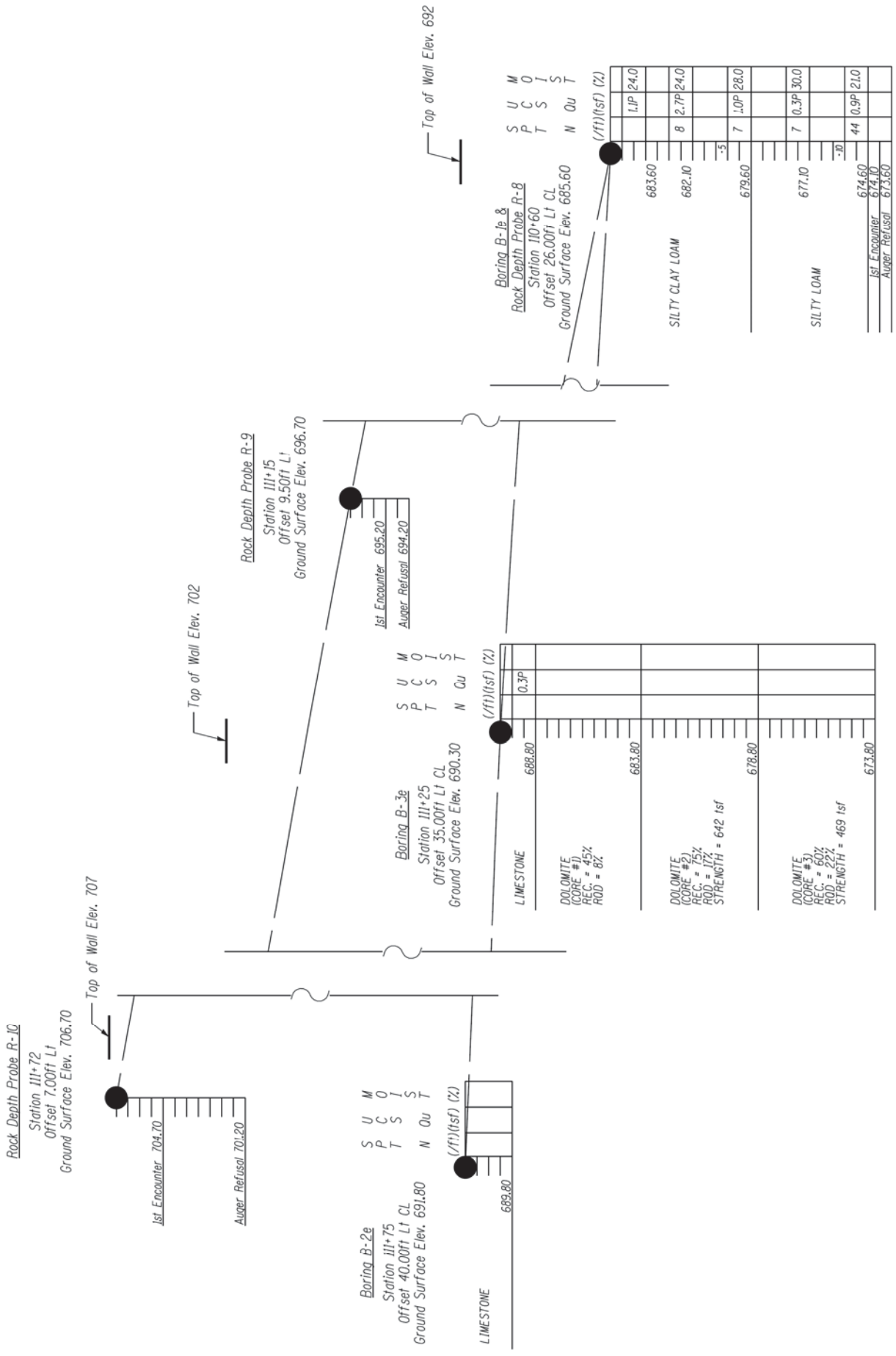
Logged By: Wally Garza

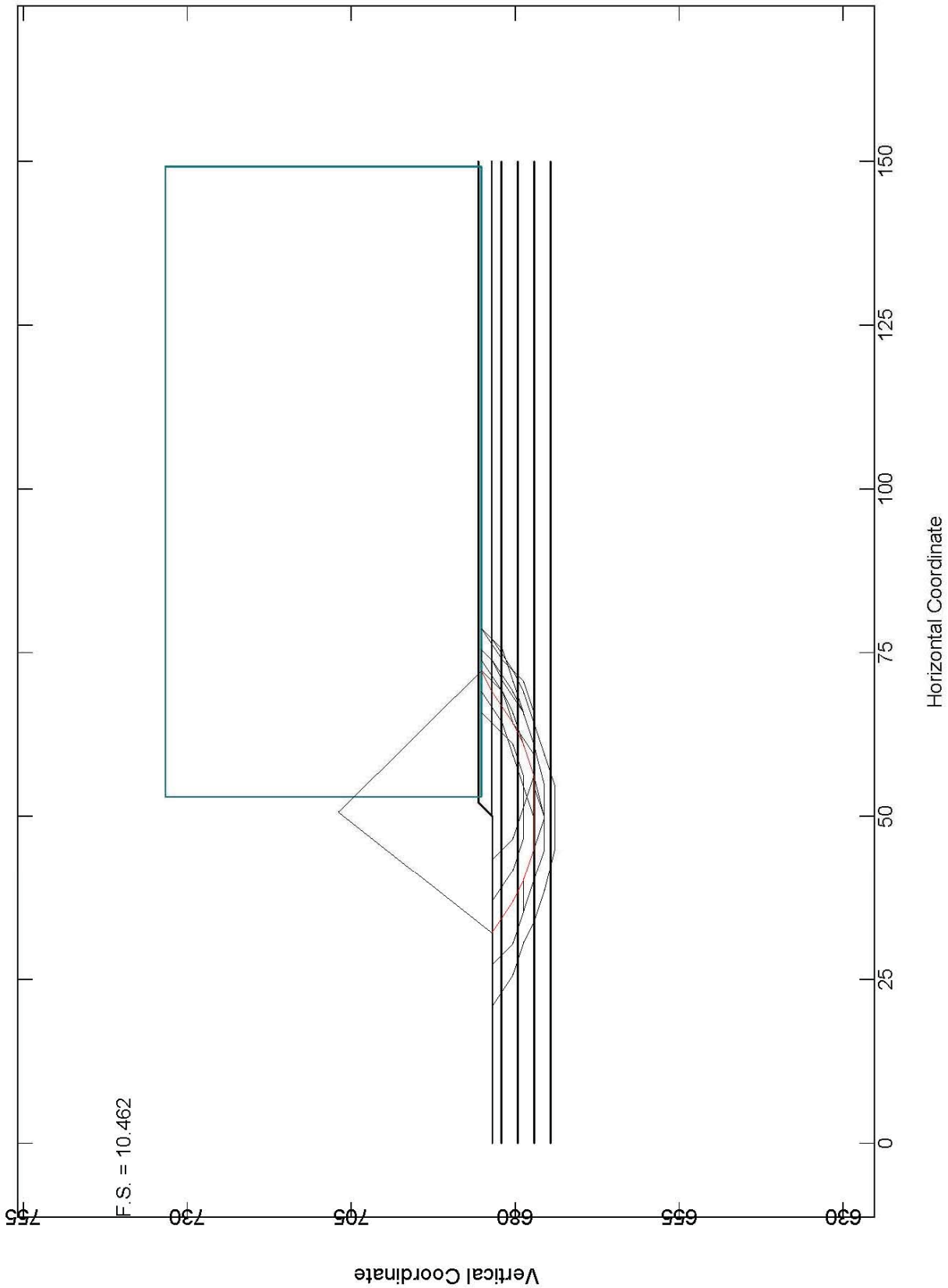
Date: 7/30/15		**Sta.:** 111+72 (Elev. 706.7)				**Offset:** 7' Lt
Depth	**Sample No.**	**Soil Type**	**Water**	**Can No.**	**Qu**	**Description of Soil Layer** (Color, Moisture, Strength, Etc.)
1						
2						1st Encounter – 704.7
3						
4						Auger Refusal @ 701.2
5						
6						
7						8" Asphalt
8						
9						
10						

Qu: 0-.25 Very Soft; .25-.5 Soft; .5-1.0 Medium; 1.0-2.0 Stiff; 2.0-4.0 Very Stiff; >4.0 Hard jt9-1-15-1

Jt9-1-15-1 Soil Survey Data US 20

Page 4


Top of Wall Elev. 692
Boring B-1e &
Rock Depth Probe R-8
Station 110+60
Offset 26.00ft Lt CL
Ground Surface Elev. 685.60
S U M
P C O
T S I S
N Qu T
(/ft)(tsf) (%)
1.1P 24.0
2.7P 24.0
8
-5
1.0P 28.0
7
0.3P 30.0
7
-10
0.9P 21.0
44
683.60
SILTY CLAY LOAM
682.10
679.60
677.10
SILTY LOAM
674.60
1st Encounter 674.10
Auger Refusal 673.60
Top of Wall Elev. 702
Rock Depth Probe R-9
Station 111+15
Offset 9.50ft Lt
Ground Surface Elev. 696.70
1st Encounter 695.20
Auger Refusal 694.20
Boring B-3e
Station 111+25
Offset 35.00ft Lt CL
Ground Surface Elev. 690.30
S U M
P C O
T S I S
N Qu T
(/ft)(tsf) (%)
0.3P
688.80
LIMESTONE
DOLOMITE
(CORE #1)
REC. = 45%
ROD = 8%
683.80
DOLOMITE
(CORE #2)
REC. = 75%
ROD = 11%
STRENGTH = 642 tsf
678.80
DOLOMITE
(CORE #3)
REC. = 60%
ROD = 22%
STRENGTH = 469 tsf
673.80
Top of Wall Elev. 707
Rock Depth Probe R-10
Station 111+72
Offset 7.00ft Lt
Ground Surface Elev. 706.70
1st Encounter 704.70
Auger Refusal 701.20
Boring B-2e
Station 111+75
Offset 40.00ft Lt CL
Ground Surface Elev. 691.80
S U M
P C O
T S I S
N Qu T
(/ft)(tsf) (%)
689.80
LIMESTONE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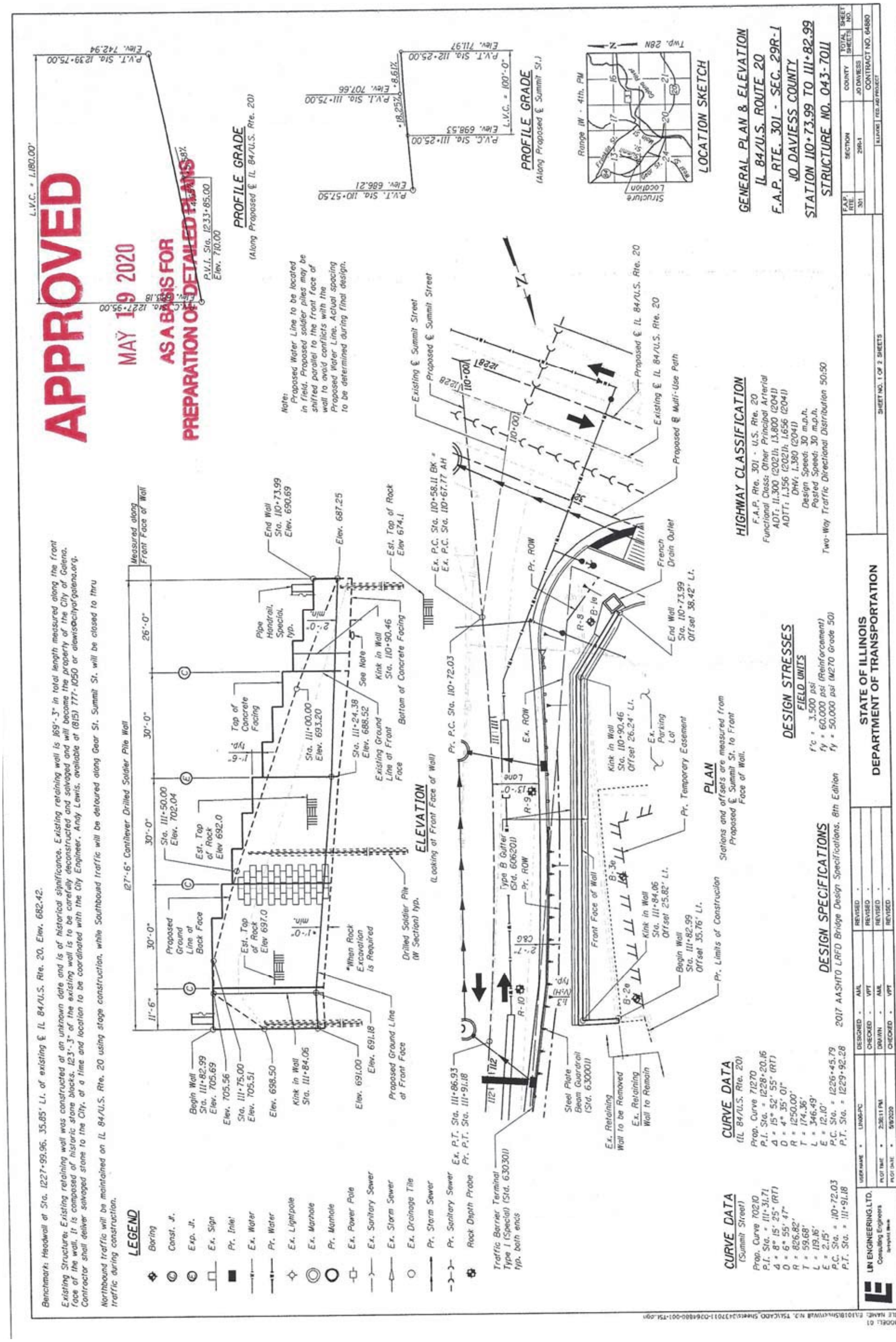
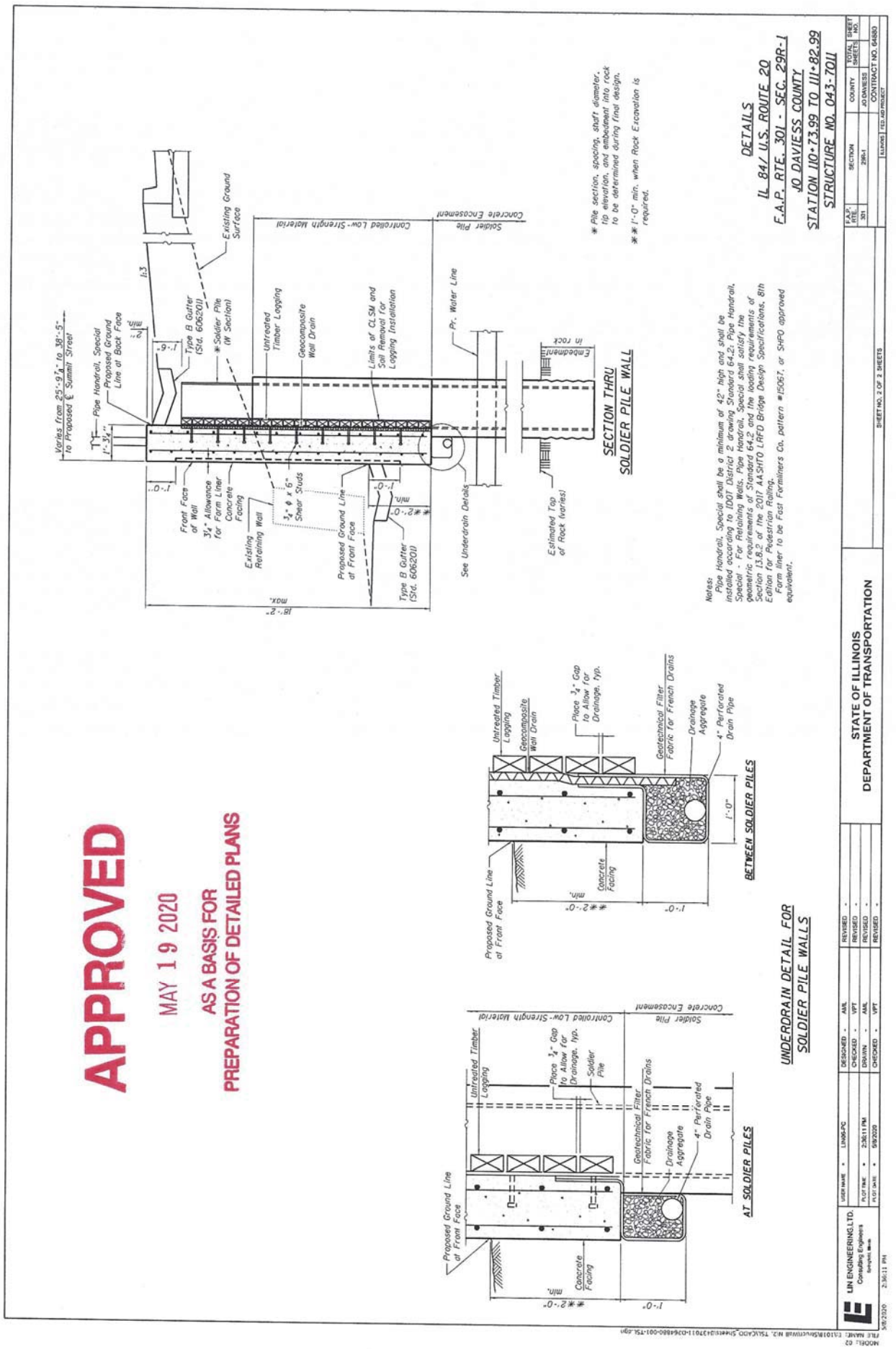

APPROVED
MAY 19 2020
AS A BASIS FOR PREPARATION OF DETAILED PLANS
GENERAL PLAN & ELEVATION
IL 84/U.S. ROUTE 20
F.A.P. RTE. 301 - SEC. 29R-1
JO DAVIESS COUNTY
STATION 110+73.99 TO 111+82.99
STRUCTURE NO. 043-7011
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION


APPROVED
MAY 19 2020
AS A BASIS FOR
PREPARATION OF DETAILED PLANS
SECTION THRU
SOLDIER PILE WALL
UNDERDRAIN DETAIL FOR
SOLDIER PILE WALLS
BETWEEN SOLDIER PILES
AT SOLDIER PILES
DETAILS
IL 84/ U.S. ROUTE 20
F.A.P. RTE. 301 - SEC. 29R-1
JO DAVIESS COUNTY
STATION 110+73.99 TO 111+82.99
STRUCTURE NO. 043-7011
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION
LIN ENGINEERING LTD.
Consulting Engineers
Notes:
Pipe Handrail, Special shall be a minimum of 42" high and shall be installed according to IDOT District 2 drawing Standard 64.2; Pipe Handrail, Special - For Retaining Walls. Pipe Handrail, Special shall satisfy the geometric requirements of Standard 64.2 and the loading requirements of Section 13.8.2 of the 2017 AASHTO LRFD Bridge Design Specifications, 8th Edition for Pedestrian Railing.
Form liner to be Fast Formliners Co. pattern #15067, or SHPO approved equivalent.
* Pile section, spacing, shaft diameter, tip elevation, and embedment into rock to be determined during final design.
** 1'-0" min. when Rock Excavation is required.