STRUCTURE GEOTECHNICAL REPORT
ILLINOIS ROUTE 176 WEST
RETAINING WALL ALONG COMED FACILITY
MCHENRY COUNTY, ILLINOIS

For
Strand Associates, Inc.

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Submitted by

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11. Abstract

A new retaining wall is proposed along westbound Illinois Route 176 West to support a new 8.0-foot wide multi-use path. The wall will be about 645.0 feet long, extending from Station 408+50 to Station 414+95. The face of the wall will be constructed about 85.0 feet north of the IL 176 West centerline. The wall will have a maximum exposed height of 9.0 feet. This report provides geotechnical recommendations for the design and construction of the proposed retaining wall.

Along the proposed wall alignment, the foundation soils consists of up to 6.5 feet of stiff to hard silty clay to silty clay loam and clay loam fill overlying natural stiff to hard silty clay to silty clay loam. Groundwater was recorded during the investigation at elevations of 904 to 881 feet.

The proposed retaining wall will be in a combination of cut and fill sections. A soldier-pile wall type is proposed at the site. The designer was initially considering a Segmental Concrete Block Wall type. Fill wall types such as Mechanically Stabilized Earth (MSE), Reinforced Concrete Cantilever (RCC), and Segmental Concrete Block walls will require additional open cut excavations into the existing embankment slope and possibly a temporary soil retention system. Non-gravity wall types such as sheet pile or soldier pile walls could be considered as they are more suitable in cut sections.

Geotechnical parameters for the design and construction of cantilevered pile walls are provided. Foundation treatment recommendations are also provided for the fill wall types. With the recommended treatment, we estimate the foundation soils will provide maximum factored bearing resistances of 5,200 and 3,600 psf for the design of MSE/Segmental Concrete Block and RCC walls, respectively. The foundation soils will undergo estimated long-term settlements of less than 1.0 inch. The eccentricity lies within the middle two-thirds of the wall and the resistance against overturning is sufficient. Minimum cantilevered pile embedment depths necessary to achieve a minimum factor of safety for global stability are provided.

Permanent sheet piling may be difficult to drive between elevations of 901 to 896 feet due to the presence of cohesive soils with unconfined compressive strength values of greater than 4.5 tsf. The drilled soldier construction should expect hard drilling conditions in certain areas along the wall as discussed in the report. The construction of the MSE, RCC, and Segmental Concrete Block walls will require temporary dewatering efforts and possibly temporary soil retention systems.

12. Path to archived file

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TABLE OF CONTENTS

EXHIBITS

1. Site Location Map

2. Site and Regional Geology

3. Boring Location Plan

4. Soil Profile

APPENDIX A

Boring Logs

APPENDIX B

Laboratory Test Results

APPENDIX C

Global Stability Analysis

APPENDIX D

General Plan and Elevation

List of Tables

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STRUCTURE GEOTECHNICAL REPORT
ILLINOIS ROUTE 176 WEST
RETAINING WALL ALONG COMED FACILITY
MCHENRY COUNTY, ILLINOIS
FOR
STRAND ASSOCIATES, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and geotechnical engineering evaluations in support of a new retaining wall proposed along westbound Illinois Route 176 West (IL 176 West) about 1,200 feet west of the intersection of IL 176 and Illinois Route 47 (IL 47). The proposed structure is part of the widening and reconstruction of a 1.65-mile long section of IL 47 between Station 565+80 and Station 653+00 in McHenry County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Based on the information provided by Strand Associates, Inc. (Strand) and the in-progress *General Plan and Elevation (GPE)* drawings dated September 9, 2020, Wang Engineering, Inc. (Wang) understands the proposed retaining wall will measure about 645.0 feet in length, extending along IL 176 West from Station 408+50 to Station 414+95, adjacent to a ComEd facility. The face of the wall will be constructed at an average distance of about 85 feet north of the existing IL176 West centerline. The wall will support a new 8.0-foot wide multi use path to be constructed along westbound IL 176 West. A soldier-pile wall type is currently shown on the in-progress GPE sheets. We also understand from Strand that a Segmental Concrete Block wall type was initially under consideration. Based on the drawings, we estimate the wall will have a maximum exposed height of approximately 9.0 feet at Station 414+95.

1.2 Existing Structure and Land Use

There is no existing structure at the proposed retaining wall site. The area adjacent to the proposed wall is currently a ComEd facility. Prior to 2002, the area was an agricultural field. The wall is proposed along the grassy area south of the limits of the ComEd facility.

The purpose of this investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide recommendations for the design and construction of the proposed retaining wall.

2.0 SITE AND REGIONAL GEOLOGY

The project area is located in Dorr Township in McHenry County, Illinois. On the USGS Woodstock 7.5 Minute Series Quadrangle map, the retaining wall is located in SE ¼ of Section 29, Tier 44 N, Range 7 E of the Third Principal Meridian.

The following review of published geologic data, with emphasis on factors that might influence the design and construction of the proposed engineering works, is meant to place the project area within a geological framework and confirm the dependability and consistency of the subsurface investigation results. For the study of the regional geologic framework, Wang considered northeastern Illinois in general and McHenry County in particular. Exhibit 2 illustrates the *Site and Regional Geology*.

2.1 Physiography

The Wheaton Morainal Country Physiographic Subsection (Leighton et al. 1948) dominates the eastern two thirds of McHenry County. The project site runs along the Barlina Moraine at the limit with one of the former outwash valleys carved by glacial meltwater through the moraine. The morainic surface is marked by kettle depressions left behind by ice blocks that were, in time, filled with lacustrine and organic sediments giving the topography a hummocky look.

In general, the relief within the project area is flat and occasionally hummocky. About 500 yards southeast of the project, the Kishwaukee River crosses IL 47 and flows from east to west, through a channel about 20-foot wide. The existing surface elevation varies from as low as 900 feet to as high as 915 feet.

2.2 Surficial Cover

The project area was shaped during the Wisconsin-age glaciation and about 200-foot thick overburden covers the bedrock. The glacigenic deposits were emplaced during pulsating advances and retreats of an icesheet lobe responsible for the formation of end moraines and associated low-relief till and lake plains (Hansel and Johnson 1996). The surficial cover within the project area consists of silty clayey diamicton of the Yorkville Member of the Lemont Formation resting over gravelly sand outwash of the Henry Formation, which in turn overlies the loamy diamicton of the Tiskilwa Formation. The Tiskilwa Formation diamicton rests over Illinois-age, loamy and sandy diamicton of the Glasford Formation.

The Yorkville Member of the Lemont Formation, up to 40 feet thick, consists of yellowish brown to gray silty clay to silty clay loam diamicton that contains lenses of gravel, sand, silt, and clay (Hansel and Johnson 1996, Curry and Thomason 2012). The Henry Formation consists of stratified sand and gravel outwash with thicknesses of about 15 feet (Curry and Thomason 2012). The Tiskilwa Formation, about 60 feet thick, consists of calcareous reddish brown to gray clay loam, loam to sandy loam diamicton that contains lenses of gavel, sand, silt, and clay (Wickham et al. 1988, Curry and Thomason 2012). The Tiskilwa Formation diamicton rests over the Illinois-age drift of the Glasford Formation about 75-foot thick, which in turn unconformably rests over the Silurian-age dolostone (Curry and Thomason 2012). The diamicton accounts for about 80% of the soil profile.

From a geotechnical viewpoint, the Yorkville Member characterized by low to moderate plasticity, high strength, and low to moderate moisture content and the Tiskilwa Formation characterized by low plasticity, medium to high strength, low moisture content, moderately to highly pebbly (Wickham et al. 1988, Bauer et al. 1991).

2.3 Bedrock

In McHenry County, the surficial cover rests unconformably on top of Silurian-age and Ordovician-age bedrock. The top of the bedrock lies about 190 to 200 feet below the ground surface (bgs). Structurally, the site is located on the eastern flank of the Wisconsin Arch (Willman 1971). No active faults or underground mines are known in the area.

Our subsurface investigation results fit into the local geologic context. The borings drilled in the project area encountered native sediments consisting of occasionally lacustrine clay and silt of the Equality Formation and silty clay diamicton of the Yorkville Member of the Lemont Formation and loamy diamicton of the Tiskilwa Formation. None of the borings were deep enough to encounter bedrock.

3.0 METHODS OF INVESTIGATION

The following sections outline the subsurface and laboratory investigations performed by Wang.

3.1 Field Investigation

The subsurface investigation along the wall alignment consisted of ten structure borings, designated as RWB-01 through RWB-10, drilled by Wang in June and July of 2020. The borings were drilled from elevations of 906.8 to 912.3 feet to depths of 30 feet below the ground surface (bgs). The as-drilled northings and eastings were acquired with a mapping-grade GPS unit and boring elevations were surveyed with a level. Stations and offsets were measured from drawings provided by Strand. The boring location information is included in the *Boring Logs* (Appendix A) and the as-drilled locations are shown in the *Boring Location Plan* (Exhibit 3).

An ATV-mounted drilling rig equipped with hollow stem augers was used to advance and maintain open boreholes. Soil sampling was performed according to AASHTO T 206, "*Penetration Test and Split Barrel Sampling of Soils*". The soil was sampled at 2.5-foot intervals to the boring termination depths. Soil samples collected from each sampling interval were placed in sealed jars and transported to the laboratory for further examination and laboratory testing.

Field boring logs, prepared and maintained by a Wang field engineer, included lithological descriptions, visual-manual soil classifications, pocket penetrometer and Rimac unconfined compressive strength tests, and results of field standard penetration test (SPT) results recorded as blows per 6 inches of penetration.

Groundwater levels were measured while drilling and at completion of each boring. At each boring location, the boreholes were backfilled upon completion with soil cuttings and/or bentonite chips, and the surface was restored as close as possible to its original condition.

3.2 Laboratory Testing

Soil samples were tested in our laboratory for moisture content (AASHTO T 265). Atterberg limits (AASHTO T 89/90) and particle size (AASHTO T 88) analysis was performed on selected samples. Field visual descriptions of soil samples were verified in the laboratory and index tested soils were classified according to the IDH Soil Classification System. The laboratory test results are shown in the *Boring Logs* (Appendix A) and *Laboratory Test Results* (Appendix B).

4.0 INVESTIGATION RESULTS

Detailed descriptions of the soil conditions encountered during the subsurface investigation are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profile* (Exhibit 4). Please note that strata contact lines represent approximate boundaries between soil types. The actual transition between soil types in the field may be gradual in horizontal and vertical directions.

4.1 Lithological Profile

The borings encountered 3 to 15 inches of black and brown, silty clay to silty clay loam topsoil at the surface. In descending order, the general lithologic succession encountered beneath the topsoil includes: 1) man-made ground (fill) and 2) stiff to hard silty clay to silty clay loam.

(1) Man-made ground (fill)

Underneath the topsoil, the borings encountered 0.5 to 6.5 feet of fill materials. The fill consists of medium stiff to hard, black, brown, and gray silty clay to silty clay loam and clay loam. The cohesive fill has unconfined compressive strength (Q_u) values of 0.9 to 5.2 tsf and moisture content values of 12 to 24%. Laboratory index testing on a sample of the cohesive fill revealed liquid limit (L_L) and plastic limit (P_L) values of 32 and 16%, respectively.

A 7- to 30-inch thick layer of black and brown silty clay to silty clay loam buried topsoil was sampled in Borings RWB-01 to RWB-07 and RWB-09. The presence of this layer possibly indicates the boundary between native soils and fill materials at the site.

(2) Stiff to hard silty clay to silty clay loam

Beneath the fill and buried topsoil, at elevations of 907 to 904 feet (1.0 to 8.0 feet bgs), the borings advanced through stiff to hard, brown to gray silty clay to silty clay loam with Q_u values of 1.2 to 6.4 tsf and moisture content values of 11 to 24% with wet to saturated silt, sand, sandy loam to loam, and silty loam interbeds characterized by N values of 9 to 12 blows per foot and moisture contents of 12 to 16%. This unit is the predominate foundation soil type beneath the proposed retaining wall and was encountered to the boring termination depths.

At elevations of 905 to 902 feet, beneath the buried topsoil, a 1.0- to 4.0-foot thick layer of medium stiff to stiff, brown and gray clay to silty clay loam was sampled in Borings RWB-01, RWB-02, RWB-04, and RWB-10. This layer has Q_u values of 0.6 to 1.5 tsf and moisture content values of 20 to 38%. Laboratory index testing on a sample from this layer revealed L_L) and P_L values of 30 and 17%, respectively.

Hard drilling conditions and frequent rig chatter was noted in Boring RWB-04 at elevations of 892 to 884 feet (20.0 to 28.5 feet bgs) which indicates the possible presence of cobbles and boulders.

4.2 Groundwater Conditions

Groundwater was encountered while drilling at elevations of 904 to 881 (3.5 to 27.0 feet bgs). At the completion of drilling, the groundwater was observed in Boring RWB-01 at an elevation of 891 feet (20.0 feet bgs). The silt, sand, and sandy loam to loam samples from **Layer 2** were encountered moist to wet. The samples did not indicate the presence of a permanent phreatic surface; however, they do indicate that during certain periods of precipitation, groundwater should be expected at these depths. It should be noted that groundwater levels might change with seasonal rainfall patterns and long-term climate fluctuations or may be influenced by local site conditions.

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

The retaining wall will support a new 8.0-foot wide multi-use path proposed along westbound IL 176 West. Based on the GPE and cross-sections (Appendix E), the wall will have a total length of 645.0 feet and a maximum exposed height of 9.0 feet near Station 414+95. As part of the improvements proposed along IL176 West, we understand the existing embankment north of the edge of the westbound IL 176 West lane will be regraded to create a drainage ditch and embankment cuts of up to 12.0 feet are anticipated. The proposed wall will be cut into the existing embankment with the remaining embankment behind the wall graded at a horizontal slope. The new embankment resulting from the cut in front of the wall will be graded at a slope of 1:3 (V: H). As such, the wall is a combination of cut and fill.

We understand a segmental concrete block wall type was initially considered by the designer. Fill wall types, such as Mechanically Stabilized Earth (MSE), Reinforced Concrete Cantilever (RCC), and Segmental Concrete Block walls would require large open cut excavations into the exiting embankment slope, temporary soil retention systems, and will impact the existing IL 176 West roadway. The construction of these wall types would likely also require more backfilling thus longer construction time. In our opinion, non-gravity wall types such as a sheet pile or soldier pile type wall would be more appropriate considering the soil conditions, constructability, and cost. The final wall type should be selected based on a wall-type study including cost and construction considerations. Recommendations for the design and construction of these wall types are discussed in the following sections.

5.1 Seismic Design Considerations

Seismic design is not required for retaining wall structures located in Seismic Performance Zone (SPZ) 1 in accordance with the IDOT *Bridge Manual* (2012).

5.2 Sheet Pile or Soldier Pile and Lagging Wall

Both sheet pile or soldier pile wall types could be considered at this location. If soldier piles are designed to support the wall, they could be installed either by driving or by setting them within prebored holes with diameters sized in accordance with IDOT criteria. The chosen system should be designed for both lateral earth pressure and lateral deformation. The embedment depth in moment equilibrium for the wall sections should be designed in accordance with the AASHTO LRFD guidelines (AASHTO 2017). It should be noted that sheet piles driven to a pile tip elevation extending below elevations of 901 to 896 feet will not be feasible due to potential difficulty of driving the sheet piles in cohesive soils with unconfined compressive strength values of greater than 4.5 tsf.

Generally, both granular soils and overconsolidated clayey soils, such as the stiff to hard silty clay to silty clay loam encountered in the borings will exhibit lower overall shear strength in the long-term condition. Therefore, in accordance with AASHTO (2017), the lateral earth pressure analysis should be performed for walls in the long-term (drained) condition using the soil parameters recommended in Tables 1 and 2 based on station limits. Elevations provided in the table are based on the average layer elevations across the soil profile and may vary from one boring location to another. The active and passive earth pressure coefficients are provided for straight backfill behind the wall and a slope of 1:3 (V: H) in front of the wall.

The design of the wall should ignore 3.0 feet of soil in front of the wall measured from the finished ground surface elevation in providing passive pressure due to excavations required for installation of concrete facing, drainage systems, and frost-heave conditions. In developing the design lateral pressure, the pressure due to construction equipment surcharge loads should be added to the lateral earth pressure. Drainage behind the wall should be in accordance with IDOT guidelines (IDOT 2012). The water pressures should be added to the earth pressure if drainage is not provided.

Table 1: Drained Geotechnical Parameters for Design of Cantilevered Pile Walls
Station 408+50 to Station 411+13 (Reference Borings RWB-01 to RWB-04)

Soil Description Average Elevation (feet)	Unit Weight γ (pcf)	Drained Shear Strength Properties		Earth Pressure Coefficients	
		Cohesion (psf)	Friction Angle (°)	Active Pressure (straight)	Passive Pressure (1V:3H)
Stiff to Hard SI CL to SI CL LOAM FILL Surface to Elevation 906 feet	120	100	30	0.33	2.38
Medium Stiff CLAY to SI CLAY Elevation 906 to 901 feet	115	0	30	0.33	2.38
Very Stiff to Hard SI CLAY to SI CL LOAM Elevation 901 to 893 feet	120	100	30	0.33	2.38
Stiff to Very Stiff SI CLAY to SI CL LOAM Elevation 893 to 881*	58 (submerged)	100	30	0.33	2.38

*Boring termination depth.

Table 2: Drained Geotechnical Parameters for Design of Cantilevered Pile Walls
Station 411+13 to Station 414+95 (Reference Borings RWB-05 to RWB-10)

Soil Description Average Elevation (feet)	Unit Weight γ (pcf)	Drained Shear Strength Properties		Earth Pressure Coefficients	
		Cohesion (psf)	Friction Angle (°)	Active Pressure (straight)	Passive Pressure (1V:3H)
Stiff to Hard SI CL to SI CL LOAM FILL Surface to Elevation 906 feet	120	100	31	0.32	2.37
Loose to Medium Dense SA LOAM to LOAM Elevation 906 to 901 feet	115	0	30	0.33	2.38
Very Stiff to Hard SI CLAY to SI CL LOAM Elevation 901 to 892 feet	120	100	30	0.33	2.38
Stiff to Very Stiff SI CLAY to SI CL LOAM Elevation 892 feet to 877*	58 (submerged)	100	30	0.33	2.38

*Boring termination depth.

The lateral deformation of the wall should be designed for movement and moment fixity at the base of the pile. The roadway and utilities should not be impacted by the lateral movement of the wall. Therefore, the design of the soldier pile wall should establish lateral movement limits. The evaluations should be performed using the recommended soil parameters shown in Tables 3 and 4, based on station limits, via the p-y curve (COM624) method. Elevations provided in Tables 3 and 4 are based on the average layer elevations across the profile and may vary from one boring location to another.

Table 3: Recommended Geotechnical Parameters for Lateral Load Analysis of Cantilevered Pile Walls
Station 408+50 to Station 411+13 (Reference Borings RWB-01 to RWB-04)

Soil Description Average Elevation (feet)	Unit Weight γ (pcf)	Undrained Shear Strength c_u (psf)	Estimated Friction Angle Φ (°)	Estimated Lateral Soil Modulus Parameter k (pci)	Estimated Soil Strain Parameter ε_{50}
Stiff to Hard SI CL to SI CL LOAM FILL Surface to Elevation 906 feet	120	1500	0	500	0.007
Medium Stiff CLAY to SI CLAY Elevation 906 to 901 feet	115	700	0	100	0.01
Very Stiff to Hard SI CLAY to SI CL LOAM Elevation 901 to 893 feet	120	3800	0	1000	0.005
Stiff to Very Stiff SI CLAY to SI CL LOAM Elevation 893 to 881*	58 (submerged)	2400	0	1000	0.005

*Boring termination depth.

Table 4: Recommended Geotechnical Parameters for Lateral Load Analysis of Cantilevered Pile Walls
Station 411+13 to Station 414+95 (Reference Borings RWB-05 to RWB-10)

Soil Description Average Elevation (feet)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50}
Stiff to Hard SI CL to SI CL LOAM FILL Surface to Elevation 906 feet	120	3000	0	1000	0.005
Loose to Medium Dense SA LOAM to LOAM Elevation 906 to 901 feet	115	0	30	25	--
Very Stiff to Hard SI CLAY to SI CL LOAM Elevation 901 to 892 feet	120	3600	0	1000	0.005
Stiff to Very Stiff SI CLAY to SI CL LOAM Elevation 892 feet to 877*	58 (submerged)	2600	0	1000	0.005

*Boring termination depth.

5.3 MSE and RCC Walls

The top of the levelling pad for an MSE wall should be established a minimum of 3.5 feet below the finished grade at the front face of the wall, while the bottom of the footing for an RCC wall should be established a minimum of 4.0 feet below the finished grade at the front face of the wall (IDOT 2012). MSE walls are constructed in accordance with IDOT Section 522 (2016).

From the preliminary drawings, we estimate that the MSE wall will have a maximum total height of 12.5 feet and will apply a maximum factored bearing pressure of 3,800 psf. The estimated factored bearing pressure should be confirmed by Strand and the wall manufacturer based on the final geometry of the wall. The width of the reinforcement zone should be taken as 0.7 times the total height or a minimum of 8.0 feet (AASHTO 2017).

We evaluated the suitability of the soils encountered below the estimated top of the leveling pad and/or bottom of footing elevations of 899.5 to 901.5 feet. The wall base will be established primarily on stiff to hard silty clay (**Layer 2**) soils, however, the subsurface investigation identified the presence of an area near Boring RWB-01 with a 6.0-inch thick layer of medium stiff clay to silty clay loam with low Q_u values (0.6 tsf) at the base of the wall. To provide sufficient bearing resistance and minimize potential settlement, we recommend removing unstable soils and replacing with compacted granular fill as described in Section 6.3. The approximate limits of the area requiring removal and replacement are presented in Table 5.

Table 5: Summary of Foundation Soil Treatment Recommendations

Station Limits	Treatment Width*	Removal Elevation (feet)	Reference Boring(s)
408+50 to 408+96	Out-to-out of reinforcement width	901.0	RWB-01 (Q_u=0.66 tsf)

*The treatment width for a RCC wall type should extend 2.0 feet on both sides of the footing.

The actual need for removal and replacement of soils, including the required width and depth of improvement shown in Table 5, should be determined in the field at the time of construction. The subsurface investigation did not reveal the presence of buried topsoil at the estimated foundation base; however, if it is encountered during construction it should be removed and replaced with compacted granular fill as described in Section 6.3.

Following the recommended foundation treatment, we estimate the foundation soils will have a maximum factored bearing resistance of 5,200 psf based on a geotechnical resistance factor of 0.65 (AASHTO 2017) for MSE wall design. For the RCC alternative, the wall can be designed based on a maximum factored bearing resistance of 3,600 psf considering a geotechnical resistance factor of 0.45 (AASHTO 2017). The pressure applied by the wall should account for vertical and lateral load factors (AASHTO 2017). The improved foundation soils will provide sufficient bearing resistance for the support of both the MSE and RCC wall types.

The estimated friction angles between an MSE base and the underlying existing silty clay or granular backfill are 28º and 30°, respectively, and the corresponding friction coefficients are 0.53 and 0.58, respectively. MSE walls are designed based on an AASTHO soil-to-soil contact geotechnical sliding resistance factor of 1.0 (AASHTO 2017). The friction angles between a cast-in-place RCC wall and the underlying silty clay or granular backfill is 24°and 29º, respectively, and the corresponding friction coefficients are 0.45 and 0.55, respectively. Cast-in-place concrete walls on clay are designed based on an AASHTO resistance factor of 0.85 (AASHTO 2017). We estimate the sliding along the clayey soils has sufficient resistance and the eccentricity lies within the required middle 2/3 of the wall (AASHTO 2017).

5.4 Segmental Concrete Block Wall

The wall can be designed as a segmental concrete block walls. Usually this type of wall is considered as a design-build type wall. The wall should be designed in accordance with Section 3.11.6 of the IDOT *Bridge Manual* (IDOT 2012) and the AASHTO LRFD *Bridge Design Specifications* (AASHTO 2017). The external stability of the wall including bearing capacity, sliding, overturning, and overall stability should be evaluated (IDOT 2016). Segmental Concrete Block walls should be constructed in accordance with Article 522.12 *Segmental Concrete Block Retaining Walls* of the IDOT *Standard Specifications* (IDOT 2016).

This wall type is designed similar to MSE walls (IDOT 2012). As such, the top of leveling pad should be at least 3.5 feet below the lowest finished grade in front of the wall for frost protection. As discussed in Section 5.3, removal and replacement of the unstable and/or unsuitable soils encountered during the investigation at the estimated base of the wall is recommended to provide sufficient bearing resistance and minimize potential settlement. The weaker foundation soils should be replaced with compacted granular fill as described in Section 6.3. The approximate limits of the area requiring removal and replacement is presented in Table 5 and the treatment width at a minimum should be the out-to-out of reinforcement width for the wall.

The actual need for removal and replacement of soils, including the required width and depth of improvement shown in Table 5, should be determined in the field at the time of construction. The subsurface investigation did not reveal the presence of buried topsoil at the estimated foundation base; however, if it is encountered during construction it should be removed and replaced with compacted granular fill as described in Section 6.3.

Following the recommended foundation treatment, we estimate the wall could be designed based on a factored bearing resistance similar to that recommended for the MSE wall type of 5,200 psf based on a geotechnical resistance of 0.65. The pressure applied on the wall should account for vertical and lateral load factors (AASHTO 2017). The estimated friction angles between the segmental concrete block wall and the underlying existing silty clay or granular backfill are 28º and 30°, respectively, and the corresponding friction coefficients are 0.53 and 0.58, respectively. The wall should be designed based on geotechnical sliding resistance factor of 1.0 (AASHTO 2017).

5.5 Settlement

Wang evaluated the potential consolidation settlements resulting from the proposed grade change for the wall. We estimate the foundation soils will undergo long-term settlements of less than 1.0 inch which are suitable for the construction of the MSE, RCC, and Segmental Concrete Block wall options.

5.6 Global Stability

The global stability of the proposed wall was analyzed based on the soil profile described in Section 4.1 and the information provided in the design drawings and cross-sections. The stability was analyzed at the critical section near Station 414+95 where the maximum exposed height is 9.0 feet. The minimum required factor of safety (FOS) is 1.7 in both short-term (undrained) and long-term (drained) conditions (IDOT 2015).

Details of the global stability analysis with critical failure surfaces and results are presented in Appendix C. We estimate the wall will have an adequate FOS of 3.0 (Appendix C-1) in the undrained condition. Global stability evaluations were performed to estimate the minimum pile tip elevation required to achieve an FOS of 1.7 in the drained condition. The embedded portion of the cantilevered piles will provide resistance against the slope instability above the tip of the piles. The results of our analysis are summarized in Table 6. We recommend that the wall tip elevations be installed at or deeper than the minimum elevations shown in Table 6 to provide long-term global stability FOS values of at least 1.7 as shown in Appendix C-2. It should be noted that typically, the lateral earth pressure and deformation analyses will determine the minimum embedment depth for cantilevered pile walls. Therefore, the designer should perform other analyses including lateral earth pressure and deflection analyses to determine the required design pile embedment.

Table 6: Results of Global Stability Analysis

Station	Reference Boring(s)	Retained Wall Height (feet)	Short-term (Undrained) Condition		Long-term (Drained) Condition	
			FOS	Minimum Tip Elevation (feet)	FOS	Minimum Tip Elevation (feet)
414+95	RWB-05, RWB-09, and RWB-10	9.0	4.3	-/-	1.9	902.7

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

Vegetation, surface topsoil, debris, and any existing ditch sediment encountered should be cleared and stripped where the structure will be placed. If unstable or unsuitable materials are exposed during excavation, they should be removed and replaced with compacted structural fill as described in Section 6.3.

6.2 Excavation, Dewatering, and Utilities

Excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction. Excavations for the construction of the wall should be sloped at no steeper than 1:2 (V: H). Any slope that cannot be graded at 1:2 (V: H) should be properly shored and dewatering may be necessary if groundwater perched within the granular layers is encountered. Excavated material should not be stockpiled immediately adjacent to the top of slopes, nor should equipment be allowed to operate too closely to open excavations.

Depending on the type of retaining wall selected by the designer, the construction may require temporary excavation support. If an MSE, RCC, or Segmental Concrete Block wall type is proposed, temporary support systems may be needed to support the existing embankment during construction. Temporary Steel Sheet Piling designed in accordance with IDOT *Design Guide 3.13.1* is feasible at this location for a maximum retained cut height of 9.0 to 10.0 feet.

For cantilevered pile walls, it should be noted that hard drilling conditions, frequent rig chatter, and possible cobbles were noted in Boring RWB-04 at elevations of 892 to 884 (20.0 to 28.5 feet bgs) , and should be anticipated during pile driving or drilling. Additionally, sheet piles driven to a pile tip elevation extending below elevations of 901 to 896 feet will not be feasible due to potential difficulty of driving the sheet piles in cohesive soils with unconfined compressive strength values of greater than 4.5 tsf.

Groundwater was encountered while drilling at elevations of 904 to 881 (3.5 to 27.0 feet bgs) within the shallower sandy loam to loam or silt and the deeper silty clay to silty clay loam. At the completion of drilling, the groundwater was measured in Boring RWB-01 at an elevation of 891 feet (20.0 feet bgs). We do not anticipate groundwater concerns during the construction of the cantilevered pile walls; however, if drilled soldier piles are designed, temporary casing and wet installation methods may be needed for drilling and setting into the sandy loam to loam layer at elevations of 906 to 901 feet between Stations 411+13 and 414+95.

Groundwater was encountered in Borings RWB-03 to RWB-05 at elevations of 903.5 to 899.5 feet (8.5 to 12.0 feet bgs) within the sandy loam to loam and silt at or near the estimated base of the MSE, RCC, and Segmental Concrete Block walls. Excavations for the construction of these walls, particularly between Station 409+68 to Station 411+90, will encounter perched groundwater infiltration and temporary dewatering efforts should be anticipated.

Precipitation allowed to enter excavations should be immediately removed via sump pump. Any soils allowed to soften under standing water should be removed and replaced with compacted fill as described in Section 6.3.

6.3 Filling and Backfilling

Fill material used to attain final design elevations should be pre-approved, compacted; cohesive or granular soil conforming to IDOT Section 205, *Embankment* (2016). The fill material should be free of organic matter and debris and should be placed in lifts and compacted according to the Standard.
Backfill materials must be pre-approved by the Resident Engineer. To backfill the RCC wall, we

recommend porous granular material conforming to the requirements specified in the IDOT Supplemental Specification for Section 586, *Granular Backfill for Structures* (2017). Backfill material should be placed and compacted in accordance with the Special Provision.

6.4 Earthwork Operations

The required earthwork can be accomplished with conventional construction equipment. Moisture and traffic will cause deterioration of exposed subgrade soils. Precautions should be taken by the Contractor to prevent water erosion of the exposed subgrade. A compacted subgrade will minimize water runoff erosion.

Earth moving operations should be scheduled to not coincide with excessive cold or wet weather (early spring, late fall or winter). Any soil allowed to freeze or soften due to the standing water should be removed. Wet weather can cause problems with subgrade compaction.

It is recommended that an experienced geotechnical engineer be retained to inspect the exposed subgrade, monitor earthwork and soldier pile drilling operations, pile installation, and provide material inspection services during the construction phase of this project.

7.0 QUALIFICATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on the boring logs and in Exhibit 3. This report does not reflect any variations that may occur between the borings or elsewhere on the site, variations whose nature and extent may not become evident until the course of construction. In the event that any changes in the design and/or location of the walls are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

It has been a pleasure to assist Strand Associates, Inc. and the Illinois Department of Transportation on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Andri Kurnia, P.E.
Senior Geotechnical Engineer

Azza Hamad, E.I.T.
Project Geotechnical Engineer

Corina T. Farez, P.E., P.G.
QA/QC Reviewer

REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (2017) "AASHTO LRFD Bridge Design Specifications." United States Depart of Transportation, Washington, D.C.

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WILLMAN, H.B., ATHERTON, E., BUSCHBACH, T.C., COLLINSON, C., FRYE, J.C., HOPKINS, M.E., LINEBACK, J.A., and SIMON, J.A., 1971, Handbook of Illinois Stratigraphy: ISGS Bulletin 95: Urbana, Illinois State Geological Survey, 261 p.

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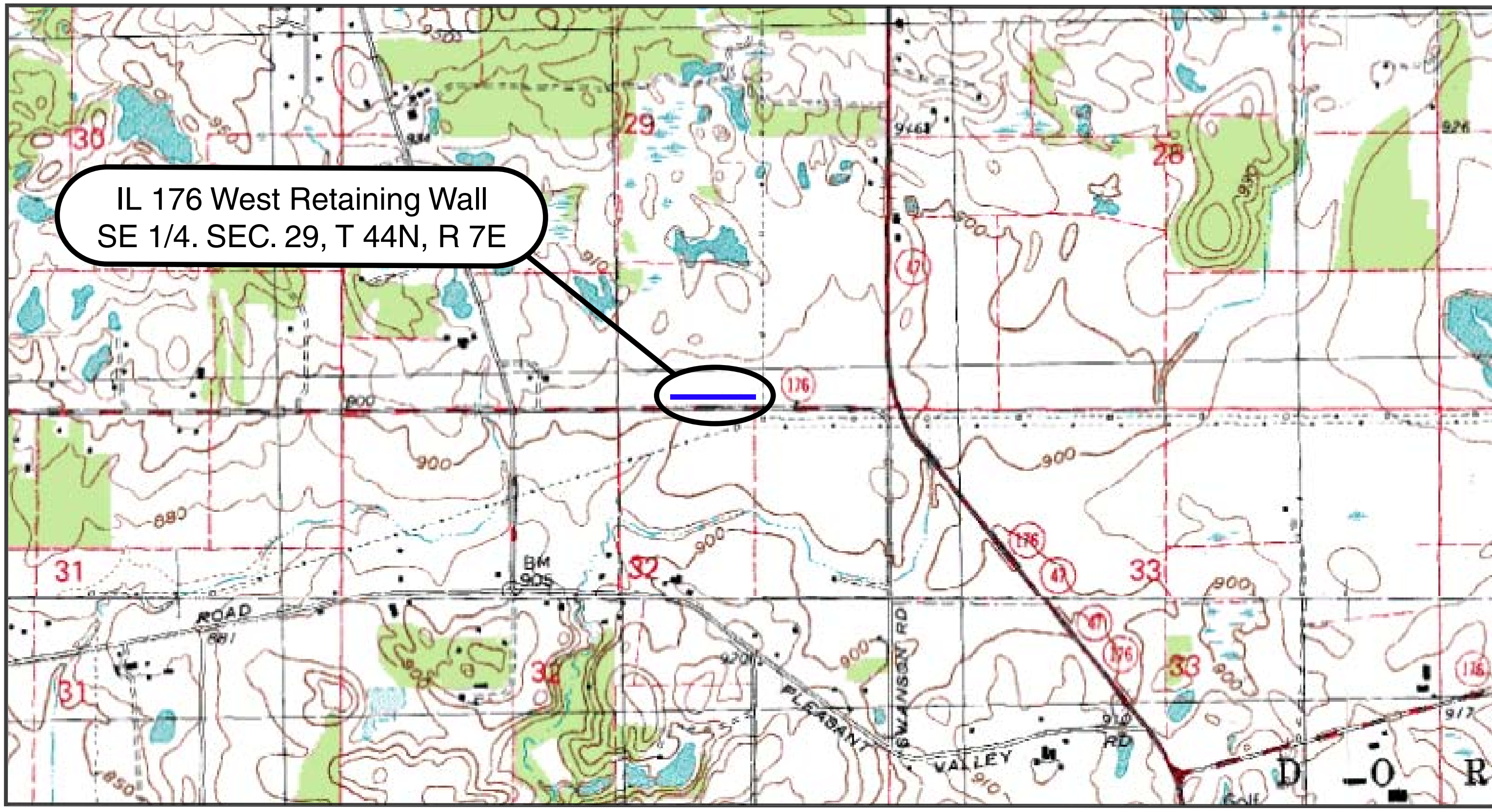
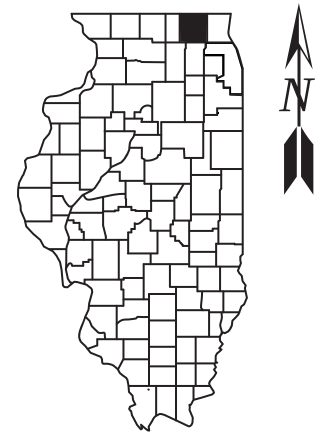
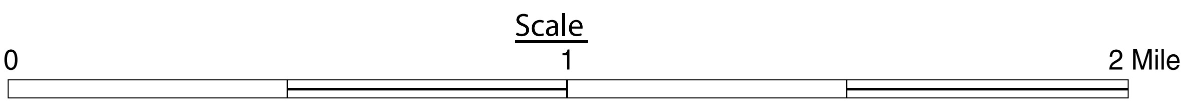
EXHIBITS





McHenry County



SITE LOCATION MAP: IL 176 WEST RETAINING WALL ALONG COMED FACILITY, MCHENRY COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: A. Hamad CHECKED BY: A. Kurnia

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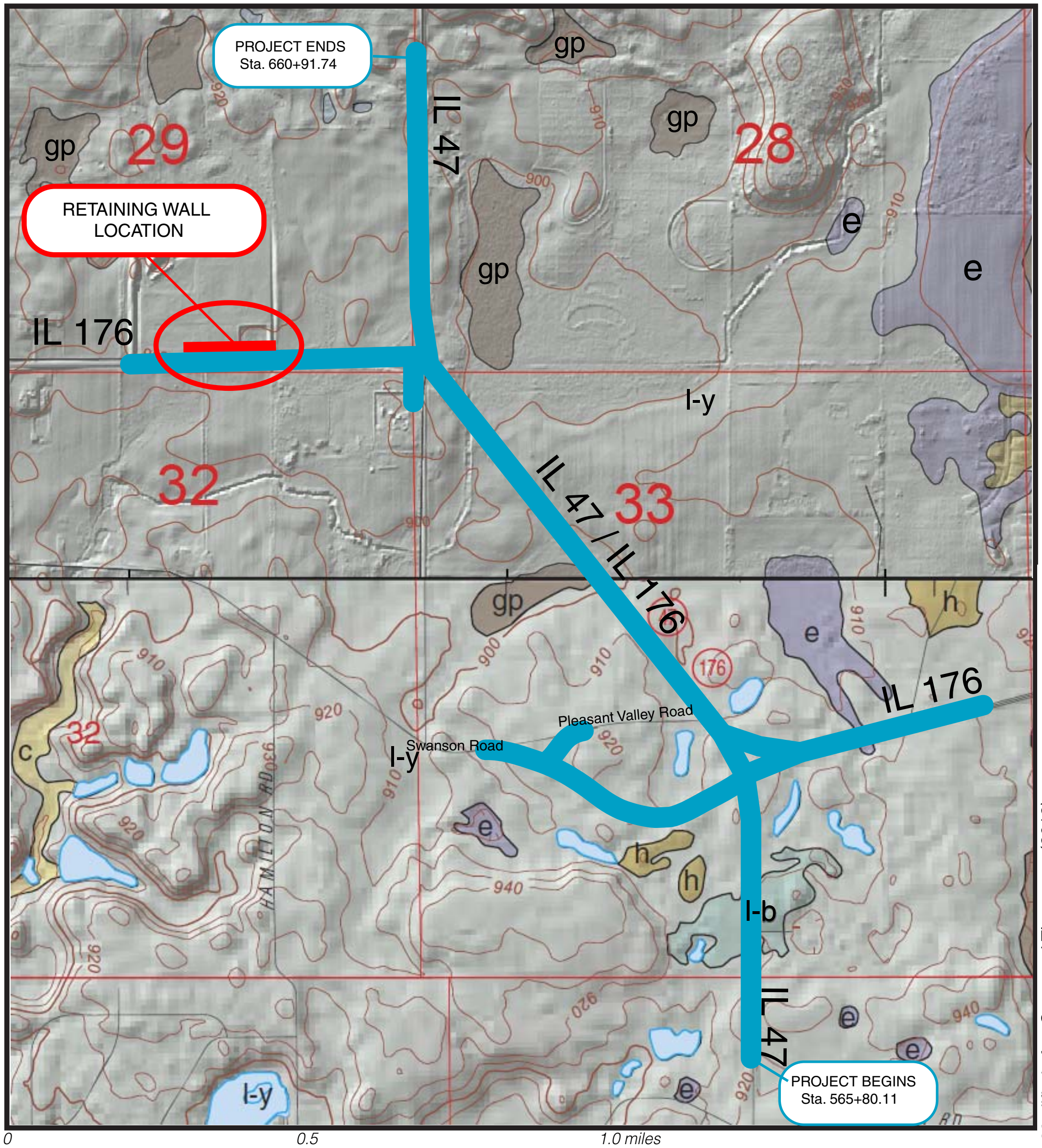


Modified after Flaherty, Thomason, and Malone (2013)

Modified after Curry and Thomason (2012)

REGIONAL GEOLOGY

Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

Modified after Hansel and Johnson (1996)

LEGEND

HUDSON EPISODE

gp — **Grayslake Peat**
Decomposed wetland vegetation and sediment; peat and muck, interbedded sand, silty clay, and marl

WISCONSIN EPISODE

e — **Equality Formation**
Lake deposits in kettles and valleys; silt, clay, and fine sand; layered to massive

h — **Henry Formation**
Proglacial outwash plains downslope of glacial margins; sand and gravel, or sand; with lenses of silt and clay, or diamicton

l-y — **Lemont Fornation, Yorkville Member**
Debris flow deposits and diamicton; silty clay, silty clay loam, and clay, includes layers of sand and gravel

l-b — **Lemont Formation, Batestown Member (Cross section only)**
Debris flow deposits and diamicton; sandy loam to loam with abundant cobbles; includes layers of sand and gravel or silt and sorted sediment

t — **Tiskilwa Formation (Cross section only)**
Till, debris flow deposits, and outwash; clay loam to loam; includes lenses of sand and gravel.

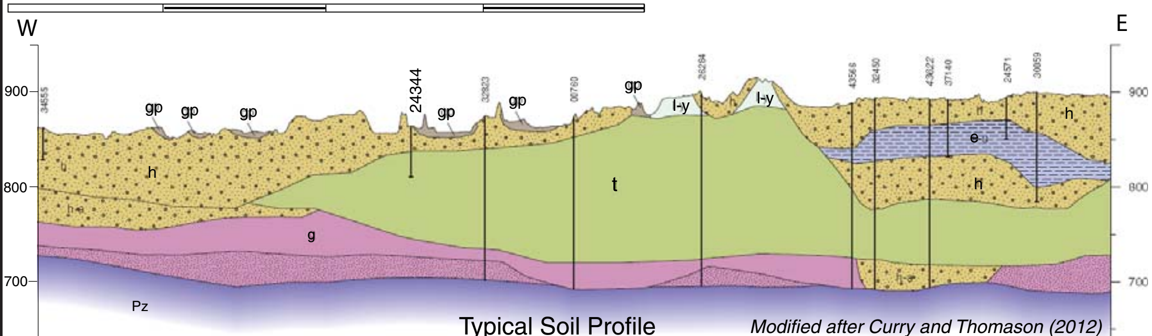
ILLINOIS EPISODE

g — **Glasford Formation (Cross section only)**
Till and debris flow deposits (diamicton) and outwash (sand and gravel); the diamicton is bouldery in places with reddish brown, sandy loam to loam matrix, with abundant lenses, and channel fills of sand and gravel.

PALEOZOIC BEDROCK

Pz — **Bedrock (Cross section only)**
Dolomite, shaly dolomite, and shale

Modified after Curry and Thomason (2012)



Typical Soil Profile

Modified after Curry and Thomason (2012)

SITE AND REGIONAL GEOLOGY: IL 176 WEST, RETAINING WALL ALONG COMED FACILITY, McHENRY COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. Marin CHECKED BY: L. Iordache

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Legend

◉ Retaining Wall Borings

Scale

0 100 200 Feet

BORING LOCATION PLAN: IL 176 WEST RETAINING WALL ALONG COMED FACILITY, MCHENRY COUNTY, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 3	DRAWN BY: A. Hamad CHECKED BY: A. Kurnia
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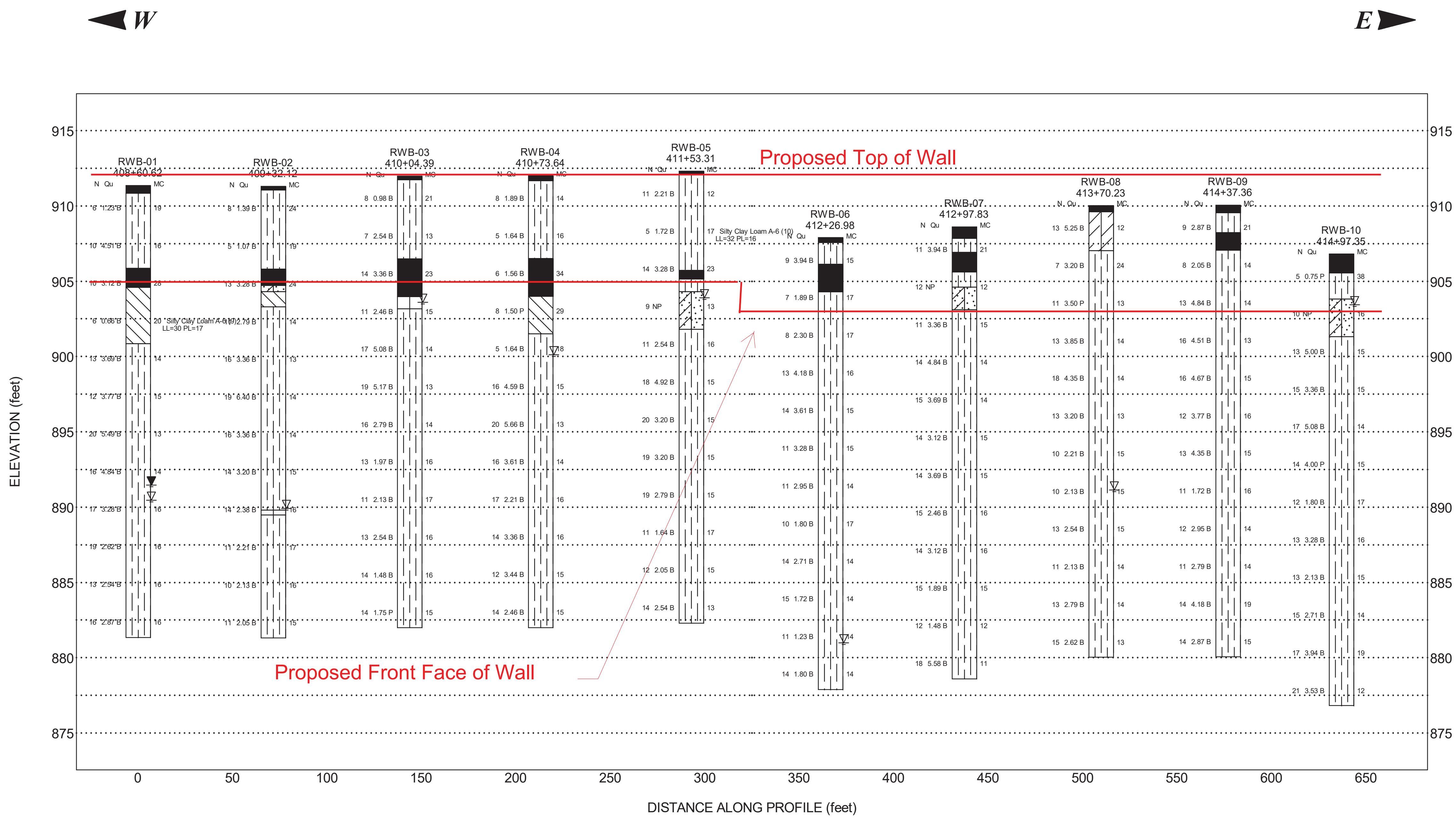
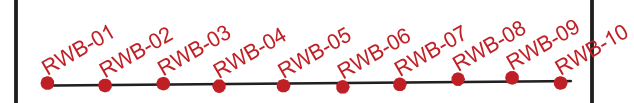
FOR STRAND ASSOCIATES, INC.		195-13-02



Lithology Graphics

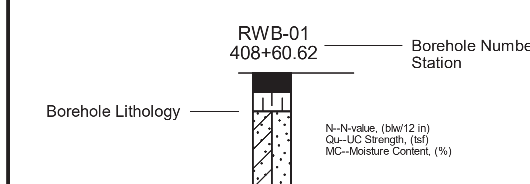
- Topsoil
- IDH Silt, Silty Loam
- IDH Silty Clay, Silty Clay Loam
- IDH Clay Loam
- IDH Clay
- IDH Loam

N



Site Map Scale 1 inch equals 240 feet

Explanation:



Water Level Reading at time of drilling.

Water Level Reading 24-hr after drilling or at end of drilling

Horizontal Scale (feet)

Vertical Exaggeration: 8x

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IL 176 West Retainihg Wall
Soil Profile

WEI SINCE 1982

IL 47 at IL 176 and Pleasant Valley Road
McHenry County, Illinois

JOB NUMBER	PLATE NUMBER
195-13-02	EXHIBIT 4

WEI 11X17 1951302.GPJ WANGENG.GDT 9/11/20

APPENDIX A

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BORING LOG RWB-01

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 911.35 ft
North: 2035643.67 ft
East: 955306.62 ft
Station: 408+60.62
Offset: 79.78 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
910.9	6-inch thick, black SILTY CLAY to SILTY CLAY LOAM --TOPSOIL--					
	Stiff to hard, black, brown, and gray, SILTY CLAY, trace gravel --FILL-- --RDR 2--		1	2, 3, 3	1.23 B	19
		5	2	3, 4, 6	4.51 B	16
905.9	Very stiff, black SILTY CLAY LOAM --BURIED TOPSOIL--					
904.6	Medium stiff to stiff (1.0P), greenish gray to brown and gray CLAY to SILTY CLAY LOAM --L_L(%)=30, P_L(%)=17-- --%Gravel=3.2-- --%Sand=16.6-- --%Silt=57.6-- --%Clay=22.6-- --A-6 (9)--		3	3, 4, 6	3.12 B	28
		10	4	3, 3, 3	0.66 B	20
900.9	Very stiff to hard, brown to gray SILTY CLAY LOAM, trace gravel --RDR 2--		5	4, 6, 7	3.69 B	14
		15	6	3, 5, 7	3.77 B	15
			7	5, 8, 12	5.49 B	13
		20	8	5, 7, 9	4.84 B	14
			9	4, 7, 10	3.28 B	16
		25	10	5, 7, 12	2.62 B	16
			11	4, 5, 8	2.54 B	16
881.4		30	12	4, 6, 10	2.87 B	16
	Boring terminated at 30.00 ft					
		35				
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **06-30-2020** Complete Drilling **06-30-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **21.00 ft**
At Completion of Drilling ▼ **20.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-02

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 911.30 ft
North: 2035640.85 ft
East: 955378.16 ft
Station: 409+32.12
Offset: 75.56 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
911.1	3-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Medium stiff to stiff, brown, SILTY CLAY LOAM to SILTY CLAY, trace gravel --FILL-- --RDR 2--		1	3 4 4	1.39 B	24
		5	2	2 2 3	1.07 B	19
905.8	Very stiff, black SILTY CLAY LOAM --BURIED TOPSOIL--		3	5 7 6	3.28 B	24
904.7						
904.3	Brown LOAM; moist					
903.3	Stiff (1.5P), brown and gray CLAY to SILTY CLAY --RDR 2--		4	2 5 6	2.79 B	14
	Very stiff to hard, brown to gray, SILTY CLAY LOAM, trace gravel --RDR 2--	10				
			5	6 7 9	3.36 B	13
		15	6	3 7 12	6.40 B	14
	--gray--		7	5 7 9	3.36 B	14
		20	8	5 6 8	3.20 B	15
889.8	Gray SILTY LOAM; saturated					
889.5	Very stiff, gray SILTY CLAY LOAM, trace gravel --RDR 2--		9	4 7 7	2.38 B	16
		25	10	4 4 7	2.21 B	17
			11	4 4 6	2.13 B	16
881.3		30	12	3 4 7	2.05 B	15
	Boring terminated at 30.00 ft	35				
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **07-01-2020** Complete Drilling **07-01-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **21.50 ft**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-03

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 911.98 ft
North: 2035643.06 ft
East: 955450.40 ft
Station: 410+04.39
Offset: 76.35 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
911.7	3-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Medium stiff to very stiff, brown SILTY CLAY, trace gravel --FILL-- --RDR 2--		1	3 2 6	0.98 B	21
		5	2	3 3 4	2.54 B	13
906.5	Very stiff, black SILTY CLAY LOAM --BURIED TOPSOIL--		3	2 5 9	3.36 B	23
904.0	Brown and gray SILT; saturated ▽					
903.2	Stiff to hard, brown and gray, SILTY CLAY LOAM, trace gravel --RDR 2 to 3--	10	4	3 5 6	2.46 B	15
			5	6 7 10	5.08 B	14
	--sand lens; damp--					
	--gray--	15	6	7 8 11	5.17 B	13
			7	5 7 9	2.79 B	14
		20	8	5 6 7	1.97 B	16
			9	4 4 7	2.13 B	17
		25	10	4 5 8	2.54 B	16
			11	5 6 8	1.48 B	16
882.0		30	12	4 6 8	1.75 P	15
	Boring terminated at 30.00 ft					

GENERAL NOTES

Begin Drilling: **07-01-2020** Complete Drilling: **07-01-2020**
Drilling Contractor: **Wang Testing Services** Drill Rig: **17D50A [87%]**
Driller: **K&J** Logger: **E. Yim** Checked by: **C. Marin**
Drilling Method: **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: ▽ **8.50 ft**
At Completion of Drilling: ▼ **DRY**
Time After Drilling: **NA**
Depth to Water: ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-04

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 912.00 ft
North: 2035639.94 ft
East: 955519.73 ft
Station: 410+73.64
Offset: 71.88 LT

Elevation (ft)	Soil and Rock Description	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
911.7	4-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Stiff to very stiff, brown SILTY CLAY, trace gravel --RDR 2-- --FILL--		1	3 4 4	1.89 B	14
		5	2	1 2 3	1.64 B	16
906.5	Stiff, black SILTY CLAY LOAM --BURIED TOPSOIL-- --RDR 2--		3	3 2 4	1.56 B	34
904.0	Brown CLAY to SILTY CLAY --RDR 2--	10	4	4 4 4	1.50 P	29
901.5	Stiff to hard, brown to gray, SILTY CLAY, trace gravel --RDR 2 to 4-- --wet clay at 12 feet--		5	3 2 3	1.64 B	18
		15	6	4 7 9	4.59 B	15
			7	7 9 11	5.66 B	13
		20	8	7 7 9	3.61 B	14
	--RDR 3 to 4-- --frequent chatter, hard drilling, 20 to 23.5 feet-- --possible cobbles--		9	4 7 10	2.21 B	16
		25	10	4 6 8	3.36 B	16
	--RDR 2 to 3-- --hard drilling, 26 to 28.5 feet-- --possible cobbles--		11	3 5 7	3.44 B	15
882.0		30	12	4 6 8	2.46 B	15
	Boring terminated at 30.00 ft					

GENERAL NOTES

Begin Drilling: **07-01-2020** Complete Drilling: **07-01-2020**
Drilling Contractor: **Wang Testing Services** Drill Rig: **17D50A [87%]**
Driller: **K&J** Logger: **E. Yim** Checked by: **C. Marin**
Drilling Method: **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **12.00 ft**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-05

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 912.30 ft
North: 2035640.39 ft
East: 955599.41 ft
Station: 411+53.31
Offset: 70.77 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
912.1	3-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Stiff to very stiff, brown SILTY CLAY to SILTY CLAY LOAM, trace gravel --FILL-- --RDR 2-- --L_L(%)=32, P_L(%)=16-- --%Gravel=8.4-- --%Sand=15.8-- --%Silt=50.0-- --%Clay=25.8-- --A-6 (10)--		1	4 5 6	2.21 B	12
		5	2	2 2 3	1.72 B	17
905.7			3	3 5 9	3.28 B	23
905.1	Very stiff, black SILTY CLAY LOAM --BURIED TOPSOIL--					
904.3	Very stiff, brown SILTY CLAY LOAM, little gravel	10	4	4 4 5	NP	13
901.8	Loose, brown SANDY LOAM to LOAM, trace gravel; wet --RDR 2--					
	Stiff to hard, brown to gray SILTY CLAY LOAM, trace gravel --RDR 2--		5	2 5 6	2.54 B	16
		15	6	5 7 11	4.92 B	15
	--gray--		7	6 9 11	3.20 B	15
		20	8	6 7 12	3.20 B	15
			9	6 9 10	2.79 B	15
		25	10	3 5 6	1.64 B	17
			11	3 5 7	2.05 B	15
882.3		30	12	5 5 9	2.54 B	13
	Boring terminated at 30.00 ft					

GENERAL NOTES

Begin Drilling **07-02-2020** Complete Drilling **07-02-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **8.50 ft**
At Completion of Drilling ▼ **DRY**
Time After Drilling **NA**
Depth to Water ▼ **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-06

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 907.89 ft
North: 2035638.90 ft
East: 955673.12 ft
Station: 412+26.98
Offset: 67.84 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
907.6	4-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
906.1	Very stiff, brown SILTY CLAY, trace gravel --FILL-- --RDR 2--		1	4 4 5	3.94 B	15
904.3	Very stiff, black SILTY CLAY LOAM --BURIED TOPSOIL-- --RDR 2--	5	2	3 3 4	1.89 B	17
	Stiff to hard, brown and gray to gray, SILTY CLAY, trace gravel --RDR 2--		3	3 3 5	2.30 B	17
		10	4	5 6 7	4.18 B	16
	--gray--		5	3 7 7	3.61 B	15
		15	6	3 4 7	3.28 B	15
			7	3 5 6	2.95 B	14
		20	8	3 4 6	1.80 B	17
			9	4 5 9	2.71 B	14
		25	10	6 7 8	1.72 B	14
	--sand seam; wet--		11	4 5 6	1.23 B	14
877.9	--sand seam; wet--	30	12	5 6 8	1.80 B	14
	Boring terminated at 30.00 ft	35 / 40 / 45 / 50				

GENERAL NOTES

Begin Drilling **07-02-2020** Complete Drilling **07-02-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **27.00 ft**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-07

WEI Job No.: 195-13-02

Client **Strand Associates, Inc.**
Project **IL 47 at IL 176 and Pleasant Valley Road**
Location **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 908.60 ft
North: 2035642.16 ft
East: 955743.92 ft
Station: 412+97.83
Offset: 69.72 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
907.9	9-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
906.9	Hard, brown SILTY CLAY, trace gravel --FILL--		1	4 5 6	3.94 B	21
905.6	Very stiff, black SILTY CLAY LOAM --BURIED TOPSOIL--		2	3 5 7	NP	12
904.6	--RDR 2--	5				
903.1	Stiff, brown SILTY CLAY LOAM, trace gravel		3	7 5 6	3.36 B	15
	Medium dense, brown LOAM, little to some gravel --RDR 2 to 3--					
	Stiff to hard, brown and gray to gray SILTY CLAY LOAM, trace gravel --RDR 2--	10	4	2 6 8	4.84 B	14
	--gray--		5	5 7 8	3.69 B	14
		15	6	5 6 8	3.12 B	15
			7	5 6 8	3.69 B	15
		20	8	4 6 9	2.46 B	16
			9	5 6 8	3.12 B	16
		25	10	6 6 9	1.89 B	15
			11	5 5 7	1.48 B	12
878.6		30	12	5 7 11	5.58 B	11
	Boring terminated at 30.00 ft	35				
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **07-02-2020** Complete Drilling **07-02-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **DRY**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-08

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 910.03 ft
North: 2035648.59 ft
East: 955816.21 ft
Station: 413+70.23
Offset: 74.73 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
909.6	5-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Very stiff to hard, black and brown CLAY LOAM, trace gravel --FILL-- --RDR 2--		1	4 6 7	5.25 B	12
907.0	Very stiff to hard, brown to gray SILTY CLAY LOAM, trace gravel --RDR 2--		2	3 3 4	3.20 B	24
		5				
	--2-in silt; moist--		3	4 5 6	3.50 P	13
			4	3 5 8	3.85 B	14
		10				
	--gray--		5	5 7 11	4.35 B	14
			6	4 5 8	3.20 B	13
		15				
			7	4 4 6	2.21 B	15
			8	3 4 6	2.13 B	15
		20				
			9	4 6 7	2.54 B	15
			10	4 5 6	2.13 B	14
		25				
	--silt lens; moist--		11	4 5 8	2.79 B	14
			12	5 7 8	2.62 B	13
880.0		30				
	Boring terminated at 30.00 ft					
		35				
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **07-06-2020** Complete Drilling **07-06-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **19.00 ft**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-09

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 910.05 ft
North: 2035650.43 ft
East: 955883.31 ft
Station: 414+37.36
Offset: 75.26 LT

Elevation (ft)	Soil and Rock Description	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
909.6	6-inch thick, dark brown SILTY CLAY LOAM --TOPSOIL--					
908.2	Very stiff, brown SILTY CLAY LOAM --FILL--		1	4, 4, 5	2.87 B	21
907.1	Very stiff, dark brown SILTY CLAY LOAM --BURIED TOPSOIL-- --RDR 2--	5	2	2, 4, 4	2.05 B	14
	Stiff to hard, brown to gray SILTY CLAY LOAM, trace gravel --RDR 2--		3	3, 6, 7	4.84 B	14
		10	4	3, 6, 10	4.51 B	13
			5	6, 7, 9	4.67 B	15
	--gray--	15	6	3, 5, 7	3.77 B	16
			7	3, 5, 8	4.35 B	15
		20	8	4, 5, 6	1.72 B	16
			9	4, 4, 8	2.95 B	14
		25	10	3, 5, 6	2.79 B	14
			11	5, 5, 9	4.18 B	19
880.1		30	12	4, 5, 9	2.87 B	15
	Boring terminated at 30.00 ft					

GENERAL NOTES

Begin Drilling: **07-06-2020** Complete Drilling: **07-06-2020**
Drilling Contractor: **Wang Testing Services** Drill Rig: **17D50A [87%]**
Driller: **K&J** Logger: **E. Yim** Checked by: **C. Marin**
Drilling Method: **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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BORING LOG RWB-10

WEI Job No.: 195-13-02

Client: **Strand Associates, Inc.**
Project: **IL 47 at IL 176 and Pleasant Valley Road**
Location: **McHenry County, Illinois**

Datum: NAVD 88
Elevation: 906.82 ft
North: 2035643.88 ft
East: 955943.46 ft
Station: 414+97.35
Offset: 67.51 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	15-inch thick, medium stiff, black SILTY CLAY LOAM					
905.6	--TOPSOIL--					
	Medium stiff (0.5P) brown SILTY CLAY		1	3 3 2	0.75 P	38
903.8	--RDR 2--					
	Medium dense, brown SANDY LOAM to LOAM, little gravel --RDR 2--	5	2	3 5 5	NP	16
901.3	Stiff to hard, brown to gray SILTY CLAY LOAM, trace gravel --RDR 2--		3	3 6 7	5.00 B	15
		10	4	3 6 9	3.36 B	15
	--gray--		5	5 8 9	5.08 B	14
		15	6	4 6 8	4.00 P	15
			7	4 5 7	1.80 B	17
		20	8	4 5 8	3.28 B	16
			9	4 5 8	2.13 B	15
		25	10	6 6 9	2.71 B	14
			11	5 7 10	3.94 B	19
876.8		30	12	6 9 12	3.53 B	12
	Boring terminated at 30.00 ft	35, 40, 45, 50				

GENERAL NOTES

Begin Drilling **07-06-2020** Complete Drilling **07-06-2020**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **K&J** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **3.50 ft**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

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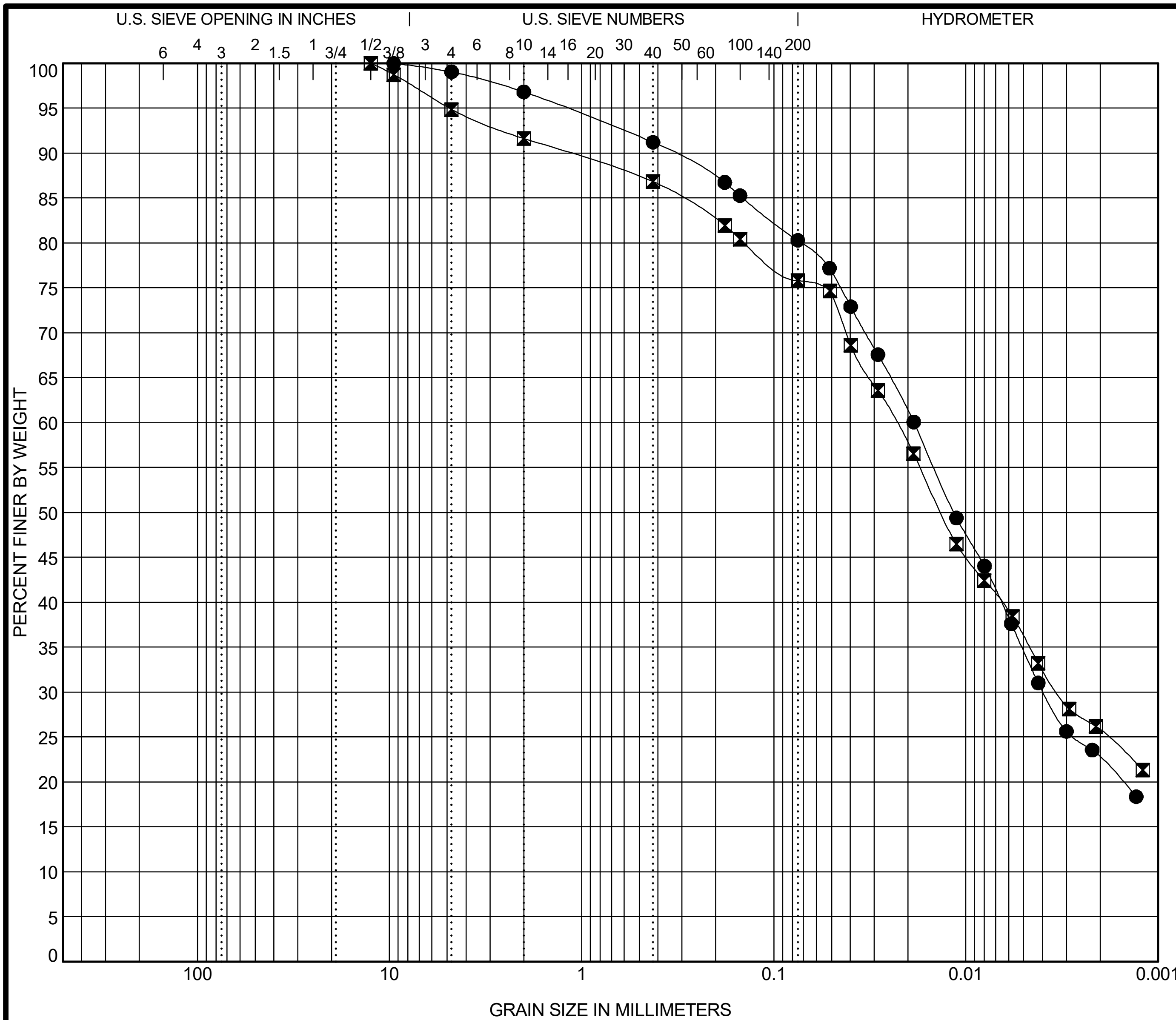
APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	RWB-01#4	8.5 ft	**Silty Clay Loam**	**30**	**17**	**13**		
⊠	RWB-05#2	3.5 ft	**Silty Clay Loam**	**32**	**16**	**16**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	RWB-01#4	8.5 ft	**9.5**	**0.019**	**0.004**		**3.2**	**16.6**	**57.6**	**22.6**
⊠	RWB-05#2	3.5 ft	**12.5**	**0.023**	**0.003**		**8.4**	**15.8**	**50.0**	**25.8**

WEI GRAIN SIZE IDH 1951302.GPJ US LAB.GDT 9/11/20

WEI
SINCE 1982

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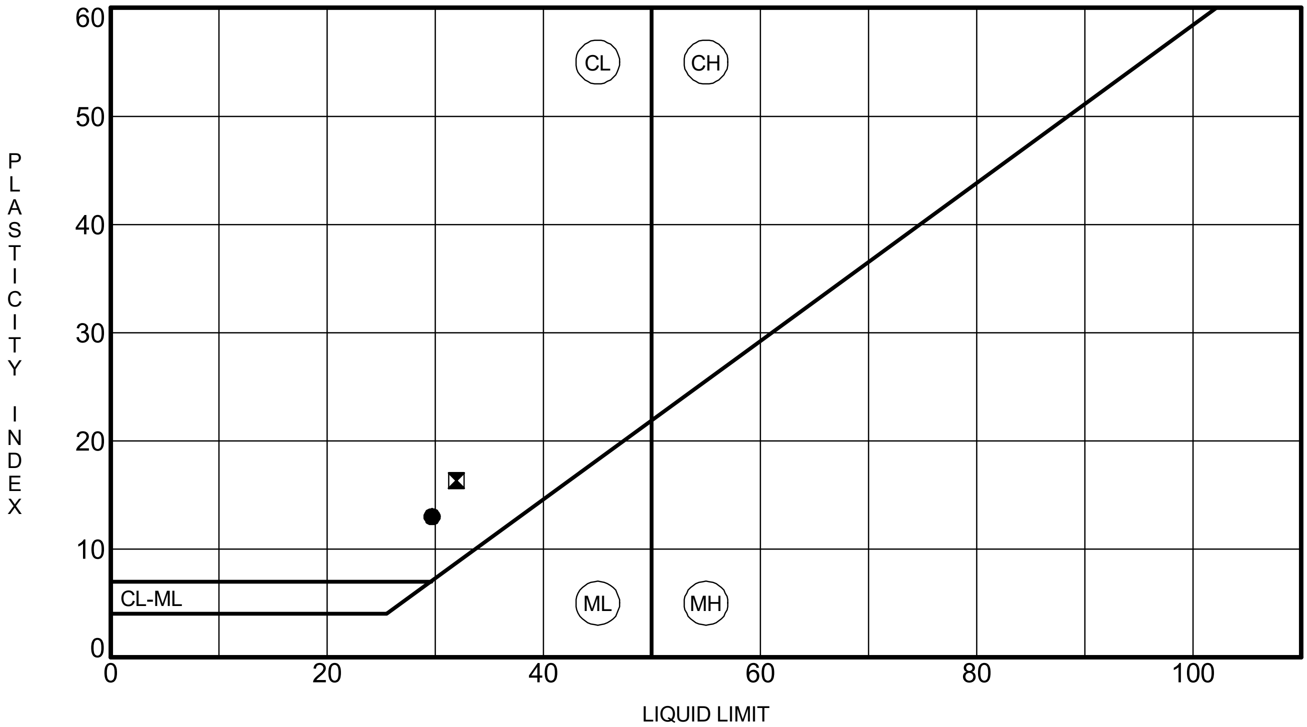
Telephone: (630) 953-9928
Fax: (630) 953-9938

GRAIN SIZE DISTRIBUTION

Project: IL 47 at IL 176 and Pleasant Valley Road

Location: McHenry County, Illinois

Number: 195-13-02



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**RWB-01#4**	**8.5 ft**	**30**	**17**	**13**	**80**	**Silty Clay Loam**
⊠	**RWB-05#2**	**3.5 ft**	**32**	**16**	**16**	**76**	**Silty Clay Loam**

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ATTERBERG LIMITS' RESULTS

Project: IL 47 at IL 176 and Pleasant Valley Road

Location: McHenry County, Illinois

Number: 195-13-02

WEI ATTERBERG LIMITS IDH 1951302.GPJ US LAB.GDT 9/11/20

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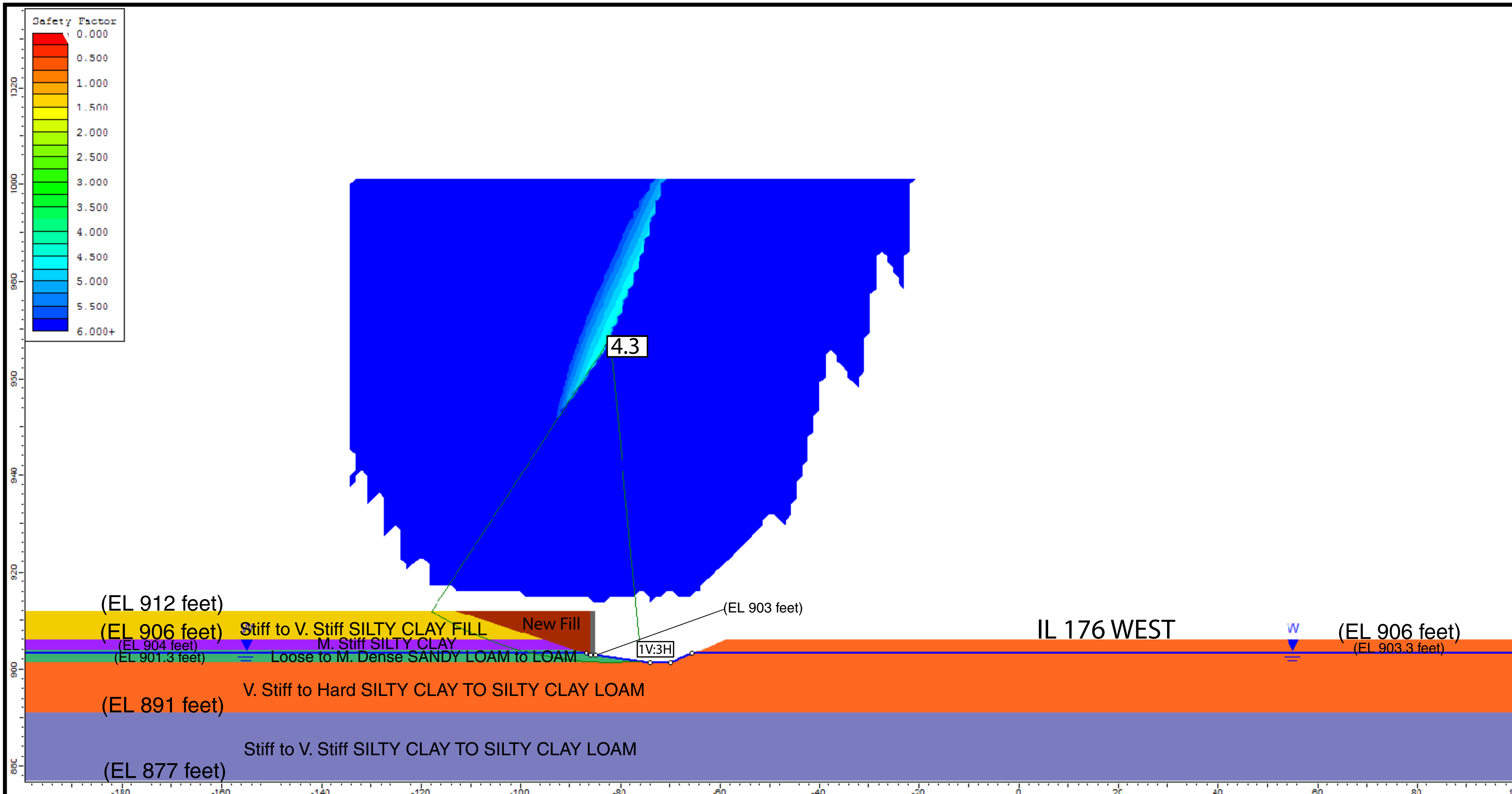
APPENDIX C



Undrained Analysis, Station 414+95, Ref Boring RWB-05, RWB-09, and RWB-10

Layer ID	Description	Total Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	New Fill	125	1000	0
2	Stiff to V. Stiff SILTY CLAY FILL	120	2000	0
3	M. Stiff SILTY CLAY	115	750	0
4	Loose to M. Dense SANDY LOAM to LOAM	110	0	28
5	V. Stiff to Hard SILTY CLAY to SILTY CLAY LOAM	120	4200	0
6	Stiff to V. Stiff SILTY CLAY to SILTY CLAY LOAM	120	2700	0

GLOBAL STABILITY: IL ROUTE 176 WEST RETAINING WALL ALONG COMED FACILITY, MCHENRY COUNTY, ILLINOIS

SCALE: GRAPHICAL

APPENDIX C-1

DRAWN BY: E. Greenwood
CHECKED BY: A. Hamad

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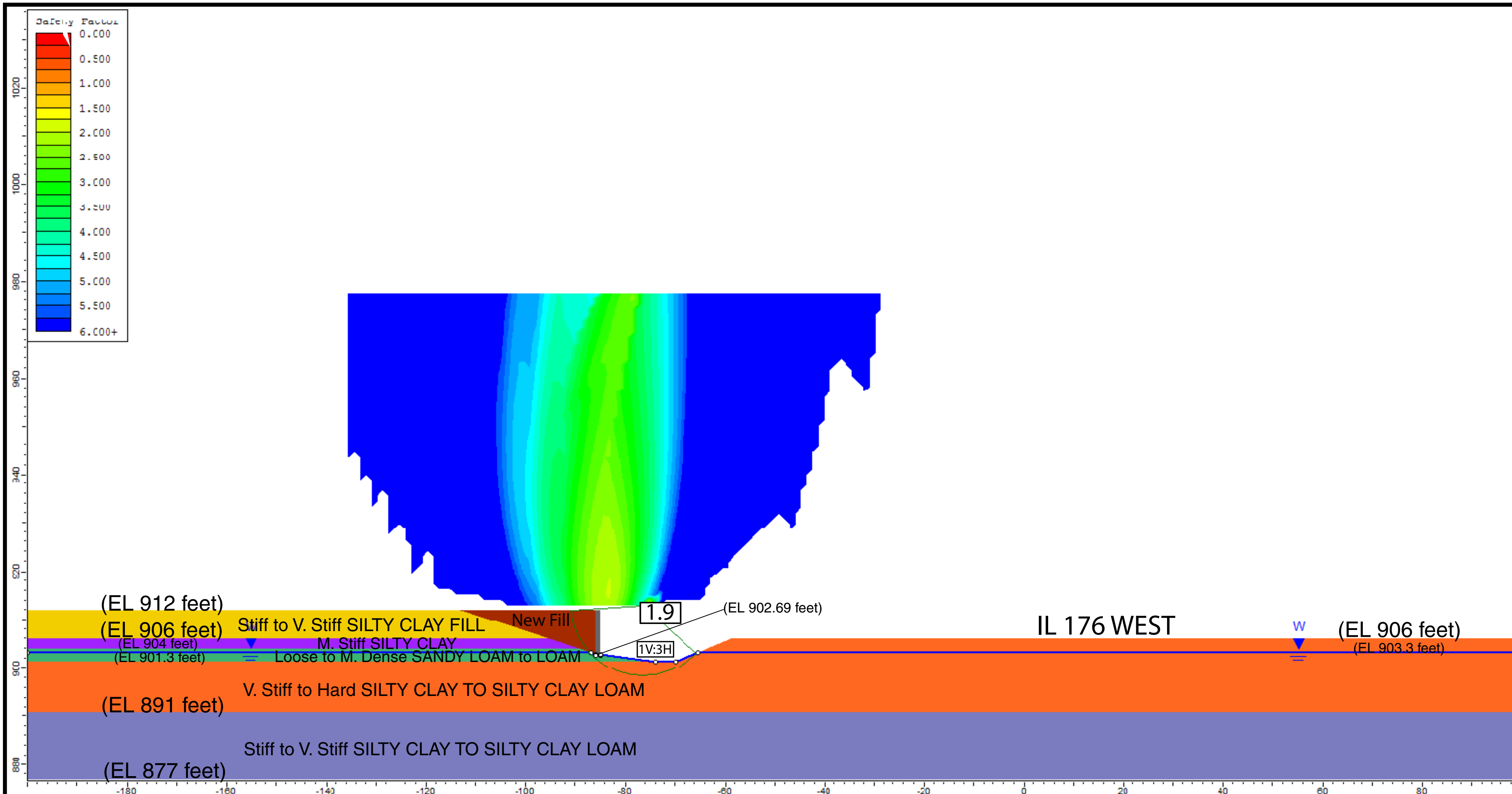
FOR STRAND ASSOCIATES, INC

195-13-02



Drained Analysis, Station 414+95, Ref Boring RWB-05, RWB-09, and RWB-10

Layer ID	Description	Total Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	New Fill	125	100	30
2	Stiff to V. Stiff SILTY CLAY FILL	120	100	31
3	M. Stiff SILTY CLAY	115	0	30
4	Loose to M. Dense SANDY LOAM to LOAM	110	0	28
5	V. Stiff to Hard SILTY CLAY to SILTY CLAY LOAM	120	100	30
6	Stiff to V. Stiff SILTY CLAY to SILTY CLAY LOAM	120	100	30

GLOBAL STABILITY: IL ROUTE 176 WEST RETAINING WALL ALONG COMED FACILITY, MCHENRY COUNTY, ILLINOIS

SCALE: GRAPHICAL	APPENDIX C-2	DRAWN BY: E. Greenwood CHECKED BY: A. Hamad

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FOR STRAND ASSOCIATES, INC | 195-13-02

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APPENDIX D

Benchmark:

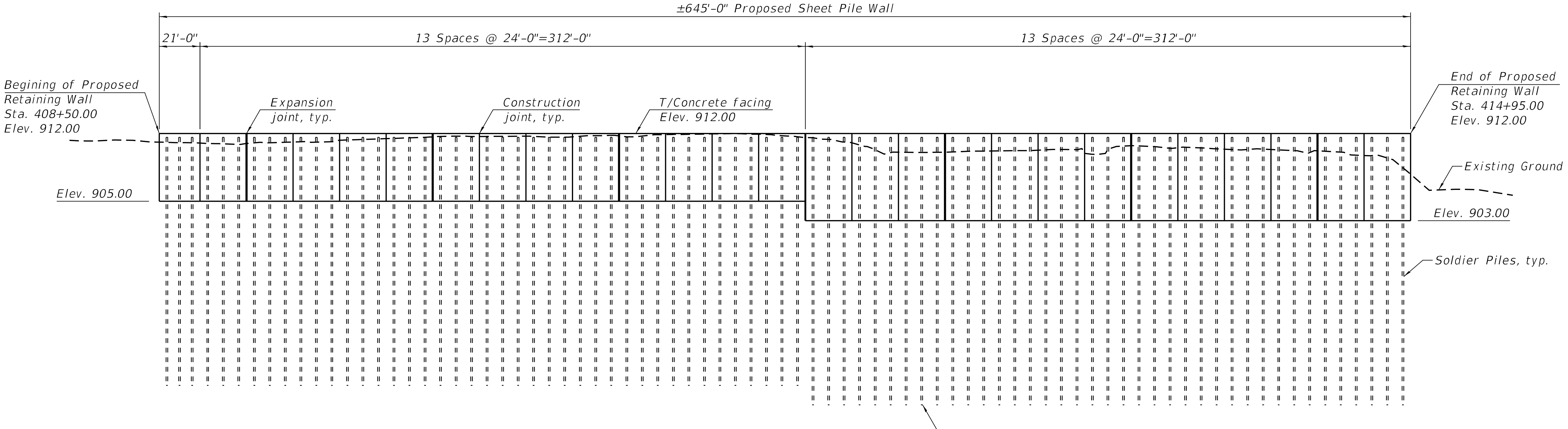
Existing Structure: None.

Salvage: None.

SCOPE OF WORK

INDEX OF SHEETS

CONSTRUCTION SEQUENCE



ELEVATION

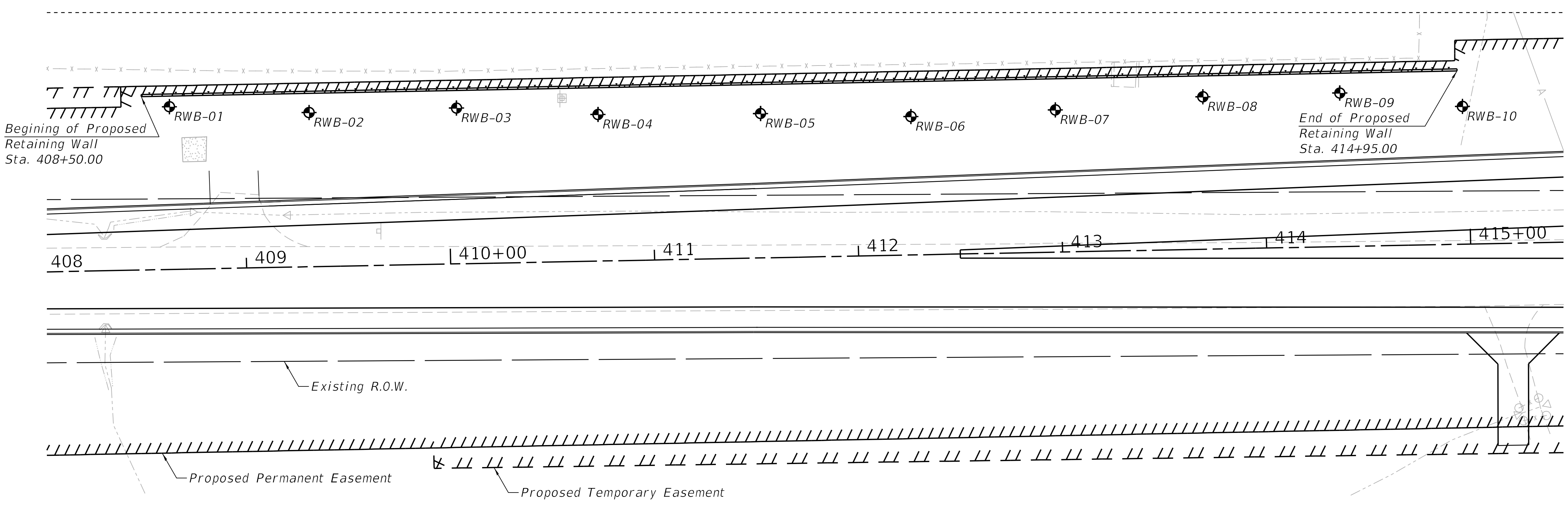
DESIGN SPECIFICATIONS

AASHTO LRFD Bridge Design Specifications, 9th Edition

DESIGN STRESSES

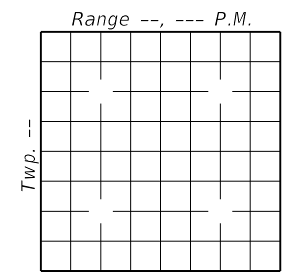
FIELD UNITS

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



PLAN

PROFILE GRADE



LOCATION SKETCH

GENERAL PLAN & ELEVATION

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SA STRAND ASSOCIATES®	1170 SOUTH HOUBOLT ROAD JOLIET, ILLINOIS 60431 (815) 744-4200 IDFPR NO. 184-001273	USER NAME = brianf	DESIGNED - BRL	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	GENERAL PLAN AND ELEVATION		
			CHECKED - KRB	REVISED -		STRUCTURE NO.		
		PLOT SCALE =	DRAWN - BJF	REVISED -				
		PLOT DATE = 9/9/2020	CHECKED - BRL	REVISED -		SHEET NO. 1 OF 9 SHEETS		

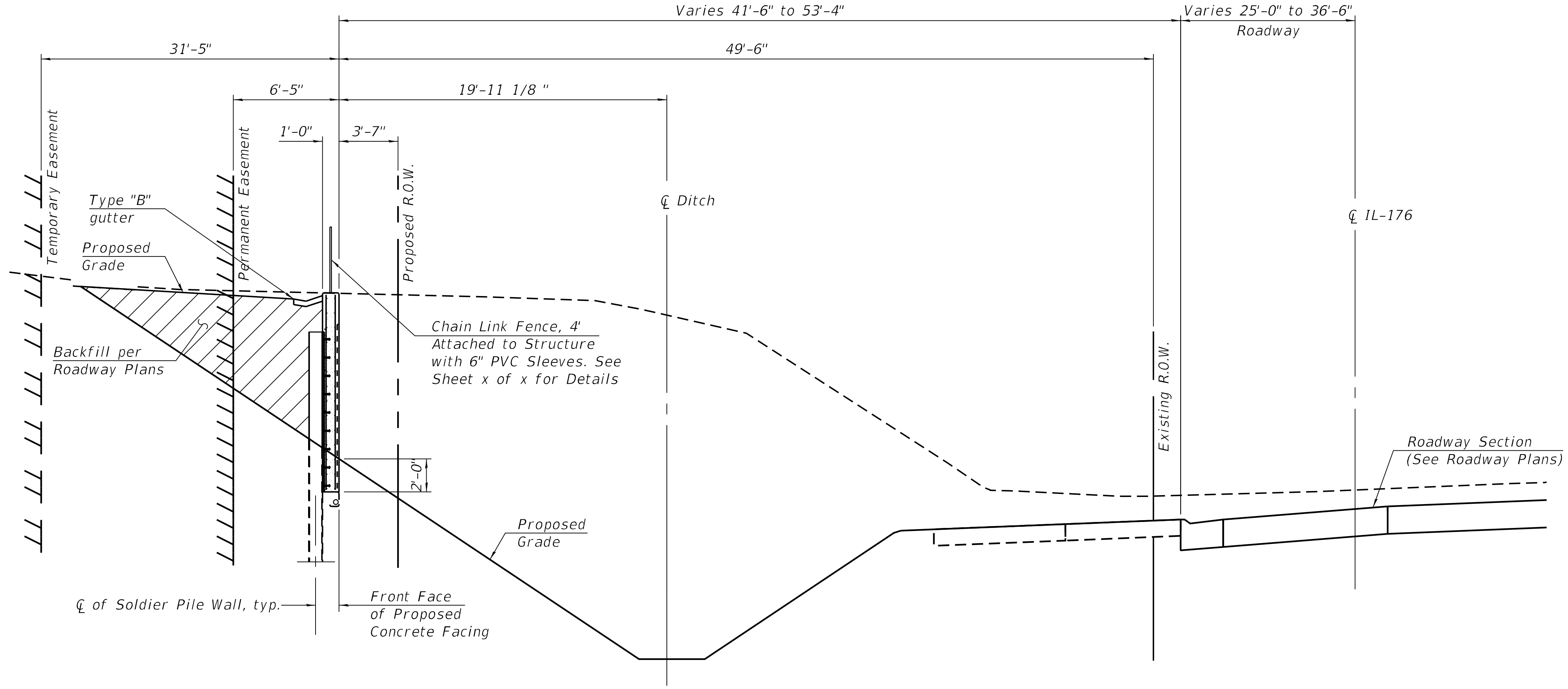
F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	McHENRY	TOT	1
		CONTRACT NO. 62B43		
		ILLINOIS FED. AID PROJECT		

GENERAL NOTES

Reinforcement bars designated (E) shall be epoxy coated.
The timber lagging shall be a minimum 3 inch nominal rough-swan thickness with a minimum allowable bending stress of 1,000 psi.
Concrete sealer shall be applied to exposed surfaces of the front face, top face, and back face of the wall.
The Concrete Facing shall not be poured before all grading work behind and above the wall are complete.

TOTAL BILL OF MATERIAL

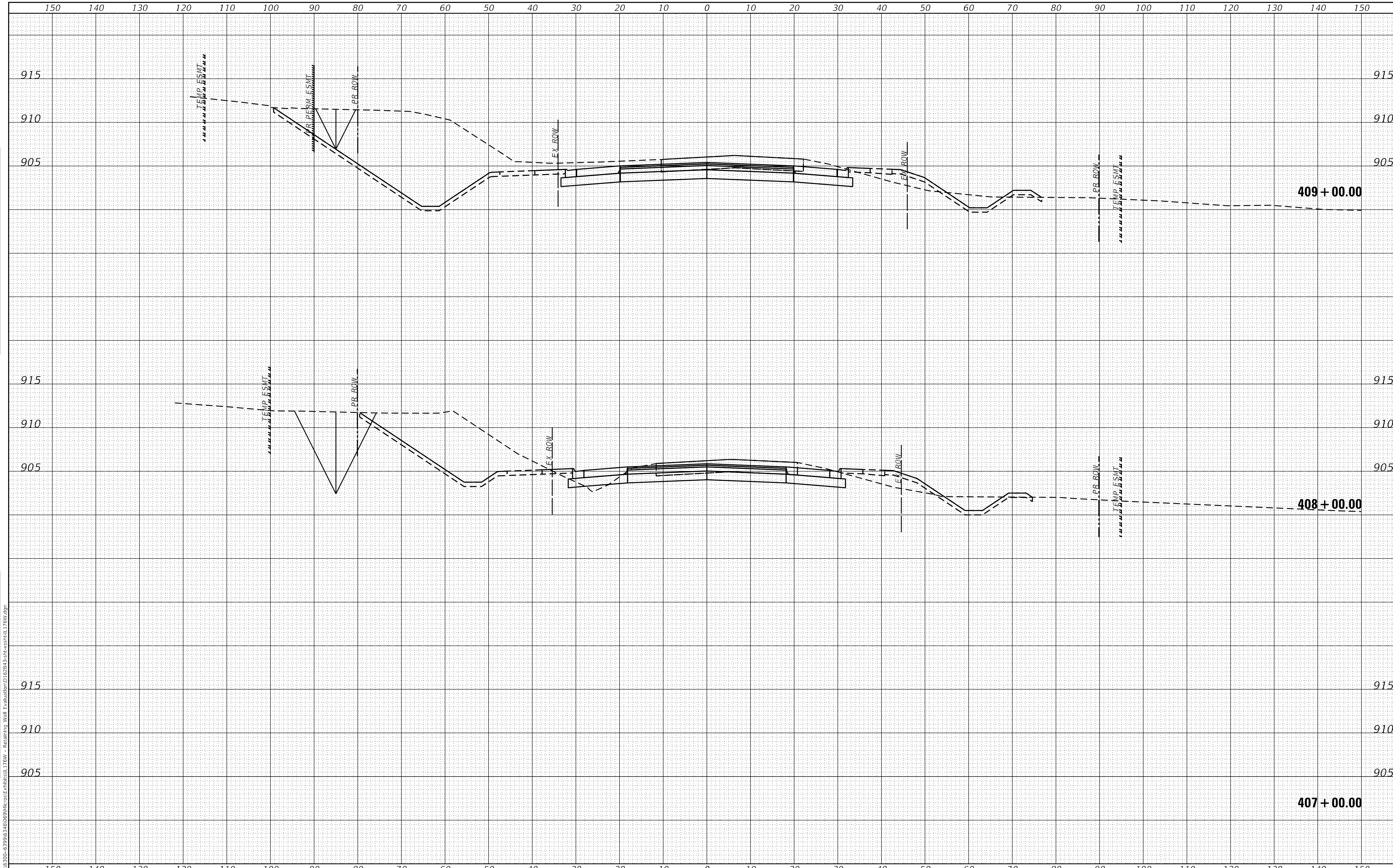
Item	Unit	Total
Structure Excavation	Cu Yd	
Concrete Structures	Cu Yd	
Stud Shear Connectors	Each	
Reinforcement Bars, Epoxy Coated	Pound	
Concrete Sealer	Sq Ft	
Geocomposite Wall Drain	Sq Yd	
Concrete Gutter, Type B	Foot	
Drilling And Setting Soldier Piles (In Soil)	Cu Ft	
Granular Backfill For Structures	Cu Yd	
Untreated Timber Lagging	Sq Ft	
Furnishing Soldier Piles (W Section)	Foot	
Pipe Underdrains For Structures 4"	Foot	



SECTION THRU SOLDIER PILE WALL

(Looking North)

**Included in the cost of Weep Holes Cored



FINAL SURVEY NOTE BOOK NO. — SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED — BY — DATE

ORIGINAL SURVEY NOTE BOOK NO. — SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED — BY — DATE

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STRAND ASSOCIATES
1170 SOUTH HOUBOLT ROAD
JOLIET, ILLINOIS 60431
(815) 744-4200

USER NAME = StevenB	DESIGNED - MAG	REVISED -	
	DRAWN - DJW	REVISED -	
PLOT SCALE = 20.0000 ' / in.	CHECKED - DWG	REVISED -	
PLOT DATE = 2/15/2019	DATE - $PLANDATE$	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: 10H 5V | SHEET OF SHEETS | STA. 407+00.00 TO STA. 409+00.00

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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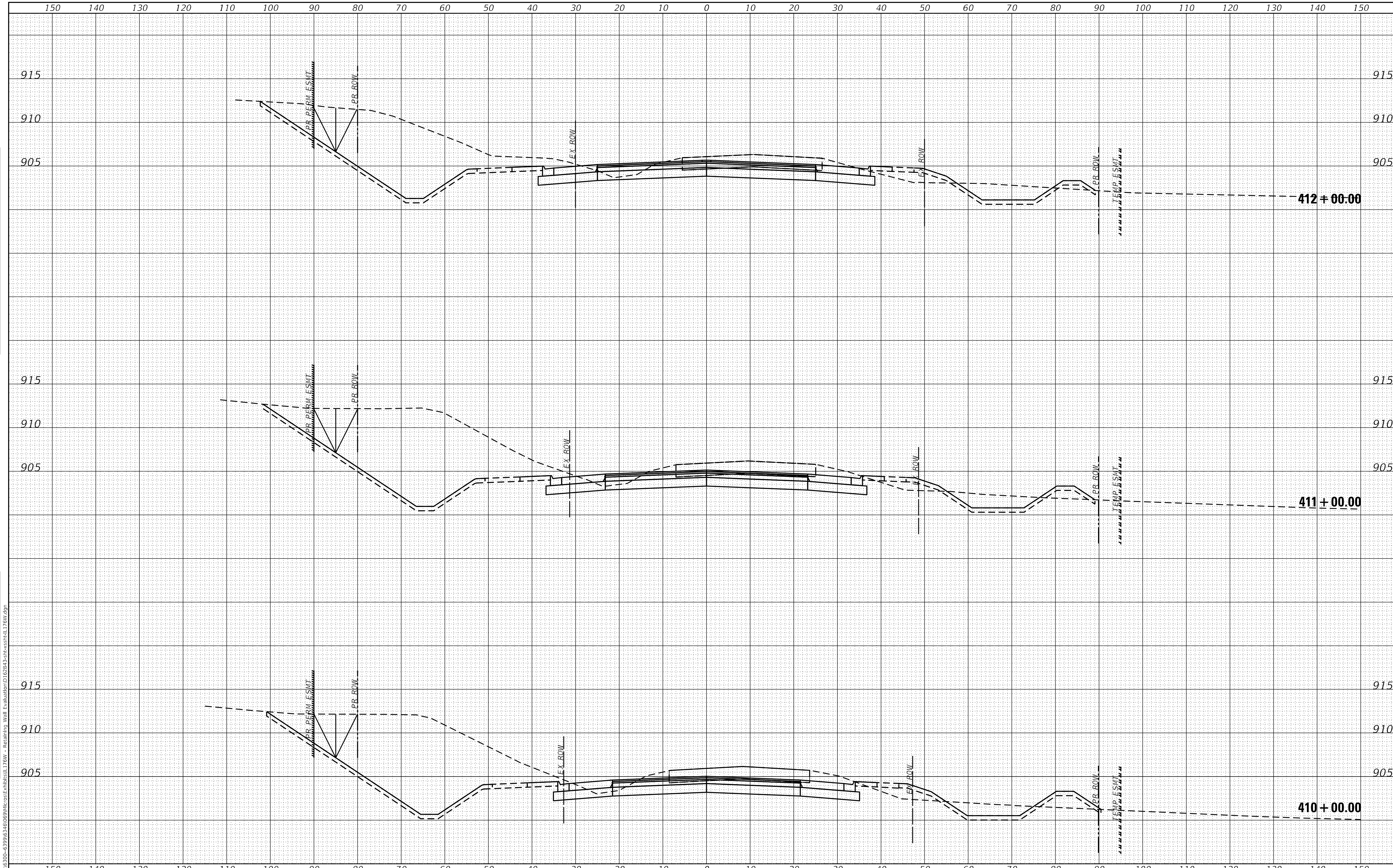
CONTRACT NO. 62B43				
ILLINOIS FED. AID PROJECT				



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1170 SOUTH HOUBOLT ROAD
JOLIET, ILLINOIS 60431
(815) 744-4200

USER NAME = StevenB	DESIGNED - MAG	REVISED -
	DRAWN - DJW	REVISED -
PLOT SCALE = 20.0000 ' / in.	CHECKED - DWG	REVISED -
PLOT DATE = 2/15/2019	DATE - $PLANDATE$	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: 10H 5V | SHEET OF SHEETS | STA. 410+00.00 TO STA. 412+00.00

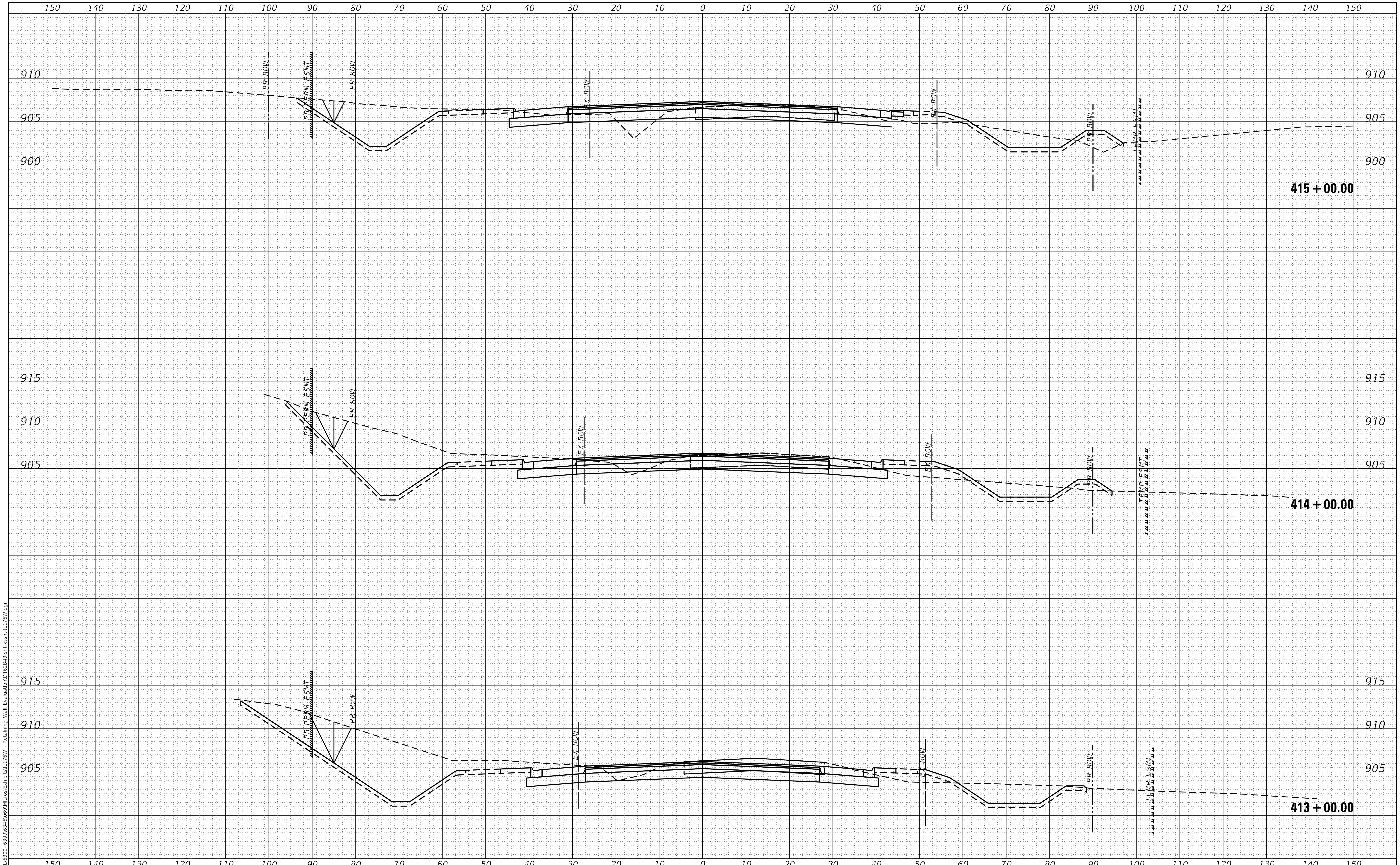
F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	TOT	

CONTRACT NO. 62B43

ILLINOIS | FED. AID PROJECT

FINAL SURVEY: NOTE BOOK NO. ___ SURVEYED ___ PLOTTED ___ TEMPLATE ___ AREAS ___ AREAS CHECKED ___ BY DATE

ORIGINAL SURVEY: NOTE BOOK NO. ___ SURVEYED ___ PLOTTED ___ TEMPLATE ___ AREAS ___ AREAS CHECKED ___ BY DATE



STRAND ASSOCIATES® 1170 SOUTH HOUBOLT ROAD JOLIET, ILLINOIS 60431 (815) 744-4200	USER NAME = StevenB	DESIGNED - MAG	REVISED -
		DRAWN - DJW	REVISED -
	PLOT SCALE = 20.0000 ' / in.	CHECKED - DWG	REVISED -
	PLOT DATE = 2/15/2019	DATE - $PLANDATE$	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: 10H 5V | SHEET OF SHEETS | STA. 413+00.00 TO STA. 415+00.00

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	TOT	

CONTRACT NO. 62B43

ILLINOIS FED. AID PROJECT

MODEL: Default
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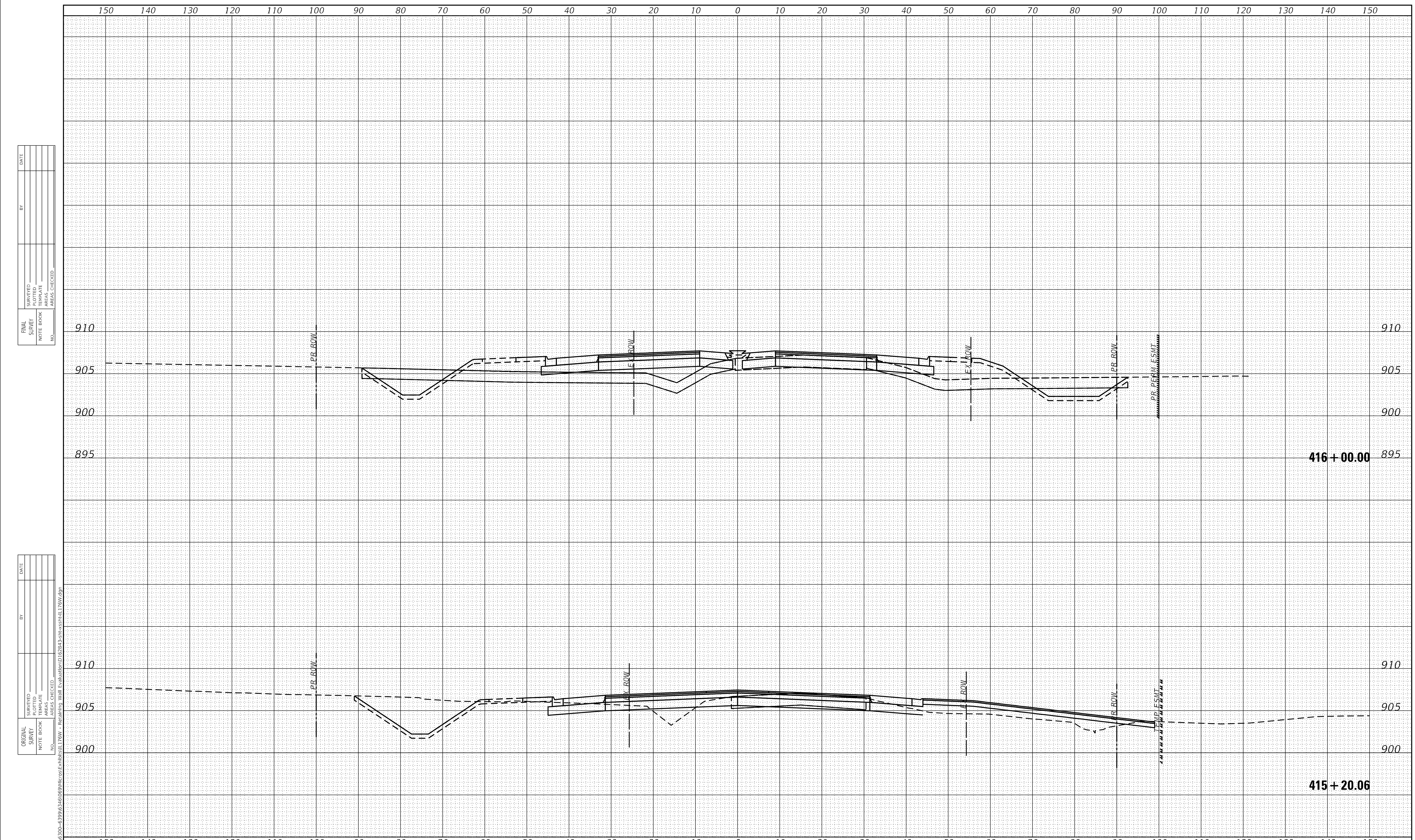
FINAL SURVEY NOTE BOOK NO. SURVEYED PLOTTED TEMPLATE AREAS AREAS CHECKED BY DATE

ORIGINAL SURVEY NOTE BOOK NO. SURVEYED PLOTTED TEMPLATE AREAS AREAS CHECKED BY DATE



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1170 SOUTH HOUBOLT ROAD
JOLIET, ILLINOIS 60431
(815) 744-4200

USER NAME = StevenB	DESIGNED - MAG	REVISED -
	DRAWN - DJW	REVISED -
PLOT SCALE = 20.0000 ' / in.	CHECKED - DWG	REVISED -
PLOT DATE = 2/15/2019	DATE - $PLANDATE$	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: 10H 5V	SHEET OF SHEETS	STA. 415+20.06	TO STA. 416+00.00

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
326	105-N-2(15)	MCHENRY	TOT	
		CONTRACT NO. 62B43		
	ILLINOIS	FED. AID PROJECT		