DRAFT
Geotechnical Evaluation
West Segment 3

August 29, 2014

Revision 0

Southwest LRT Project Technical Report

This page intentionally blank.

Contents

List of Appendices

Executive Summary

This technical memorandum presents the *Geotechnical Evaluation of West Segment 3* of the Southwest Light Rail Transit (SWLRT) project in Hennepin County. This document combines six separate memorandums, included in the appendices, under one cover. They provide the details of the geotechnical findings and recommendations for the following areas:

- **Retaining Walls W301, W301C and W302** - This preliminary design report addresses the design and construction of three retaining walls that will support the track embankment from STA 2352+00 to STA 2379+00. This area has been commonly referred to as the Opus Hill in design team meetings. A pedestrian underpass is proposed near STA 2361+50. See Appendix A.
- **Feltl Road and Smetana Road Bridges** – This Foundation Analysis Design Recommendation (FADR) report addresses the geotechnical evaluation for the proposed bridges to be installed beneath Smetana Road and Feltl Road from STA 2381+70 to STA 2384+50 in Minnetonka, Minnesota. See Appendix B
- **Minnetonka Hopkins Crossing** – This FADR report provides the results of the soil borings along the alignment of the proposed Minnetonka/Hopkins Crossing from approximate track STA 2386+00 to STA 2420+00 and provides preliminary recommendations for the bridge structure (continuous with 3-structure types) and corresponding embankment support. A final geotechnical report should be prepared after final geotechnical borings are completed. See Appendix C
- **Shady Oak Station** – This geotechnical evaluation report addresses the proposed Shady Oak Platform Station, from approximate track STA 2430+00 to STA 2432+75. The site is located approximately 500 feet north of the intersection of K-Tel Drive (5th Street South) and 16th Avenue South in Hopkins, Minnesota. See Appendix D
- **Track STA 2413+65 to STA 2450+22** – This geotechnical evaluation report addresses the proposed light rail transit line track, retaining wall and traction power substation construction between STA 2413+65 and STA 2450+22 in Hopkins. See Appendix E
- **OMF** – This preliminary report provides the results of the soil borings and preliminary recommendations regarding the proposed Operations and Maintenance Facility (OMF), Site 9A in Hopkins, Minnesota. See Appendix F

This information was used in other elements of the project development including preliminary site plans, station plans, roadway improvements and traffic analysis.

Appendix A

Retaining Walls W301, W301C and W302

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Preliminary Retaining Walls and Track Recommendations
Retaining Walls RTW-W301, RTW-W301C, and RTW-W302 – 30% Design
STA 2352+00 to STA2379+00
Southwest LRT, West Segment 3
Minnetonka, Minnesota

Dear Mr. Demers:

The Opus Hill is a steeply sloped area of the proposed Southwest Light Rail Transit (SWLRT) alignment in Minnetonka, Minnesota. The slope is essentially entirely wooded. Due to lack of right of entry for our drilling equipment -- many mature trees would need to be removed to allow access to our drilling equipment -- and because heavy equipment would be needed to grade a path/road for our drilling equipment, soil borings have not been completed at this time.

In this report we describe the proposed design described to us in past meetings and shown in the preliminary engineering plans. We use our historical geotechnical experience in the area including published soil maps to provide commentary and recommendations for the proposed construction. We recommend a drilling program be completed prior to construction to confirm our assumptions provided in this report and to assist in estimating design parameters.

This report is part of a larger series of reports for the west segment of the SWLRT project. Recommendations for general track construction, pedestrian underpasses, and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project information

The west segment of the SWLRT project is proposing to construct a light rail transit line through the cities of Hopkins, Minnetonka, and Eden Prairie, Minnesota. This preliminary design report addresses the design and construction of three retaining walls that will support the track embankment from STA 2352+00 to STA 2379+00. This area has been commonly referred to as the Opus Hill in design team meetings. A pedestrian underpass is proposed near STA 2361+50.

A.1. Type of Structure

Cast-in-place (CIP) concrete will be used to construct retaining wall RTW-W301. RTW-W301C is proposed to be either a soldier pile or sheet pile retaining wall. RTW-W302 is proposed to be a combination of both CIP concrete and Mechanically Stabilized Earth (MSE) retaining wall. The proposed CIP concrete walls will be supported by spread footing foundations founded at least 4 1/2 feet below the lowest finished grade along the toe of the wall. The walls will be designed and constructed by others.

A.2. Location of Walls

We were provided with drawings showing the plan and profile for each of the three walls. The locations and additional information for the walls are provided below.

A.2.a. Wall RTW-W301

Wall RTW-W301 is proposed to be CIP concrete and is located along the south portion of the proposed SWLRT alignment, extending from about STA 2352+00 to STA 2360+50 and will run on the west side of the track on the uphill side of Opus Hill. Based on the preliminary engineering plans, the wall both initially retains soil on the uphill side of the wall (cut area) and appears to retain soil on the east side of the wall where the track temporarily is higher than existing grade (fill area). Exposed wall heights appear to range from 10 to 15 feet, with stem wall heights ranging from 13 to 20 feet.

A.2.b. Wall RTW-W301C

Wall RTW-W301C is essentially the same wall as RTW-W301 except it transitions from a cast-in-place wall to either a soldier pile or sheet pile wall with tie-backs due to the height of the hill and limited ability to excavate to construct a cast-in-place wall due to the severe uphill slope. Wall RTW-W301C extends from about STA 2361+50 to STA 2379+00, with a maximum exposed wall height of up to 22 feet. Tie-backs will be used to reinforce the wall.

A.2.c. Wall RTW-W302

Wall RTW-W302 is located along the east side of the proposed SWLRT alignment, extending from about STA 2364+25 to STA 2376+00. The proposed wall is planned to be an MSE retaining wall from about STA 2364+25 to STA 2368+75 and transition into a CIP concrete wall from STA 2368+75 to Station 2376+00. The wall typically retains fill used to raise grade on the downslope side of the alignment (northbound track) but in some cases retains soil on the east side of the wall where the northbound track is below the existing grade. Exposed wall heights of 2 to 15 feet are expected, with stem wall heights ranging from 8 to 24 feet, approximately.

A.3. Embankment Construction

To construct the walls and embankment along the proposed alignment both cuts and fill will be needed to reach finished grade. We estimate approximately 70 percent of the track will be located in cut areas, with the remaining 30 percent requiring fill. In some cases there are cuts into the hill for the southbound track while fill is needed to reach finished graded for the northbound track. All of the retaining walls foundations appear to be founded in cut areas.

B. Subsurface Investigation Summary

B.1. Anticipated Soil Conditions

As previously mentioned, soil borings were not performed for this segment due to lack of right of entry, the impassible amount of tree growth, and the severe slope in many areas of this segment.

To perform final soil borings, after receiving right of entry, many trees will need to be cut down. Due to the severe slopes in parts of the segment, a grading contractor will need to create a path or roadway for our drill rigs. The grading will disturb the surficial soil creating the potential for erosion. Due to the severe slopes in some areas, any cutting into the hill and filling on the hill may create slope conditions that do not meet temporary slope stability safety requirements. Due to the difficult terrain, it may be necessary to protect or armor the slope for erosion and stability purposes after grading. Soldier pile walls or other retention systems may need to be installed to stabilize the slope.

The soils in this section of the alignment and specifically in the hill are expected to be glacial till soils in a stiff condition. The purpose of any future soil borings will be to confirm the anticipated favorable soil conditions throughout the length of the wall.

SPO will need to consider the value of performing borings due to the extreme expense of obtaining borings prior to construction. Soldier pile or sheet pile walls are specifically being used for permanent conditions due to the difficulty in construction of typical retaining walls due to the steep slopes. Future borings in areas of difficult terrain may not be able to be obtained in all areas until after construction starts.

There are areas on the south side of the hill where wall RTW-W301 starts near Station 2352+00 that have the potential to contain soft soils and/or organics. Groundwater in this area should also be measured in relation to finished grade. That area does contain extensive amounts of trees but the slopes are not as severe as further north in the middle of Opus Hill.

B.2. Anticipated Water Conditions

Groundwater near the south end of the Opus Hill walls could be close to the track elevation. WSB has provided us with information indicating wetland number 582C-L to the east of Opus Hill has a 100 year High Water Level (HWL) of 880.8 and a 500 year HWL of 881.5. The bottom of the proposed Guideway between STA 2352+00 and STA 2354+00 is below an elevation of 880. The anticipated draintile location for the retaining wall is also assumed to be at the bottom of Guideway elevation.

There may be the need to raise the track elevation in this area or to decrease the thickness of the subbase section to reduce the proximity of the Guideway and draintile systems to groundwater levels. In addition there is a risk of water flow through the Guideway soils, thereby potentially providing a drainage path for the nearby ponds.

If the track and retaining wall footings cannot be modified, raising the elevation of the draintile systems within the Guideway and for the retaining walls will reduce the risk of excess water flow.

C. Foundation Analysis and Recommendations

The anticipated soils in this area of the retaining walls are glacial till soils. The soils should be competent to directly support footings, embankments and soldier pile or sheet pile walls.

The existing vegetation, topsoil, and any soft, shallow fill encountered should be removed from below the proposed embankment and walls. After stripping, it is possible pockets of soft surficial soils exist that may need to be removed. On the southern edge of this segment near the start of wall RTW-W301 at STA 2352+00 there exists the potential for thicker areas of soft soil or even organics, however it is anticipated the unsuitable soils will be shallow enough they can be excavated.

Organic soils should be not be reused as fill unless in green areas. New fill placed beneath foundations may consist of mineral soils that are properly moisture conditioned. Fill placed for the retaining walls should follow the specifications in Table 1.

The extent of the excavation required for the walls should extend horizontally beyond the embankment limits/footing dimensions a distance equal to the depth of the subcut. Exposed excavation bottoms, deemed suitable by a Geotechnical Engineer, should be surface compacted by a large vibratory sheepsfoot compactor prior to fill or footing placement. Excavations into embankments should be "Benched" or keyed into the slope to reduce the risk of fill instability. Benches should be a minimum of 6 feet wide.

We recommend the use of engineered fill to establish slope subgrade or backfill for any subcuts of marginal soils under the proposed CIP spread foundation foundations, oversize areas, or reinforced zones. Please refer to Table 1 below for material and compaction specifications based on the 2014 MnDOT Standard Specification for Construction.

Table 1. Recommended Fill and Compaction Specifications.

Material	Material Specification	Compaction Specification
Fill Placed Beneath Footings	2105.1A7	2105.3F
Leveling Pad Beneath Footings	3138.2B	2211.3C
Retaining Wall/Embankment Backfill	3149.2D2	2105.3F

We recommend backfill material be placed in uniform layers approximately parallel to the profile, extending the full width of the retaining structures. We recommend backfill material be placed in lift thicknesses not exceeding 12 inches.

We recommend that the walls be supported on spread footings, following the MnDOT standard plans included in the *Cast-in-Place Retaining Wall Details* section of the Appendix. The size of these footings shall be determined based upon the stem wall height by the wall designer. If stem wall heights/footing sizes change during retaining wall design, we should be notified to confirm that bearing capacity and settlement criteria are within the recommended tolerances. We recommend that the footings be embedded at least 4-1/2 feet below grade (bottom of footing) for frost protection.

C.1. Embankment and Slopes

With the construction of the soldier pile or sheet pile walls shown in the Preliminary Engineering Plans, the slopes around the Opus Hill are anticipated to be stable after any unsuitable soil is removed.

Slope stability analyses should be performed in final design using assumed parameters if soil borings are not performed to verify the final structure and slope geometries are stable.

C.1.a. Walls RTW-W301 and RTW-W302

We anticipate the spread footings for CIP walls and leveling pad for MSE walls can be supported on existing glacial soil after the removal of any surficial soft soil. Both walls RTW-W301 and RTW-W302 will be excavated into existing slopes. We recommend benching into the existing slopes during construction to provide stability for engineered fill placed behind the walls.

C.1.a.1. Wall RTW-W301C

We anticipated glacial soils are located in the areas of wall RTW-W301C and should be suitable of providing good end bearing, skin resistance, and lateral pressures for the proposed soldier pile or sheet pile wall. Cobbles and boulders are known to exist in glacial soils and could obstruct the piles and tie-backs. We recommend budgeting for protective tips for the piles at this time and for extra piles and tie-backs that are damaged during installation. Some piles and tie-backs may need to be offset due to obstructions.

C.1.b. Construction Staging Requirements

Based on the anticipated wall heights and the estimated settlements, we recommend a short waiting period for the portions of the embankment where fill thicknesses exceed 10 feet.

D. Qualifications

D.1. Continuity of Professional Responsibility

D.1.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

D.1.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

D.2. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

E. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding this report, please call Matt Ruble at 952.995.2224 or Ray A. Huber at 952.995.2260.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report
Was prepared by me or under my direct supervision
And that I am a duly Licensed Professional Engineer
Under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal / Project Engineer
License Number: 45005

Reviewed by:

Ray A. Huber, PE
Vice President/Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

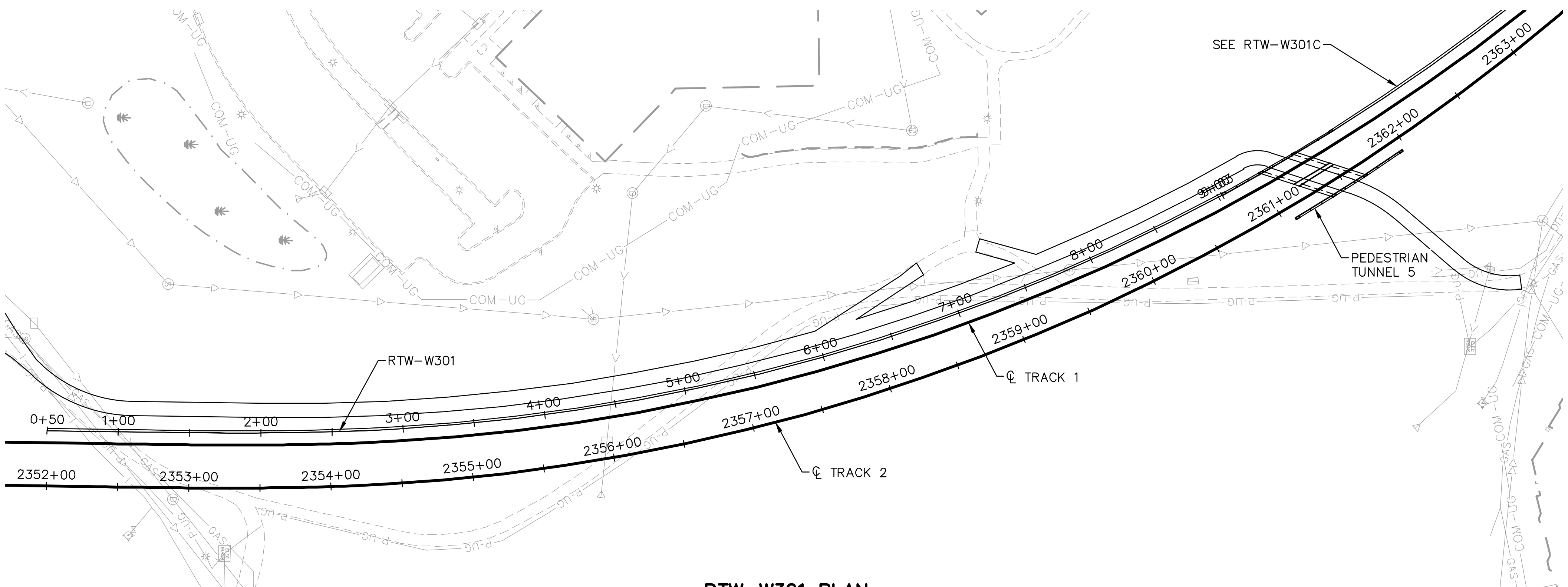
Appendix:
Preliminary Engineering Plan and Profile pages for RTW-W301, RTW-W301C and RTW-W302

APPENDIX

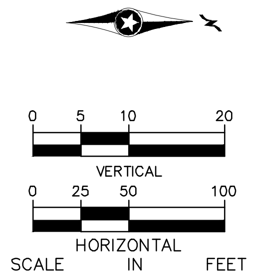
NOTE:
RTW-W301 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

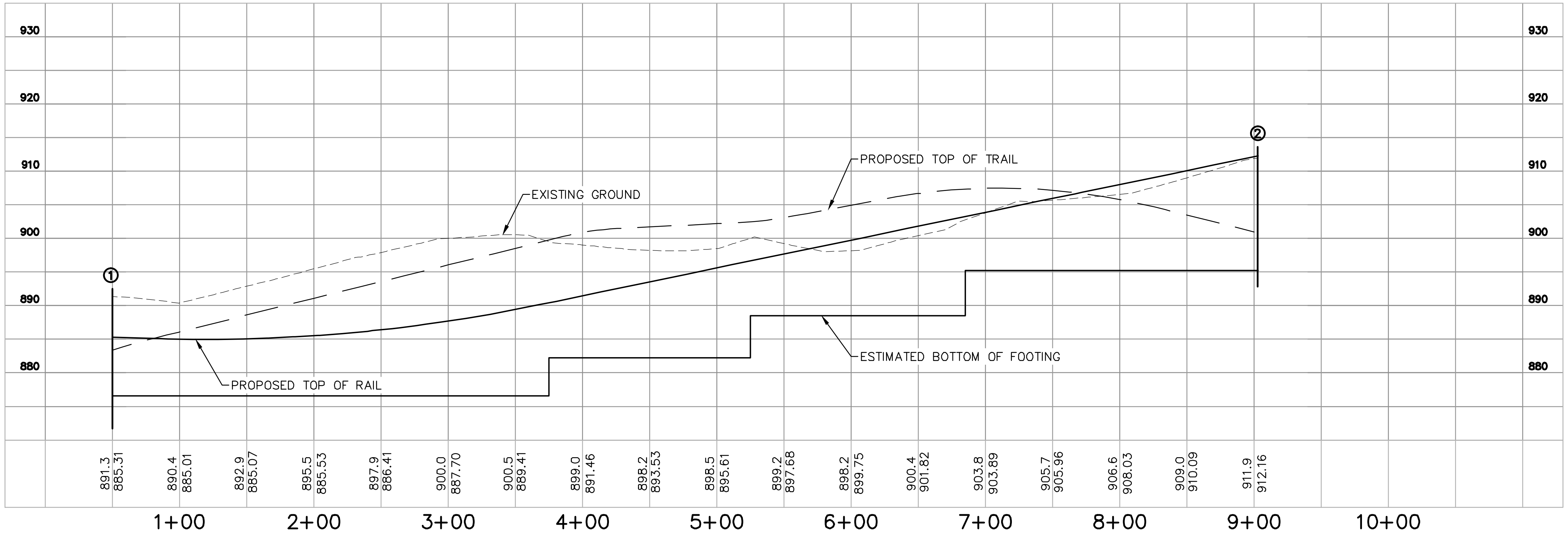
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

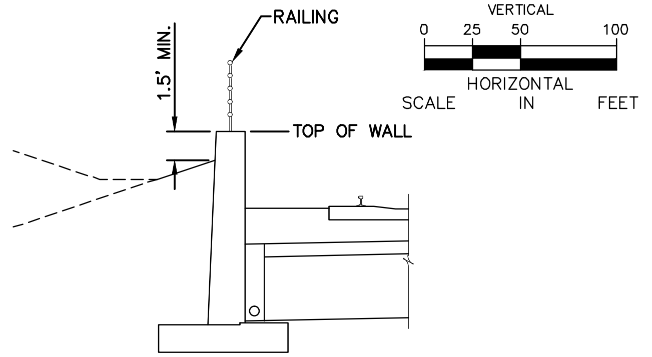


RTW-W301 PLAN

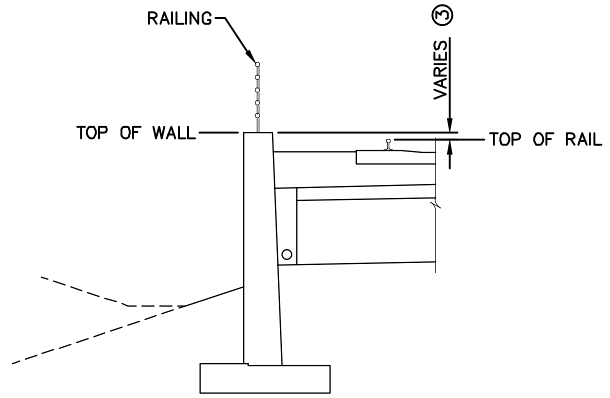




RTW-W301 PROFILE



RTW-W301 TYPICAL SECTION
STA. 0+50 TO STA. 7+69



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W301 TYPICAL SECTION
STA. 7+69 TO STA. 9+03

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

CHECK BY:	DATE:
BACK–CHECKED BY:	DATE:
CORRECTED BY:	DATE:
REVIEWED BY:	DATE:

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extension

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3
RTW-W301
PLAN AND PROFILE

DISCIPLINE: **STRUCTURES**

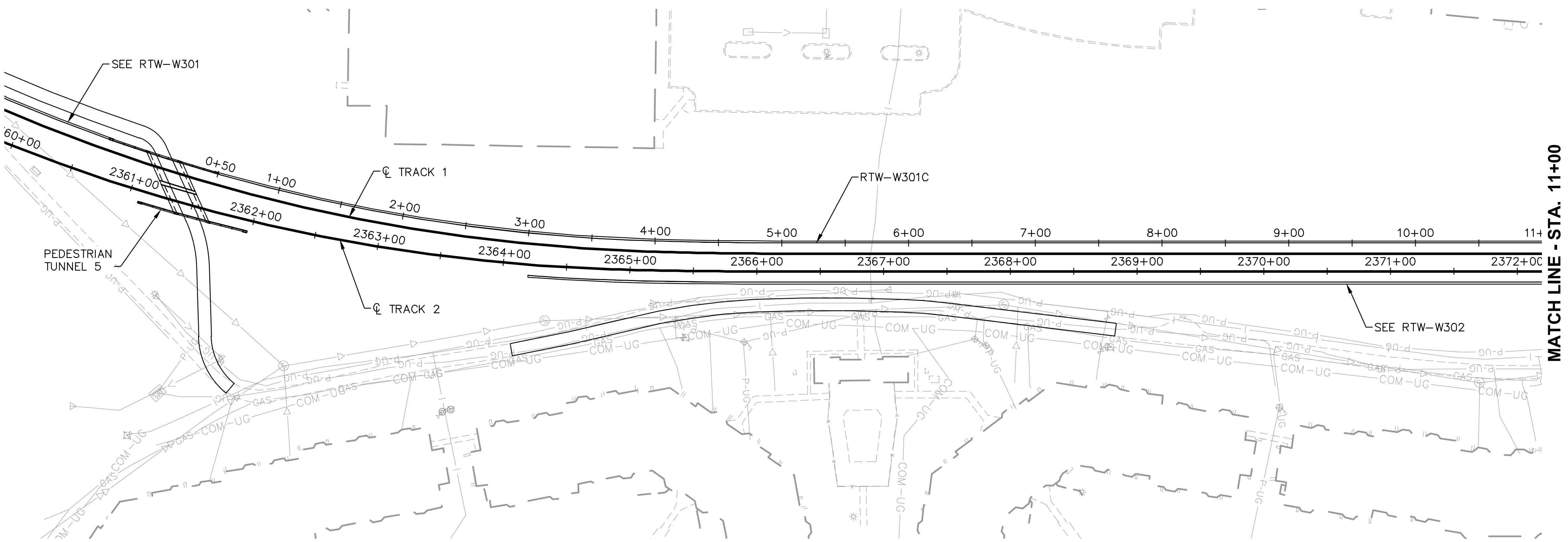
SHEET NAME: **W3-STU-RTW-PPFL001**

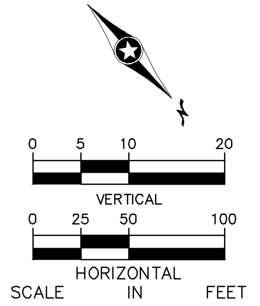
SHEET
189
OF
197

Jun, 13 2014 11:05 am V:\3200_pec-w\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: NutzmaML

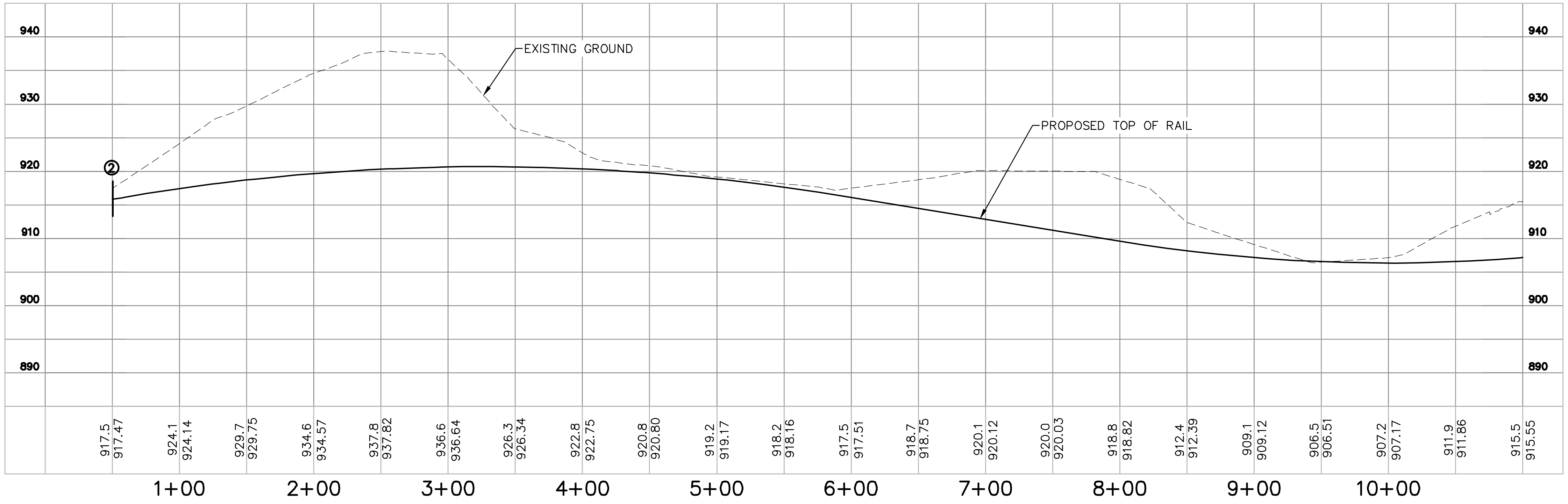
NOTE:
RTW-W301C IS ANTICIPATED TO BE A SOLDIER PILE RETAINING WALL TO MINIMIZE IMPACT ON ADJACENT PROPERTIES.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

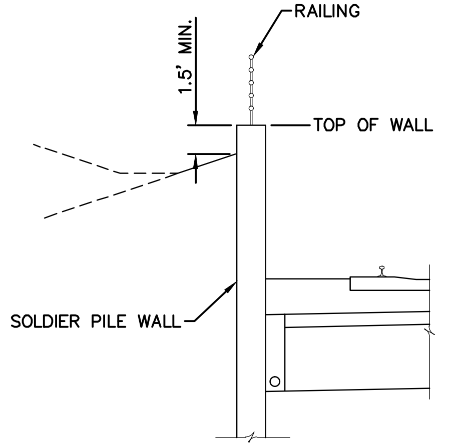




RTW-W301C PLAN



RTW-W301C PROFILE



RTW-W301C TYPICAL SECTION

Jun, 13 2014 11:06 am V:\3200_pec-w\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: NutzmaML

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

CHECK BY: DATE:
BACK-CHECKED BY: DATE:
CORRECTED BY: DATE:
REVIEWED BY: DATE:

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3 - RTW-W301C
PLAN AND PROFILE
STA. 0+50 TO STA. 11+00

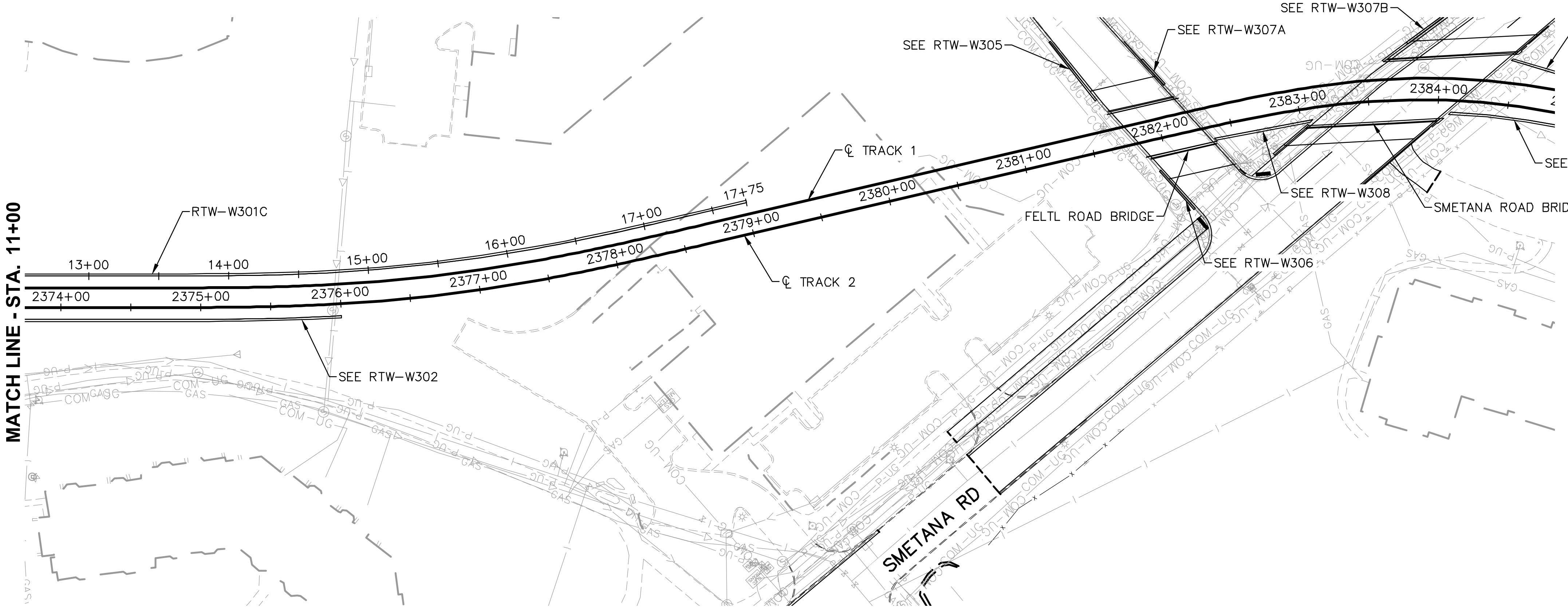
DISCIPLINE: STRUCTURES

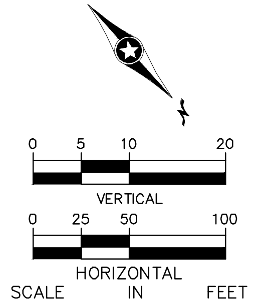
SHEET NAME: W3-STU-RTW-PPFL-002

SHEET 190 OF 197

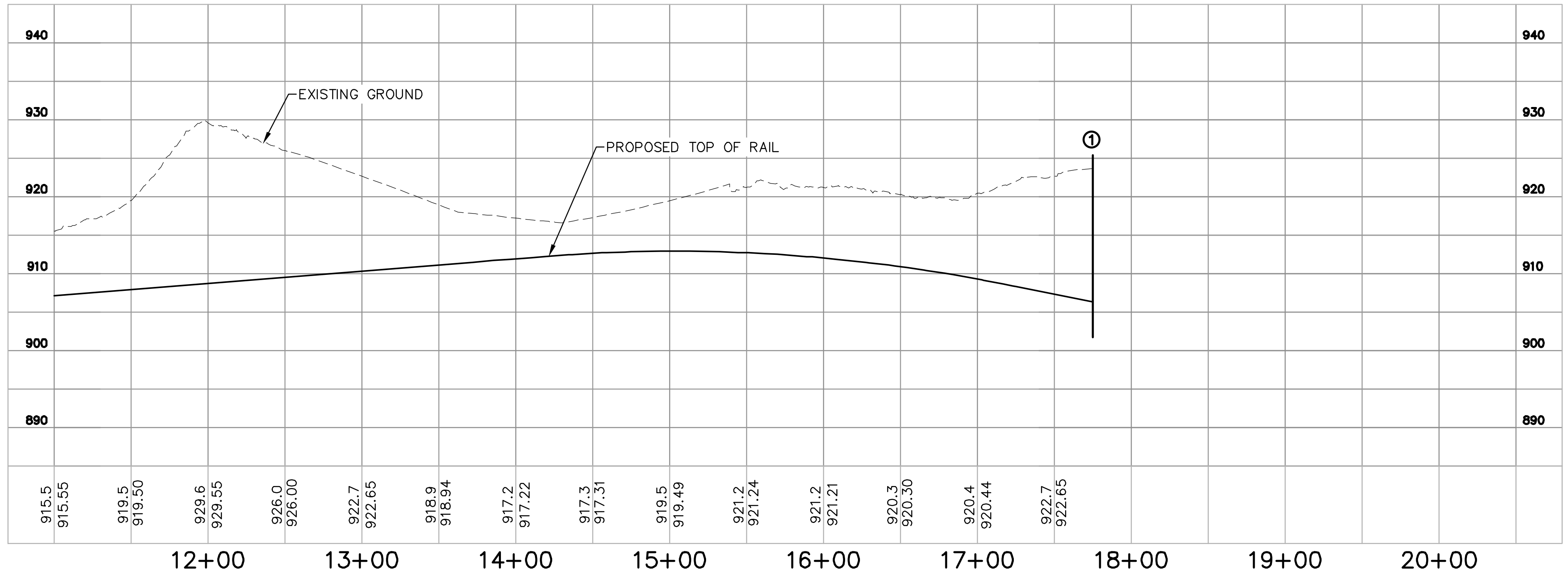
NOTE:
RTW-W301C IS ANTICIPATED TO BE A SOLDIER PILE RETAINING WALL TO MINIMIZE IMPACT ON ADJACENT PROPERTIES.

① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

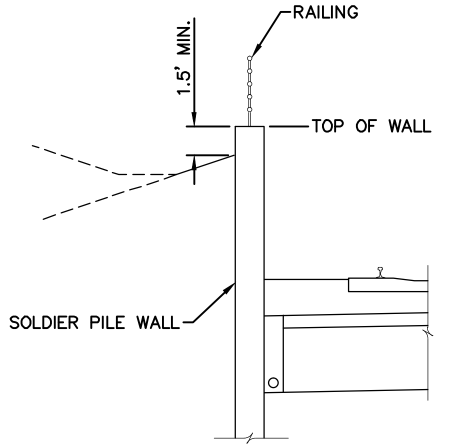




RTW-W301C PLAN



RTW-W301C PROFILE



RTW-W301C TYPICAL SECTION

Jun, 13 2014 11:06 am V:\3200_pec-w\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: NutzmaML

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

CHECK BY: DATE:
BACK-CHECKED BY: DATE:
CORRECTED BY: DATE:
REVIEWED BY: DATE:

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

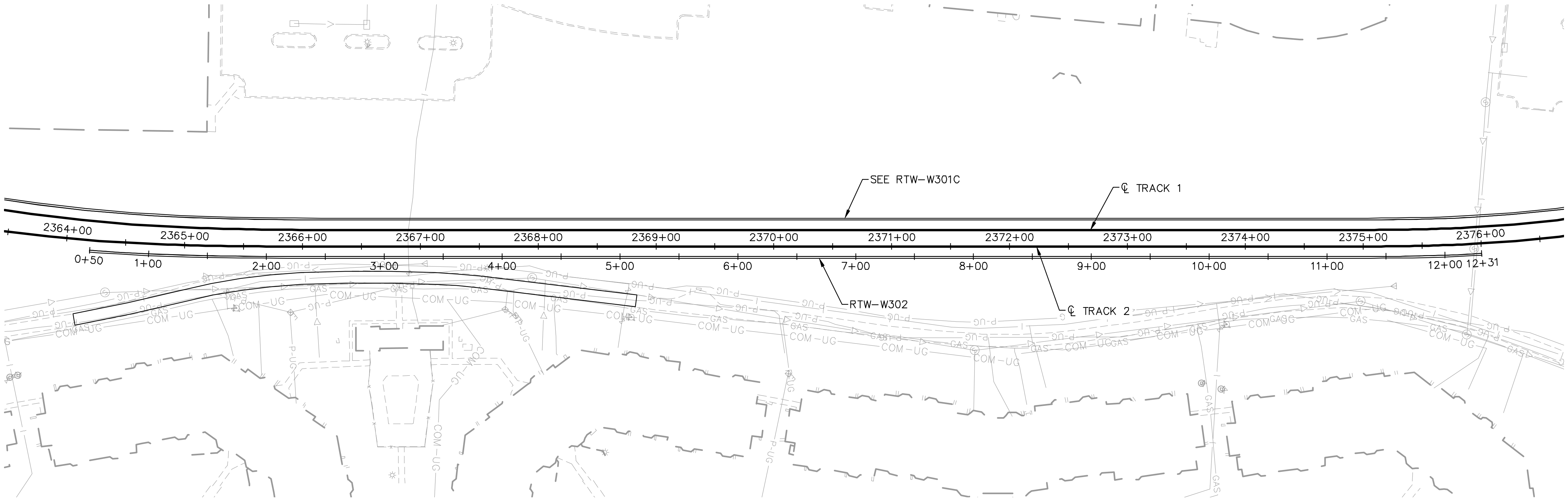
WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3 - RTW-W301C
PLAN AND PROFILE
STA. 11+00 TO STA. 17+75

DISCIPLINE: STRUCTURES
SHEET NAME: W3-STU-RTW-PPFL-003

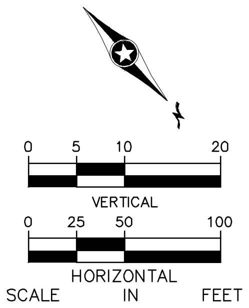
SHEET 191 OF 197

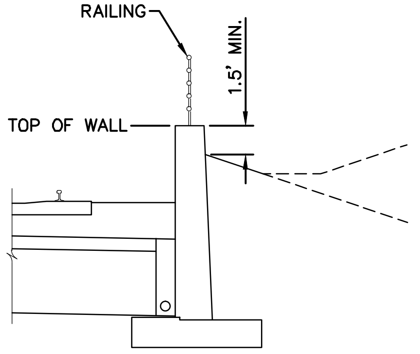
NOTE:
RTW-W302 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

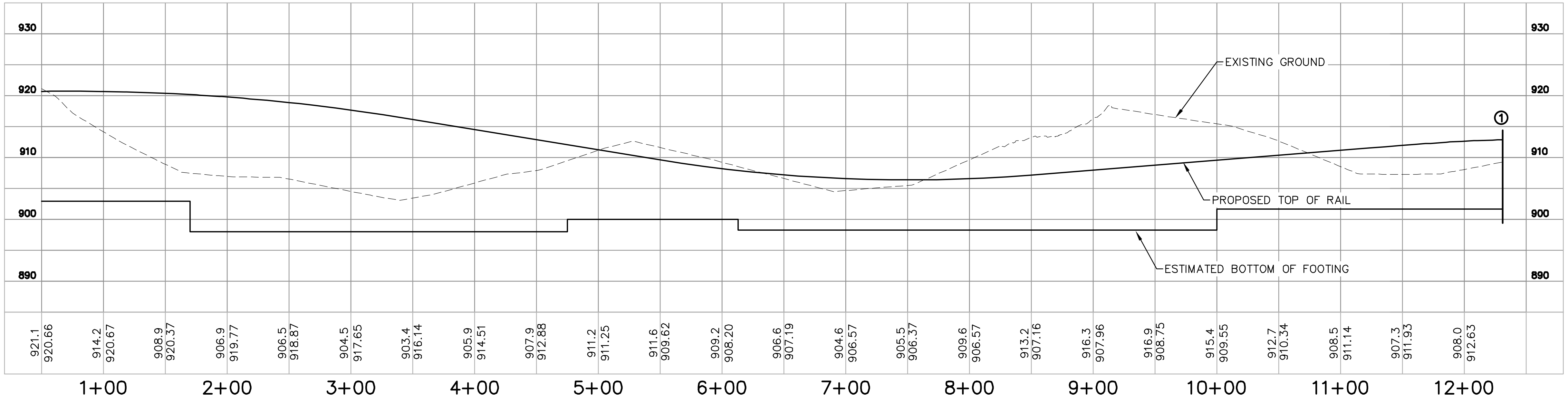


RTW-W302 PLAN

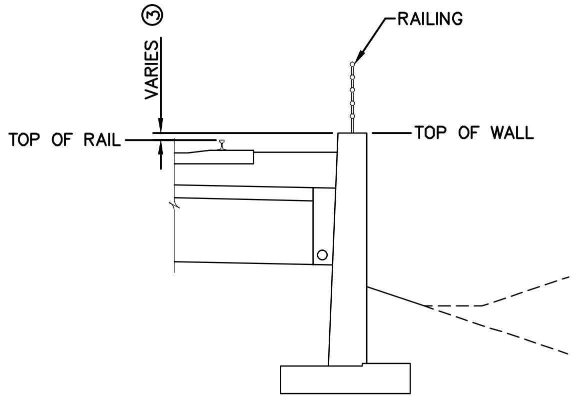




RTW-W301 TYPICAL SECTION
STA. 5+01 TO STA. 6+33
STA. 7+64 TO STA. 10+74



RTW-W302 PROFILE



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W302 TYPICAL SECTION
STA. 0+50 TO STA. 5+01
STA. 6+33 TO STA. 7+64
STA. 10+74 TO STA. 12+31

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

CHECK BY: DATE:
BACK-CHECKED BY: DATE:
CORRECTED BY: DATE:
REVIEWED BY: DATE:

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3
RTW-W302
PLAN AND PROFILE

DISCIPLINE: STRUCTURES
SHEET NAME: W3-STU-RTW-PPFL-004

SHEET
192
OF
197

Jun, 13 2014 11:07 am V:\3200_pec-w\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: NutzmaML

Appendix B

Feltl Road and Smetana Road Bridges

BRAUN
INTERTEC

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Foundation Analysis Design Recommendation Report
Proposed Feltl Road and Smetana Road Bridges – 75% Design
STA 2381+75 to STA 2384+50
Southwest LRT, West Segment 3
Minnetonka, Minnesota

Dear Mr. Demers:

Braun Intertec Corporation has completed the requested drilling and performed the geotechnical evaluation for the proposed bridges to be installed beneath Smetana Road and Feltl Road from STA 2381+70 to STA 2384+50 in Minnetonka, Minnesota. The following sections provide our recommendations for bridge substructure and associated retaining wall design and construction for these structures.

This report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for general track construction and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project information

This portion of the project consists of construction of two bridges, one at Feltl Road and a second at Smetana Road. The track alignment will be depressed with the bridges supporting the roadways over the track. The proposed design indicates the bridge spans will be 40 and 62 feet in length and will be 45 and 60 feet wide, respectively. The bridges are to be supported on spread footings with cast-in-place foundations walls. A concrete bridge deck will support the roadway. Associated retaining walls will also be supported on strip footing foundations.

A.1. Type of Construction

This design report provides recommendations for the foundation system for the Feltl Road and Smetana Road bridge abutments, supported on spread-footing foundations, as well as adjoining retaining walls RTW-W305, RTW-W306, RTW-W307A, RTW-W307B, RTW-W308, RTW-W309, and RTW-W310, supporting the roadway embankments.

The retaining walls will be CIP concrete structures with spread footing foundations embedded at least 4 1/2 feet below the lowest grades along the toe of the wall. Based on elevation data provided in the project drawings, the stem heights will vary from between 11 and 36 feet, with exposed heights ranging from 0 to 29 feet. The retaining walls range from 50 to 300 feet long.

A.2. Location of Bridges and Walls

The project is located approximately 0.3 miles east from the intersection of TH 61 (Shady Oak Road) and Smetana Road in Minnetonka, Minnesota. The bridges will be constructed near track stations 2381+75 to 2384+50 beneath Feltl Road and Smetana Road. The proposed walls will be located next to the bridge abutments.

A.3. Other Information

We anticipate existing utilities are in place beneath both Feltl Road and Smetana Road. A utility design to re-route utilities around these structures has been developed.

B. Subsurface Investigation Summary

B.1. Summary of Borings Taken

Two foundation borings (2068SB and 2069SB) were taken in the vicinity of the proposed bridges by Braun Intertec. The borings were performed on February 6 and 7, 2014, respectively. Boring 2068SB was performed at approximate track station 2382+00 on the shoulder of Feltl Road. Boring 2069SB was performed at approximate track station 2383+50 on the shoulder of Smetana Road. Copies of the borings are included in the Appendix of this report.

B.2. Description of Foundation Soil Conditions

The borings generally encountered pavement materials overlying a mixture of fill underlain by glacial soils at depths. The following paragraphs discuss the soils encountered in more detail.

The borings encountered a pavement section consisting of 3 inches of bituminous over 12 inches of aggregate base. Immediately below the pavement materials, the borings encountered fill soils consisting of silty sand, lean clay and sandy lean clay to depths ranging from 20 to 24 feet below the ground surface. The Standard Penetration Test (SPT) N-values in the fill soils range from 10 blow per foot (BPF) to 50 blows per five inches of penetration, indicating a large amount of variability. Of note, soils in the upper 5 feet were frozen and therefore will have artificially high blow counts.

Underlying the fill, the borings encountered glacial outwash and till deposits to the boring termination depths. The glacial deposits consisted of silty sand, clayey sand, lean clay, and sandy lean clay. The N-values in the glacial sands ranged from 15 to 53 BPF, indicating the soils were medium dense to dense. The N-values in the glacial clays ranged from 9 to 35 BPF, indicating the soils were rather stiff to hard.

B.3. Summary of Water Level Measurements

Borings 2068ST and 2069ST encountered groundwater at depths ranging from 45 to 60 feet below existing grade, respectively, which corresponds to elevations 871.4 and 861.0 feet above mean sea level (MSL). The wetland located within subwatershed 582 C.L., which is located further south of the wetland within subwatershed 582 C-4, has a NWL of 875.5 and a 100 year HWL of 880.8. There is a parcel pond in subwatershed 520 C-2 located southwest of the intersection of Smetana Road and Feltl Road that has a NWL of 927.7 and a HWL of 932.4. A sketch has been attached detailing the locations of the various wetlands in the vicinity of the two bridges.

Seasonal and annual fluctuations of groundwater, however, should be anticipated.

B.4. Interpretation of Water Level

Given the cohesive nature of the geologic materials encountered, it is likely that insufficient time was available for groundwater to seep into the borehole and rise to its hydrostatic level. Piezometers or monitoring wells would be required to confirm if groundwater was present within the depths explored.

Based on the borings, it appears the excavation for the track trenches (below Smetana and Feltl), and the bottom of footings for the bridges will be near 885 and the bottom of the sand subbase will likely be near 890. There may be the need for a cut-off wall north of the Smetana Bridge to reduce the risk of water seeping down the track alignment. Additional borings and piezometers may not be useful in evaluating the risk of encountering sand seams that may transmit water. The need for a cut-off wall and the cut-off wall design may need to be evaluated during construction after the trench is dug.

Care should be taken when excavating for the trenches or utilities near the pond southwest of the intersection of Smetana and Feltl. The stability of the slope should be evaluated by the Contractor as part of their means and methods. If the pond is not properly lined and a sand seam is encountered by the pond, the pond may need to be drained and re-lined.

C. Foundation Analysis

Based on the favorable soil conditions encountered in the borings and loads anticipated on the bridge substructures, we recommend the use of a spread-footing foundation system for support of the bridges.

In general, we anticipate the soils encountered at bottom of footing elevations for the bridge abutments will be suitable for support of the anticipated loads. Limited subcuts will be required beneath the retaining walls to meet the service limit for settlement.

C.1. Embankment and Slopes

No new embankment construction is anticipated for these structures as the track alignment will be excavated beneath the existing roadway. We recommend any slopes be designed to match existing conditions.

C.1.a. Global Stability

Based on the proposed abutments, retaining wall heights, and the competent soils encountered in the borings and soundings, the factor of safety is anticipated to exceed the required minimum value of 1.5.

C.1.b. Bearing Capacity

C.1.b.1. Bridge Abutments

Based on our calculations and understanding, the soil conditions identified are anticipated to provide a bearing resistance in excess of the required capacity shown on the plan sheet.

C.1.b.2. Retaining Walls

We understand the retaining walls will be designed using the Minnesota Department of Transportation (MnDOT) Retaining Wall Standard Plan Sheet for a 2-foot live load surcharge. Based on our calculations, the soil conditions are anticipated to provide a bearing resistance in excess of the required capacity shown on the plan sheet.

C.1.c. Settlement

Based on the anticipated fill heights of the walls and abutments, total settlement of the backfill will be in excess of one inch due to consolidation of the fill mass. This settlement has been taken into consideration when selecting the abutment and wall backfill materials.

C.1.d. Time Rate of Settlement

Time rate of settlement was not analyzed at the time of this report. However, it was taken into consideration with the selection of the abutment and wall backfill materials. Please refer to Section C.4.b of this report.

C.2. Spread Footing Foundations

Settlements were calculated based on two methods. The first is the Hough method with Boussinesq and Westergaard, which utilizes the standard penetration test (SPT) values from the soil borings. The second is the Menard method, which is based on pressuremeter determinations of soil parameters that were collected in the field or modified from the SPT values from the soil borings. For the Menards Method, where pressuremeter testing was not performed, conservative correlations were used to estimate pressuremeter values based on N_{60} factors provided in Federal Highway Administration (FHWA) Publication No. FHWA-IP-89-008. Tables 5 and 6 from this publication are attached for reference. After these two methods were evaluated, the results were averaged.

Terzhagi’s strength limit state is also included on the nominal bearing graphs in the Appendix, for reference. The strength limit state (bearing) will not control design.

The service limit state (settlement) will control the design and the average service limit state should be used for design of Bridge substructures. A maximum settlement of 1 inch is specified for this project.

C.3. Summarize Design Assumptions

C.3.a. Embankment Heights, Unit Weights, Side Slopes, and End Slopes

The bottom of footing elevations at the Feltl and Smetana bridge abutments are shown to be at elevations 886 to 888. The seven adjoining retaining walls are shown to have footing elevations that range from 889 to 894 and taper up as the wall extends away from the abutments. The existing grade of Feltl Road and Smetana Road ranges from 919 to 925 between the proposed abutments. Cuts ranging from 25 feet to in excess of 30 feet are anticipated near the abutments and fills ranging from 20 to 28 feet are anticipated for the retaining walls.

We have assumed the anticipated fill soils will have a moist unit weight of 120 pounds per cubic foot (pcf) and will meet the requirements Select Granular Borrow (MnDOT 3149.2B2. Typical slopes in front of the retaining wall shall be 1:4 (V:H) or flatter. Where retaining walls are present, we recommend end slopes and side slopes be 1:2 (V:H) or flatter.

C.3.b. Bridge Loading Information

Please refer to Section D.1 for Nominal Bearing Capacities and Associated Resistance Factors.

C.3.c. Retaining Wall Loading Information

It is assumed a 2-foot live load surcharge will be used for the design of the retaining walls. We recommend the design loads and footing widths follow the MnDOT standard plans included in the Appendix.

C.3.d. Design Methodologies

The LRFD (Load and Resistance Factor Design Method) was used for design of the bridge substructures supported on shallow foundations. Resistance factors were obtained from the Sixth Edition of the AASHTO (American Association of State Highway and Transportation Officials) LRFD Bridge Design Specifications (6th edition with 2013 interim revisions).

The ASD (Allowable Strength Design Method) was referenced for design of the retaining wall footings supported on shallow foundations. Strength design and safety factors were taken from the MnDOT design criteria for retaining walls with a 2-foot live load surcharge.

C.4. Construction Considerations

C.4.a. Subcut Recommendations and Backfill Requirements

We recommend removing topsoil, organic material and any other unsuitable soils along the retaining wall footings. We anticipate native glacial soils will be encountered at bottom of footing elevations of the abutments. Please refer to Table 1 for anticipated excavation depths at the wall locations.

Table 1. Anticipated Subcut Recommendations at Retaining Wall Locations

Wall Number	Boring Number	Top of Rail or Existing Ground Surface Elevation (ft)	Bottom of Footing Elevation (ft)	Anticipated Subcut Depth (ft)	Anticipated Excavation Bottom Elevation (ft)
RTW-W305	2068SB	922	893	5	888
RTW-W306	2068SB	917	893	5	888
RTW-W307A	2068SB	920	893	5	888
RTW-W307B	2069SB	927	894	5	889
RTW-W308	2069SB	898	889	NA	889
RTW-W309	2069SB	901	890	NA	890
RTW-W310	2069SB	901	890	NA	890

A limited subcut is anticipated for Retaining Walls RTW-W305, RTW-W306, RTW-W307A and RTW-W307B to remove the rather stiff lean clay and sandy lean clay soils encountered in the borings.

Following the removal of unsuitable soils, the excavation bottom soils should be evaluated by the geotechnical engineer or his representative to determine if the exposed soils are suitable for backfilling and support of the wall. Once evaluated, we recommend the foundation soils be surface compacted with a vibratory sheepsfoot compactor prior to filling to proposed footing elevations. The excavation should then be backfilled with Select Granular Modified 10% or crushed rock to re-establish grade. If groundwater is encountered, temporary dewatering is recommend with sumps and pumps to control groundwater.

Abutment and retaining wall backfill shall meet the material and compaction specifications noted below in Table 2.

Table 2. Material and Compaction Specifications for Backfill and Fill

Material	Material Specification	Compaction Specification
Fill placed beneath Footings	3149.2B2	2105.3F
Leveling Pad Beneath Footings	3138.2B	2211.3C
Retaining Wall Backfill	3149.2D2	21053.3F
Aggregate Base for Roadway Construction	3138.2B	2211.3C

For excavations extending near or below groundwater, a crushed rock with less than 10% percent passing the 0.075 mm(#200) sieve shall be used for backfill and to provide a working platform and to help control groundwater seepage.

C.4.b. Guideway Construction

A Guideway will be constructed between the bridge abutments for the placement of the tracks. The Guideway typically consists of a layer of select granular material compacted to 100 percent of standard Proctor Density, with a subballast layer and either ballast with ties or concrete supporting the rails. Please refer to the Guideway specifications in the plans for details regarding construction of the Guideway.

C.4.c. Roadway Reconstruction

Upon completion of the bridge and retaining wall construction, the existing roadways will be reconstructed. We recommend following the compaction specifications of the subgrade and aggregate base materials as noted above in Table 2. The roadway construction should follow the general guidelines established in the standard specifications for the cities of Minnetonka and Hopkins.

C.4.d. Slope Stability and Water

There are ponds around this area including pond 520C-2 as discussed in Section B.4. The Contractor should use construction techniques that ensure stable slopes and do not drain water from the ponds. If an excavation is too deep or a sand seam is encountered, there may be the need to develop cut-off walls or re-line ponds to stop water flow.

D. Foundation Recommendations

D.1. Nominal Bearing Capacities and Associated Resistance Factors

Please refer to the figures in the Appendix for the recommended bearing resistances and service limit states for the abutment substructures of the bridges. These graphs are based on the settlement methods discussed in Section C.2 of this report. For the service limit state, a resistance factor of 1.0 shall be applied.

The resistance factors for evaluating the strength limit state performance are based on the current LRFD code:

- Bearing Resistance, using SPT = 0.45
- Sliding, Cast-in-Place Concrete on Sand =0.8

Also, refer to the attached figures in the Appendix for the ultimate bearing resistances of the retaining wall footings. We based the figures on the settlement methods discussed in Section 3.2 of this report. We recommend that the average service limit state be used for retaining wall base pressure verification as identified on the MnDOT Retaining Wall standard plans.

D.2. Recommended Design Soil Parameters (e.g., Coefficient of Friction, Lateral Earth Pressure Coefficients, etc.)

The recommended soil parameters to be used for design are as follows:

Table 3. Recommended Soil Parameters

Soil Type	Angle of Internal Friction (degrees)	Effective unit Weight (pcf)	Coefficient of Sliding Friction Rough Concrete	Active Earth Pressure Coefficient	At-Rest Earth Pressure Coefficient
Select Granular Borrow Modified 10%	35	120	0.6	0.27	0.43
Granular Borrow	30	120	0.5	0.33	0.50

D.3. Recommended Footing Sizes and Embedment Depths

We recommend the bridge be supported on spread footings. The size of the footing should be determined in accordance with Section C.2 and the limit state graphs in the Appendix. We recommend placing abutment footings a minimum of 4 1/2 feet below proposed grade.

We recommend the CIP retaining walls be supported on spread footings, following the MnDOT standard plans included in the Appendix. The size of the footings shall be determined by the wall designer based on the stem wall height. If the stem wall heights and corresponding footing widths change during design, we should be notified to confirm that bearing capacity and settlement criteria are met with the revised design. We recommend placing retaining wall footings a minimum of 4 1/2 feet below proposed grade.

D.4. Temporary Slopes and Shoring Limits

Temporary slopes in Select Granular Borrow Modified 10% or Granular Borrow backfill are recommended to be constructed at 1V:1 ½ H or shallower. Temporary slopes constructed in natural material are recommended to be constructed at 1V:2H or shallower. In a temporary condition; these slopes have a Factor of Safety against global failure in excess of 1.3.

E. Material Classification and Testing

E.1. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

E.2. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate exploration logs in the Appendix. The tests were performed in accordance with ASTM procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or sealed with bentonite grout.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore, strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

F.3. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these bridge foundation recommendations, please call Joshua Kirk (952.995.2222 or Jkirk@braunintertec.com) or Ray Huber (952.995.2260) at your convenience.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal - Project Engineer
License Number: 45005

Reviewed by:

Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Soil Boring Location Sketch
Preliminary Engineering Plan and Profile Sheets - Smetana Road over Southwest Light Rail
Preliminary Engineering Plan and Profile Sheets - Feltl Road over Southwest Light Rail
Preliminary Engineering Plan and Profile Sheets – RTW-305, RTW-W306, RTW-W307A, RTW-W308, RTW-W309, RTW-W310
Preliminary Engineering Drainage Map – Figure 7
Soil Boring Logs 2068SB and 2069SB
Limit State Analysis Graphs
MnDOT Standard Sheet No. 5-297.632, 1 of 4 (2’ LL Surcharge, Spread Footing Supported)
Publication No. FHWA-IP-89-008 N_{60} Correlation Tables
Descriptive Terminology

APPENDIX

LEGEND
S - STD. PENETRATION
C - CONE PENETRATION
B - BRIDGE
T - TRACK
S - STATION
W - RETAINING WALLS

DRAFT-WORK IN PROCESS

SOUTHWEST
Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 10 OF 12

IRT: N/A

REV: 0

DATE: 06/03/2014

NORTH
0 50 100 200

METROPOLITAN COUNCIL

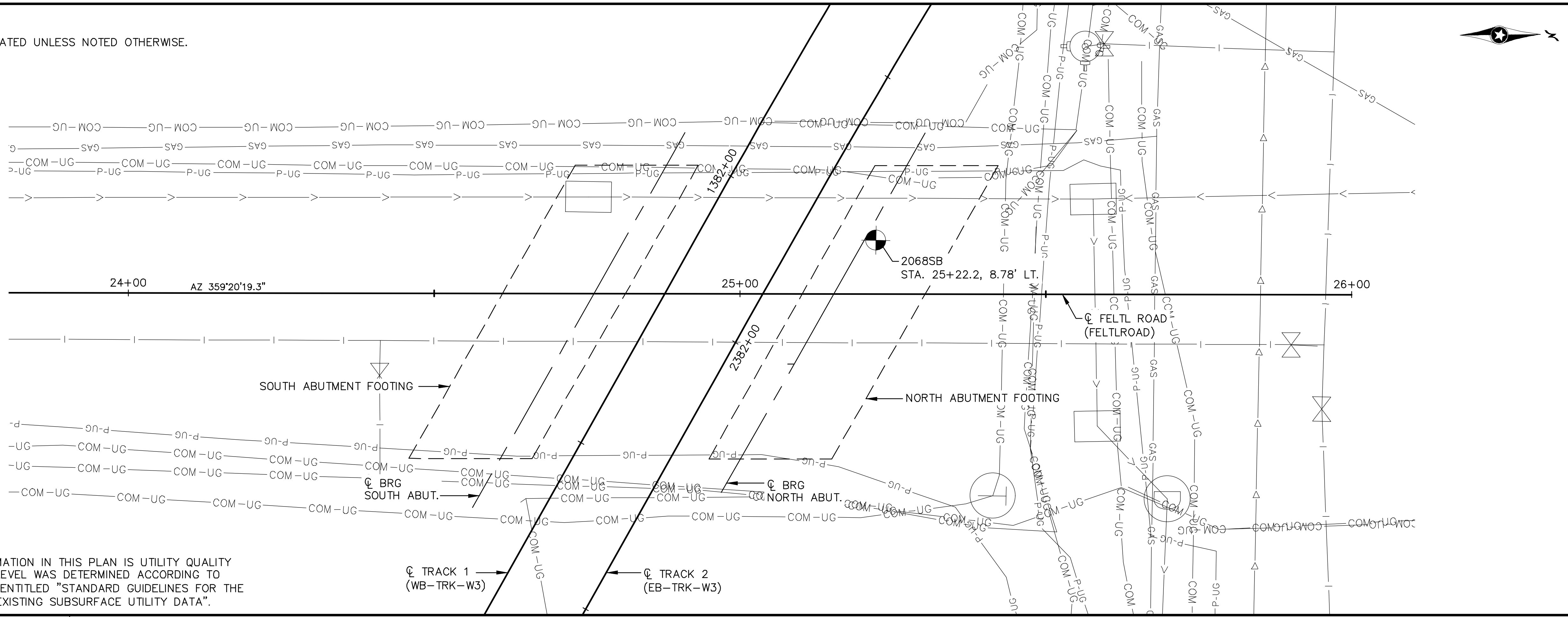
AECOM

SRF Consulting Group, Inc.

Jun, 03 2014 11:55 am C:\Users\DennisJY\appdata\local\temp\AcPublish_4180\EXHB-CIV-SOIL BORINGS.dwg By: DennisJY

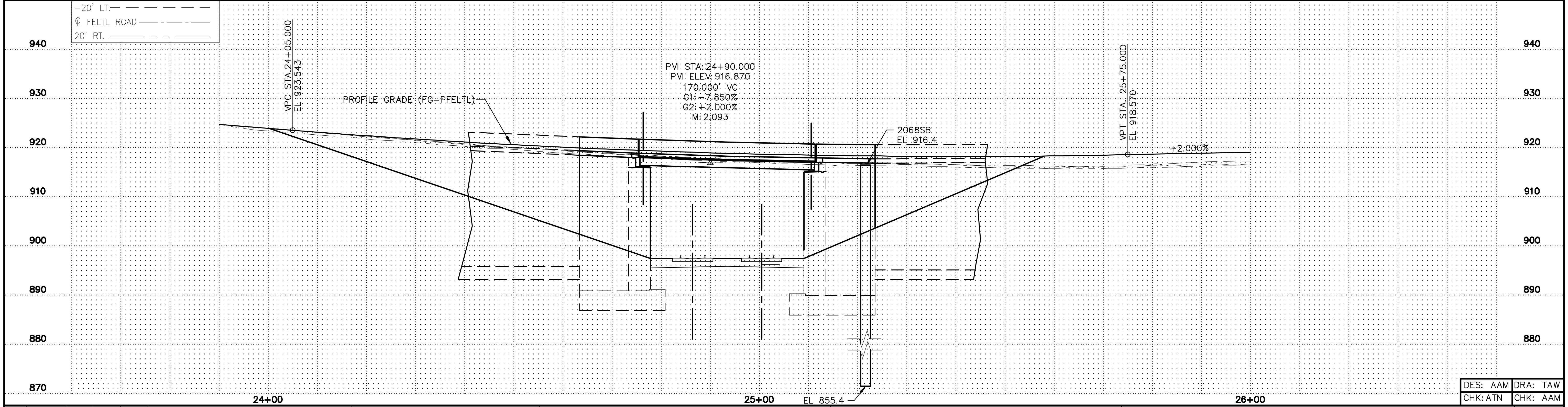
GENERAL NOTES:

1. ALL UTILITIES TO BE RELOCATED UNLESS NOTED OTHERWISE.



NOTES:

THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".



DES: AAM	DRA: TAW
CHK: ATN	CHK: AAM

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extension

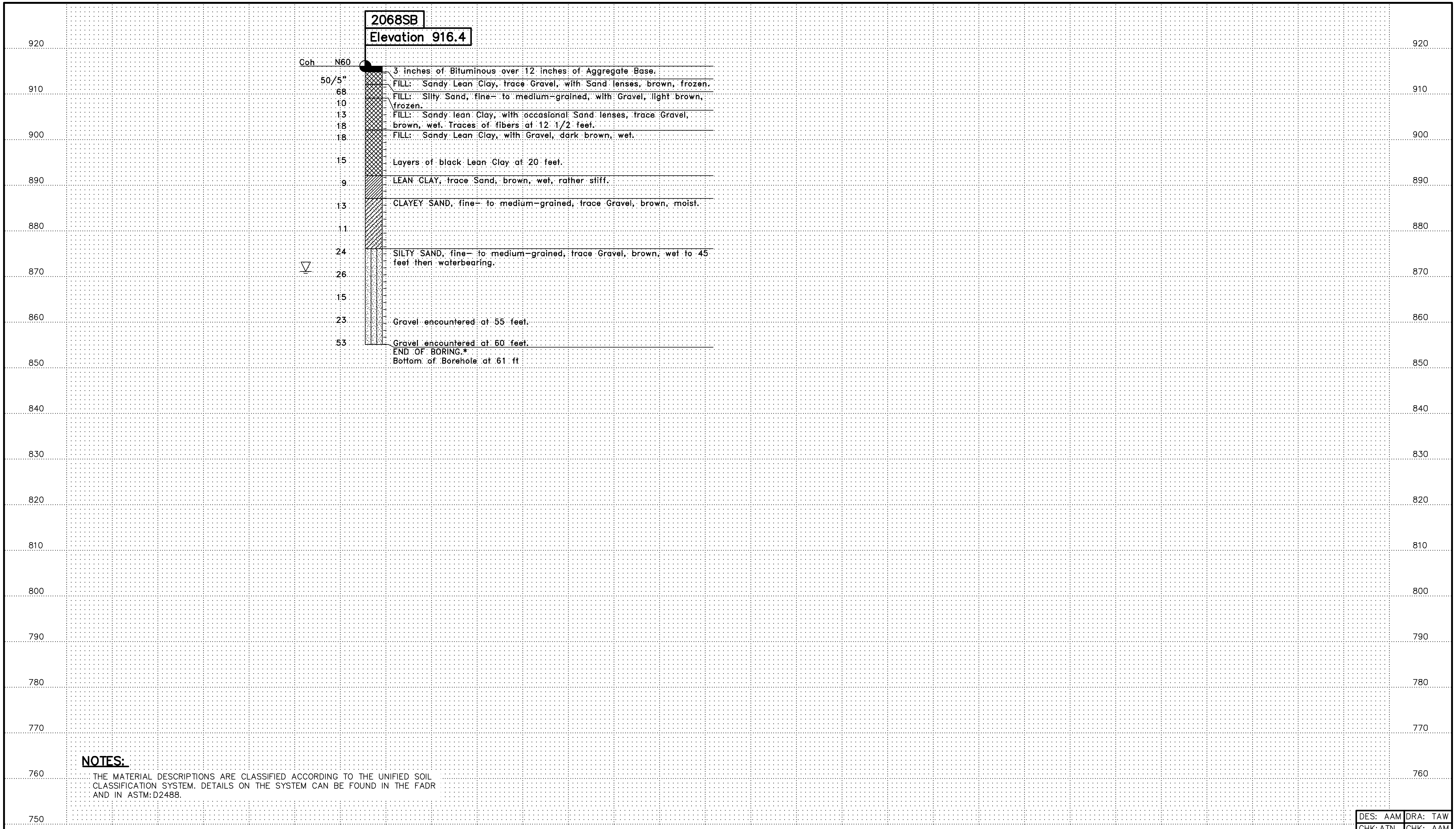
WEST - VOLUME 2 (STRUCTURES)
FELTL ROAD OVER SOUTHWEST LIGHT RAIL
BRIDGE NO. XXXXX
BORING

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-FELT-VEH-SUR-BOR

SHEET 78 OF 197

Jun, 13 2014 10:35 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-FELT-VEH-SUR-BOR.dwg By: RieckmBB



3 inches of Bituminous over 12 inches of Aggregate Base.

FILL: Sandy Lean Clay, trace Gravel, with Sand lenses, brown, frozen.

FILL: Silty Sand, fine- to medium-grained, with Gravel, light brown, frozen.

FILL: Sandy lean Clay, with occasional Sand lenses, trace Gravel, brown, wet. Traces of fibers at 12 1/2 feet.

FILL: Sandy Lean Clay, with Gravel, dark brown, wet.

Layers of black Lean Clay at 20 feet.

LEAN CLAY, trace Sand, brown, wet, rather stiff.

CLAYEY SAND, fine- to medium-grained, trace Gravel, brown, moist.

SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet to 45 feet then waterbearing.

Gravel encountered at 55 feet.

Gravel encountered at 60 feet.

END OF BORING.*

Bottom of Borehole at 61 ft

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488.

DES: AAM
DRA: TAW
CHK: ATN
CHK: AAM

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extension

WEST - VOLUME 2 (STRUCTURES)
FELTL ROAD OVER SOUTHWEST LIGHT RAIL
BRIDGE NO. XXXXX
BORING

DISCIPLINE: STRUCTURES

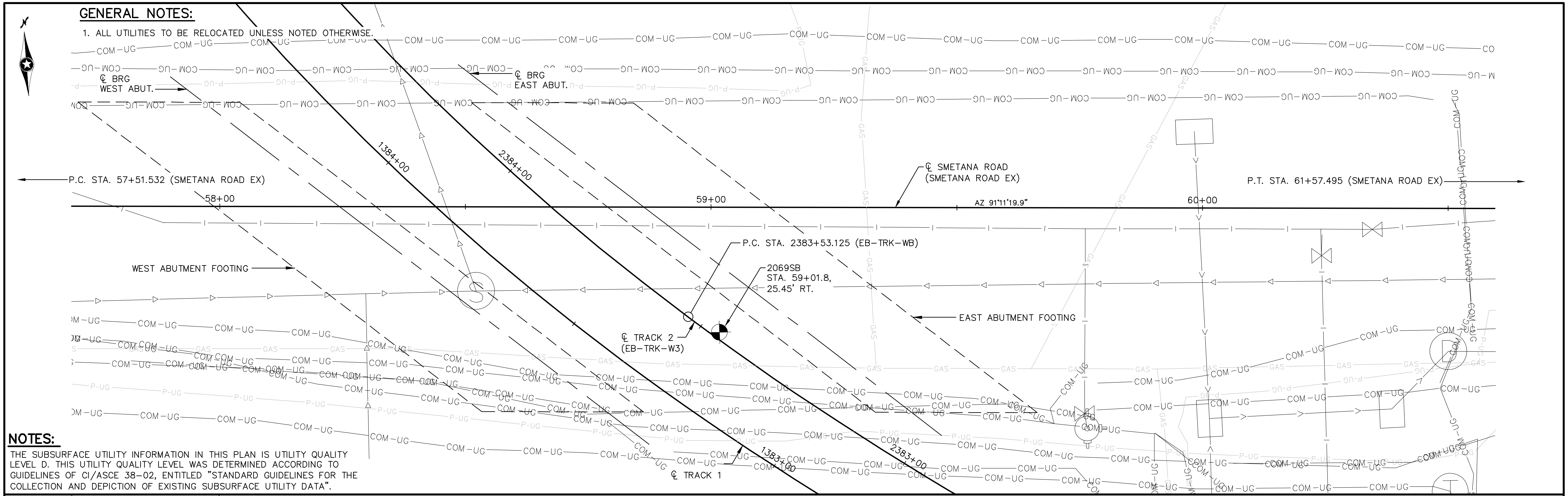
SHEET NAME: W3-STU-BRG-FELT-VEH-SUR-BOR

SHEET 79 OF 197

Jun, 13 2014 10:35 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-FELT-VEH-SUR-BOR.dwg By: RieckmBB

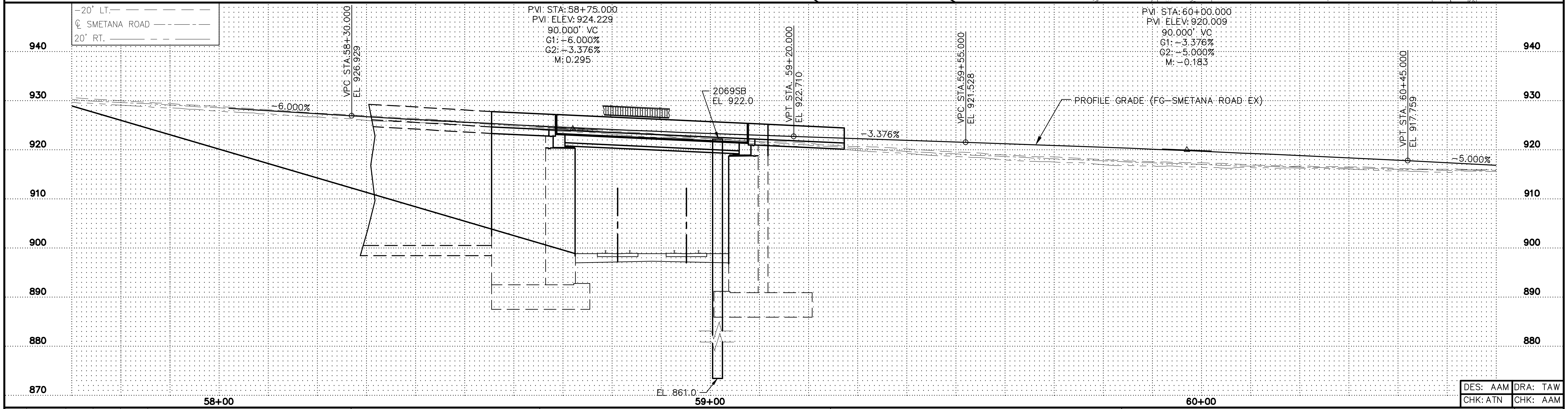
GENERAL NOTES:

1. ALL UTILITIES TO BE RELOCATED UNLESS NOTED OTHERWISE.



NOTES:

THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".



DES: AAM	DRA: TAW
CHK: ATN	CHK: AAM

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extension

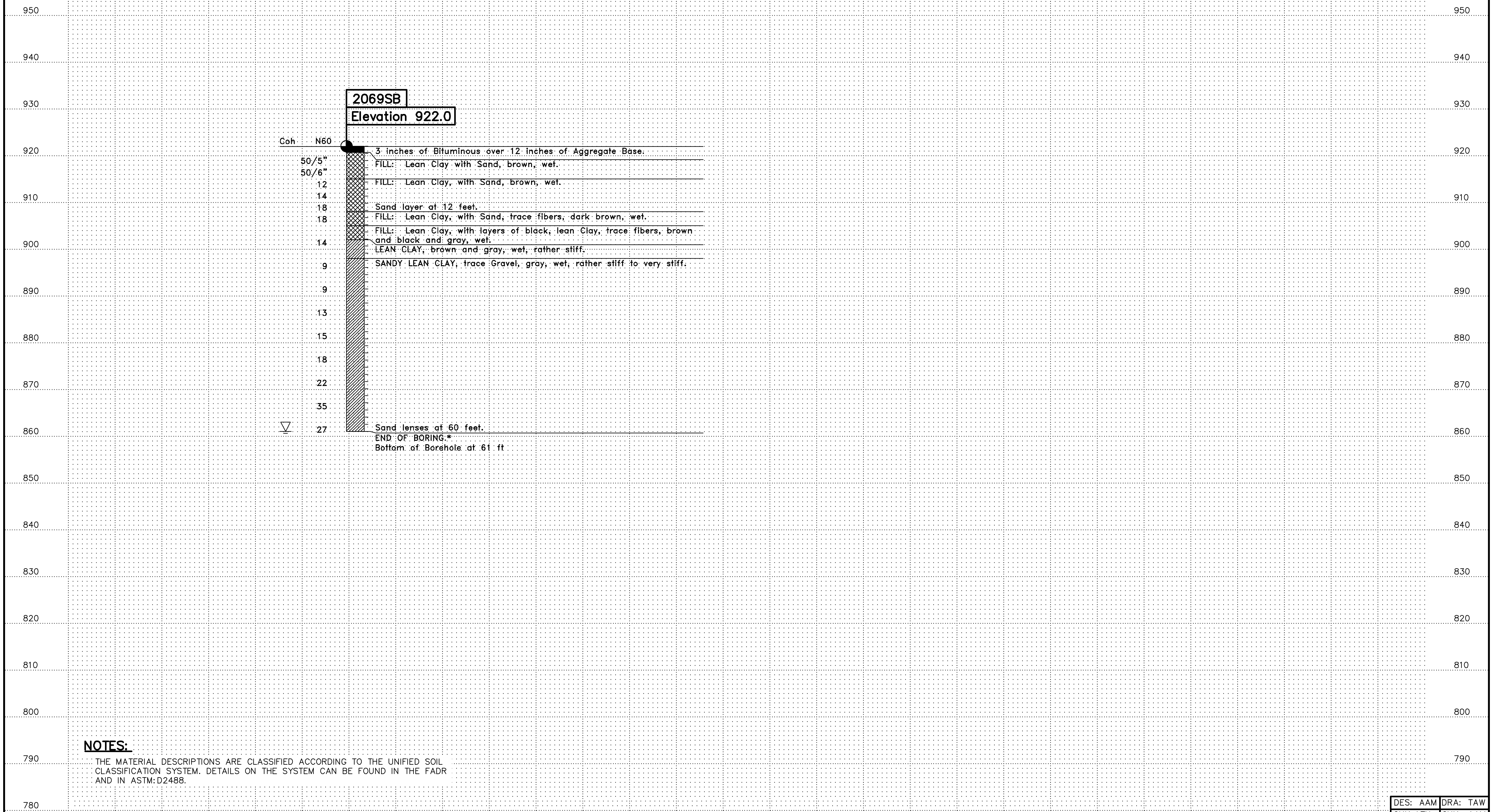
WEST - VOLUME 2 (STRUCTURES)
SMETANA ROAD OVER SOUTHWEST LIGHT RAIL
BRIDGE NO. XXXXX
BORING

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-SMET-VEH-SUR-BOR

SHEET 84 OF 197

Jun, 13 2014 10:17 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-SMET-VEH-SUR-BOR.dwg By: RieckmBB



3 inches of Bituminous over 12 inches of Aggregate Base.

FILL: Lean Clay with Sand, brown, wet.

FILL: Lean Clay, with Sand, brown, wet.

Sand layer at 12 feet.

FILL: Lean Clay, with Sand, trace fibers, dark brown, wet.

FILL: Lean Clay, with layers of black, lean Clay, trace fibers, brown and black and gray, wet.

LEAN CLAY, brown and gray, wet, rather stiff.

SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to very stiff.

Sand lenses at 60 feet.

END OF BORING.*

Bottom of Borehole at 61 ft

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488.

DES: AAM	DRA: TAW
CHK: ATN	CHK: AAM

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST - VOLUME 2 (STRUCTURES)
SMETANA ROAD OVER SOUTHWEST LIGHT RAIL
BRIDGE NO. XXXXX
BORING

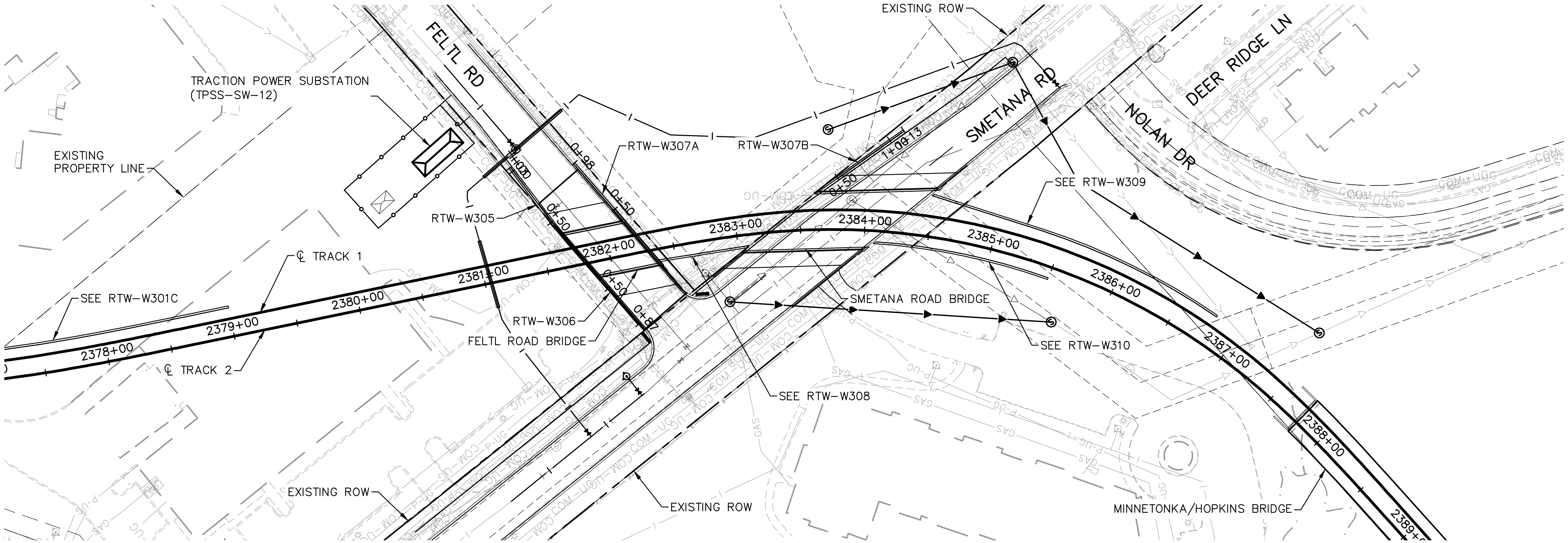
DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-SMET-VEH-SUR-BOR

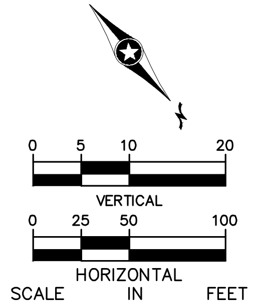
Jun, 13 2014 10:18 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-SMET-VEH-SUR-BOR.dwg By: RieckmBB

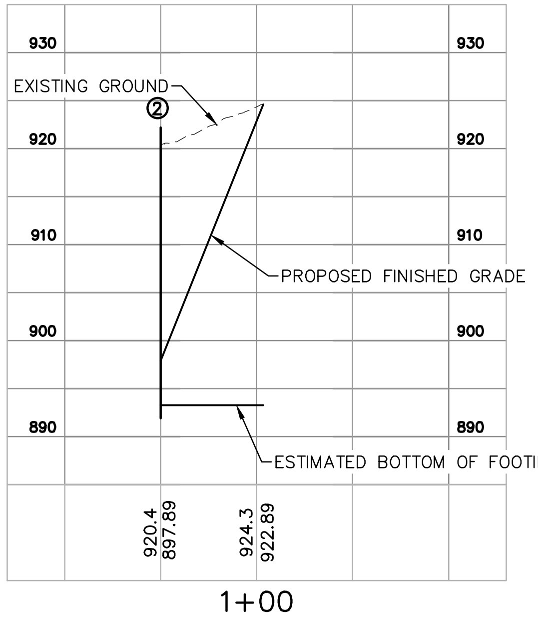
NOTE:
RTW-W305, RTW-W306, RTW-W307A AND RTW-W307B ARE ANTICIPATED TO BE CAST-IN-PLACE RETAINING WALLS ON SPREAD FOOTINGS.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

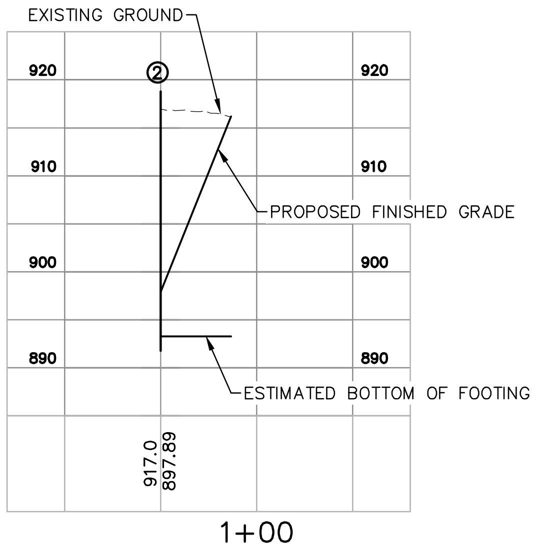


RTW-W305, RTW-W306, RTW-W307A & RTW-W307B PLAN

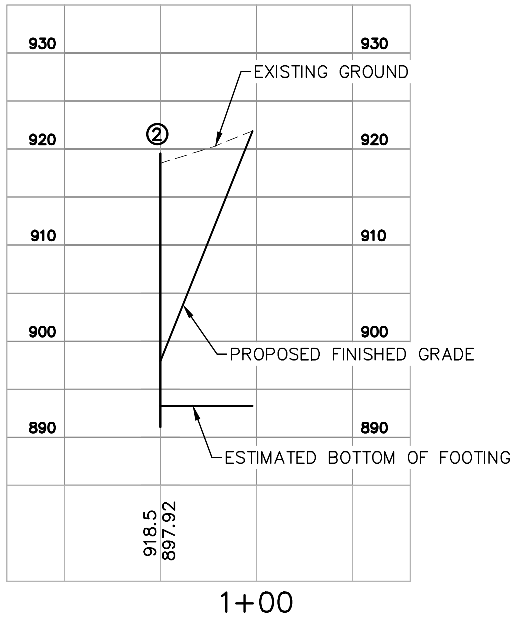




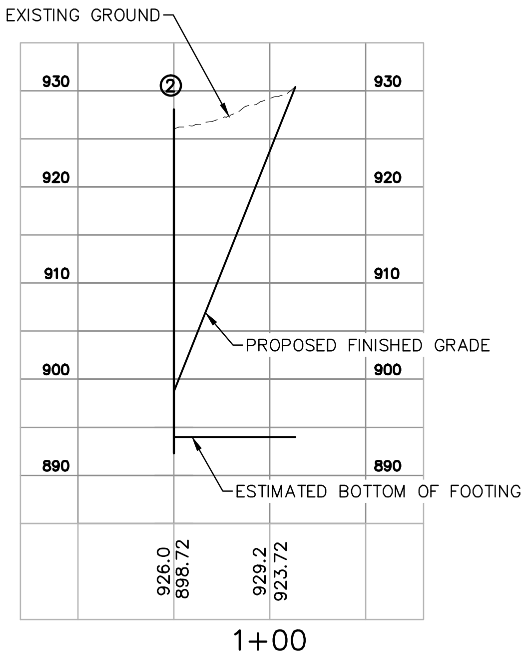
RTW-W305 PROFILE



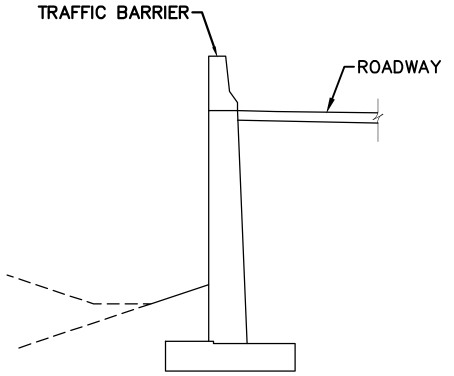
RTW-W306 PROFILE



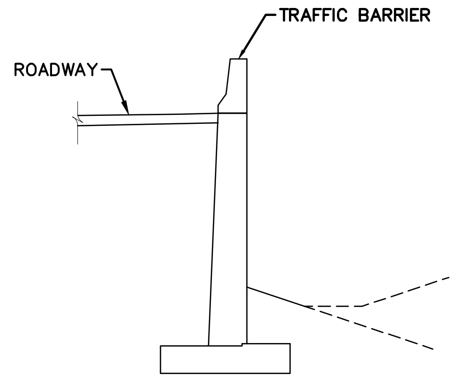
RTW-W307A PROFILE



RTW-W307B PROFILE



RTW-305 & RTW-W307B
TYPICAL SECTION



RTW-W306 & RTW-307A
TYPICAL SECTION

Aug. 13 2014 01:24 pm V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: mnutzmann

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3 - RTW-W305, RTW-W306,
RTW-W307A & RTW-W307B
PLAN AND PROFILE

DISCIPLINE: **STRUCTURES**

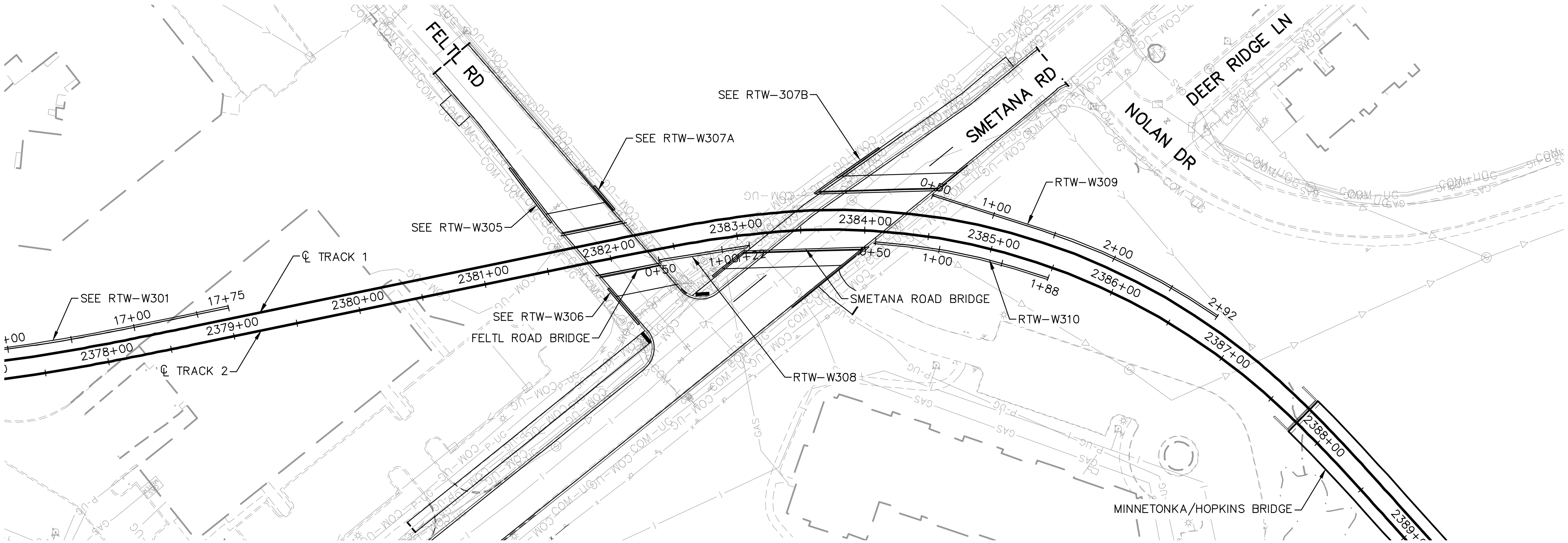
SHEET NAME: **W3-STU-RTW-PPFL-005**

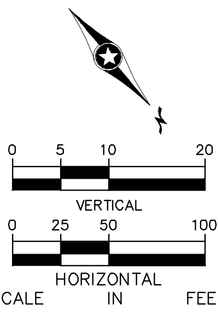
SHEET 200 OF 204

NOTE:
RTW-W308, RTW-W309 AND RTW-W310 ARE ANTICIPATED TO BE CAST-IN-PLACE RETAINING WALLS ON SPREAD FOOTINGS.

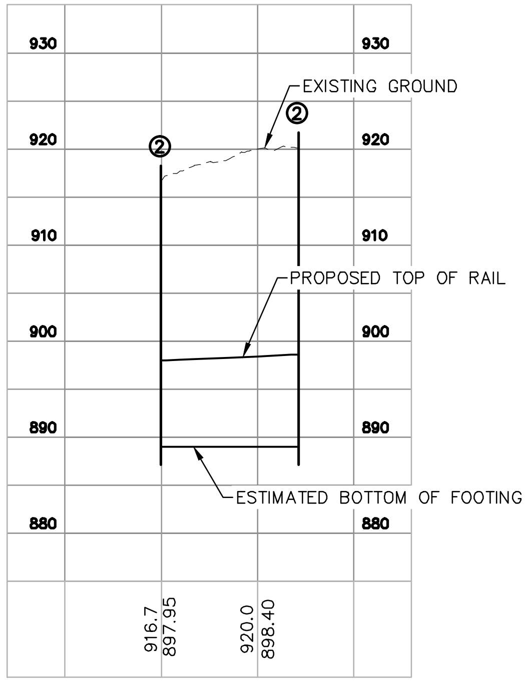
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

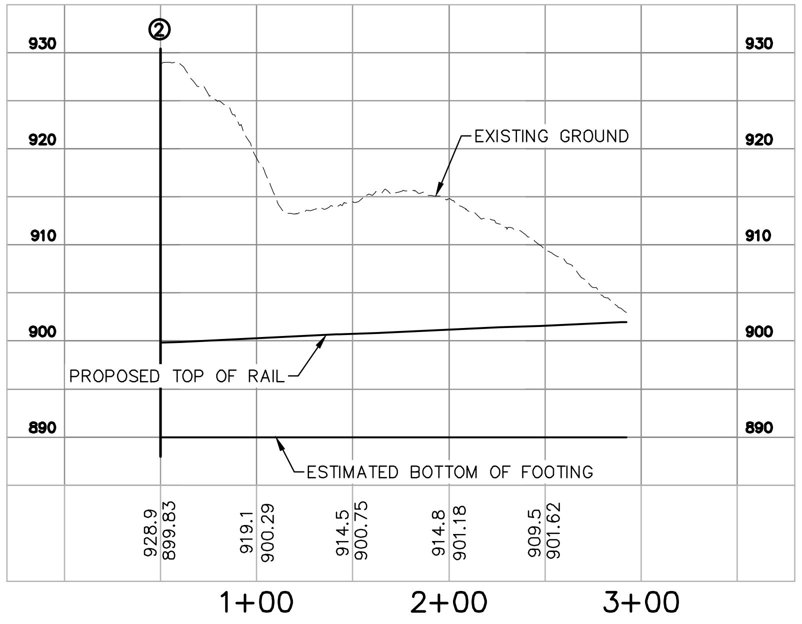




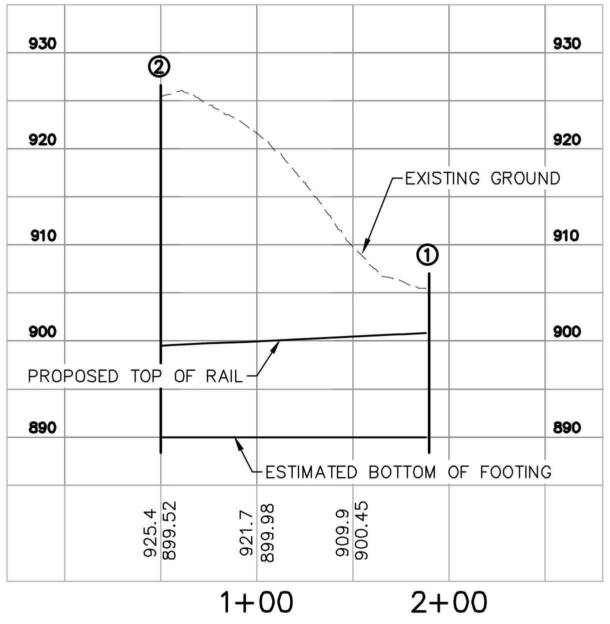
RTW-W308, RTW-W309 & RTW-W310 PLAN



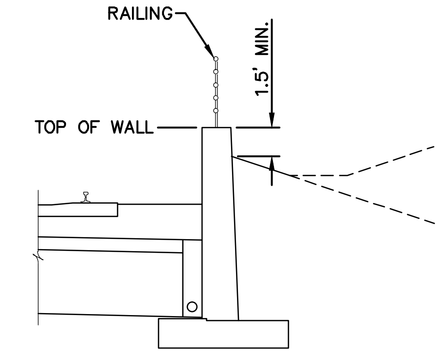
RTW-W308 PROFILE



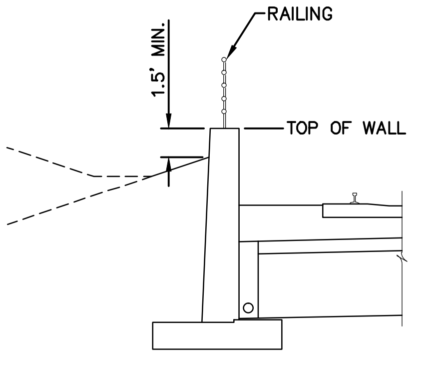
RTW-W309 PROFILE



RTW-W310 PROFILE



RTW-W308 & RTW-W310 TYPICAL SECTION



RTW-W309 TYPICAL SECTION

Jun, 13 2014 11:07 am V:\3200_pec-w\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: NutzmaML

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

CHECK BY:	DATE:
BACK-CHECKED BY:	DATE:
CORRECTED BY:	DATE:
REVIEWED BY:	DATE:

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

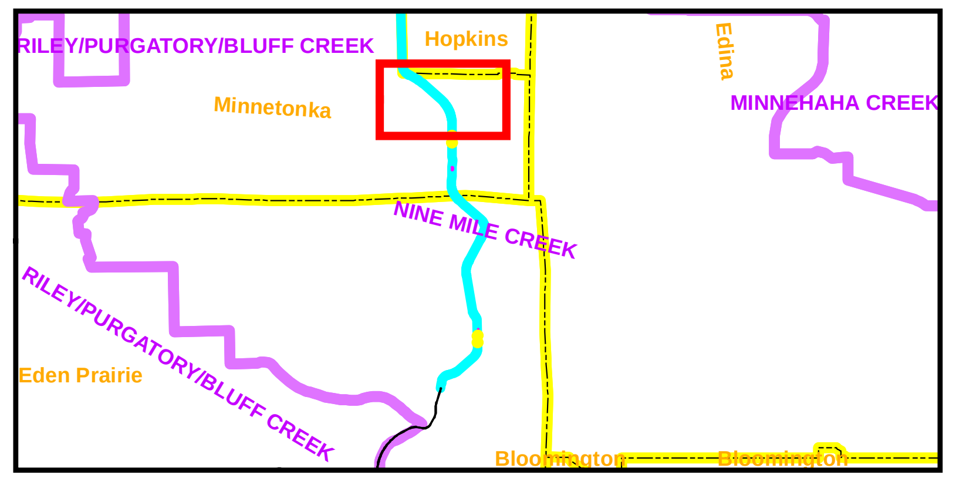
WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3
RTW-W308, RTW-W309 & RTW-W310
PLAN AND PROFILE

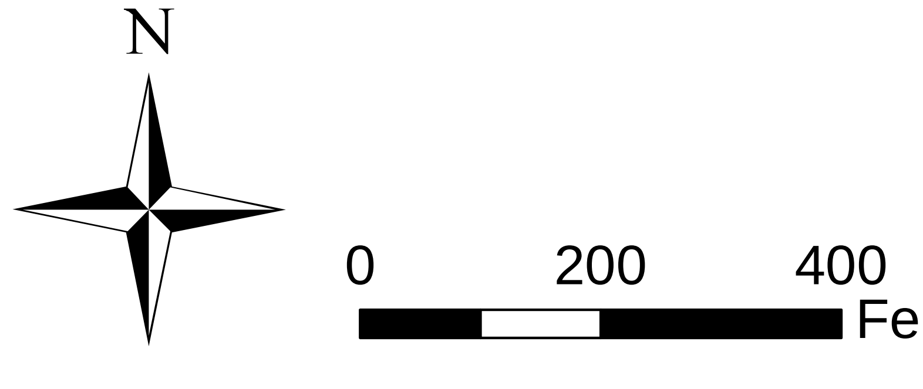
DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-RTW-PPFL-006

SHEET 194 OF 197

Preliminary Engineering Drainage Map
Figure 7





Document Path: K:\02171-000\GIS\Maps\CLL Review Maps\AECOM_Drain-Exhibit.mxd

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2068SB**	**916.4** (Surveyed)

Location: Hennepin Co. Coordinate: X=490282 Y=141932 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine **7504**

Hammer **CME Automatic Calibrated**

SHEET 1 of 2

Drilling Completed **2/6/14**

DEPTH	Depth Elev.	Lithology	Classification	Drilling Operation	SPT N60 REC (%)	MC (%) RQD (%)	COH (psf) ACL (ft)	γ (pcf) Core Breaks	Soil Rock	Other Tests Or Remarks Formation or Member
	1.3 915.1		3 inches of Bituminous over 12 inches of Aggregate Base.							
	4.0 912.4		SANDY LEAN CLAY, trace Gravel, with Sand lenses, brown, frozen, (CLS), fill		*					Frozen to 5 feet. *50 blows per 5-inch set.
5	7.0 909.4		SILTY SAND, fine- to medium-grained, with Gravel, light brown, frozen, (SM), fill		68					
			SANDY LEAN CLAY, with occasional Sand lenses, trace Gravel, brown, wet, (CLS), fill		10	13				DD=122 pcf
10					13					qp=1 3/4 tsf
	14.0 902.4				18	23				P=200=44% Pushed rock limited recovery. See grain-sized accumulation curve.
15			SANDY LEAN CLAY, with Gravel, dark brown, wet, (CLS), fill		19					qp=2 1/4 tsf
										Top of Rail
20					15	14				DD=120 pcf Layers of black Lean Clay at 20 feet.
	24.0 892.4									DD=110 pcf
25			LEAN CLAY, trace Sand, brown, wet, rather stiff, (CL), till		9	21				
	29.0 887.4									Bottom of Footing
30			CLAYEY SAND, trace Gravel, brown, moist, rather stiff to stiff, (SC), till		13	11				DD=129 pcf P200=30% See grain-sized accumulation curve.
35					11					
40	40.0 876.4		SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet to 45 feet then waterbearing, medium dense to hard, (SM), till		24					
▼45										

Index Sheet Code 3.0

(Continued Next Page)

Soil Class: Rock Class: Edit: Date: 8/29/14

N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT.GPJ

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS *SHEET 2 of 2*

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2068SB**	**916.4** *(Surveyed)*

DEPTH	*Depth* *Elev.*	*Lithology*	*Classification*	*Drilling Operation*	*SPT N60* *REC (%)*	*MC (%)* *RQD (%)*	*COH (psf)* *ACL (ft)*	*γ (pcf)* *Core Breaks*	*Soil / Rock*	*Other Tests Or Remarks* *Formation or Member*
			SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet to 45 feet then waterbearing, medium dense to hard, (SM), till *(continued)*		26	12				P200=23%
50					15					
55					23					Gravel encountered at 55 feet.
60	61.0 855.4				53					Gravel encountered at 60 feet.

Bottom of Hole - 61 feet.
Water observed at 45 feet with 45 feet of hollow-stem auger in the ground.
Boring immediately backfilled.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2069SB**	**922.0** (Surveyed)

Location Hennepin Co. Coordinate: X=490175 Y=141987 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine **7504**

Hammer **CME Automatic Calibrated**

SHEET 1 of 2

Drilling Completed **2/7/14**

Depth / Elev.	Classification
1.3 / 920.7	3 inches of Bituminous over 12 inches of Aggregate Base.
7.0 / 915.0	LEAN CLAY, with Sand, brown, frozen to 5 feet then wet, (CL), fill
14.0 / 908.0	LEAN CLAY, with Sand, brown, wet, (CL), fill
17.0 / 905.0	LEAN CLAY, with Sand, trace fibers, dark brown, wet, (CL), fill
20.0 / 902.0	LEAN CLAY, with layers of black, trace fibers, brown and black and gray, wet, (CL), fill
24.0 / 898.0	LEAN CLAY, brown and gray, wet, rather stiff, (CL), till
	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to very stiff, (CLS), till

SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
*				*50 blows per 5-inch set.
*				*50 blows per 6-inch set.
12	14			DD=121 pcf
14				
18				
18	17			DD=113 pcf
				qp=2 tsf
				Top of Rail
14	21			
9				qp=1 1/4 tsf
				qp=1 1/2 tsf
				DD=117 pcf
				Bottom of Footing
9	16			
13				
15				qp=2 1/4

DEPTH: 5, 10, 15, 20, 25, 30, 35, 40, 45

Index Sheet Code 3.0

(Continued Next Page)

Soil Class: Rock Class: Edit: Date: 8/29/14

N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT.GPJ

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

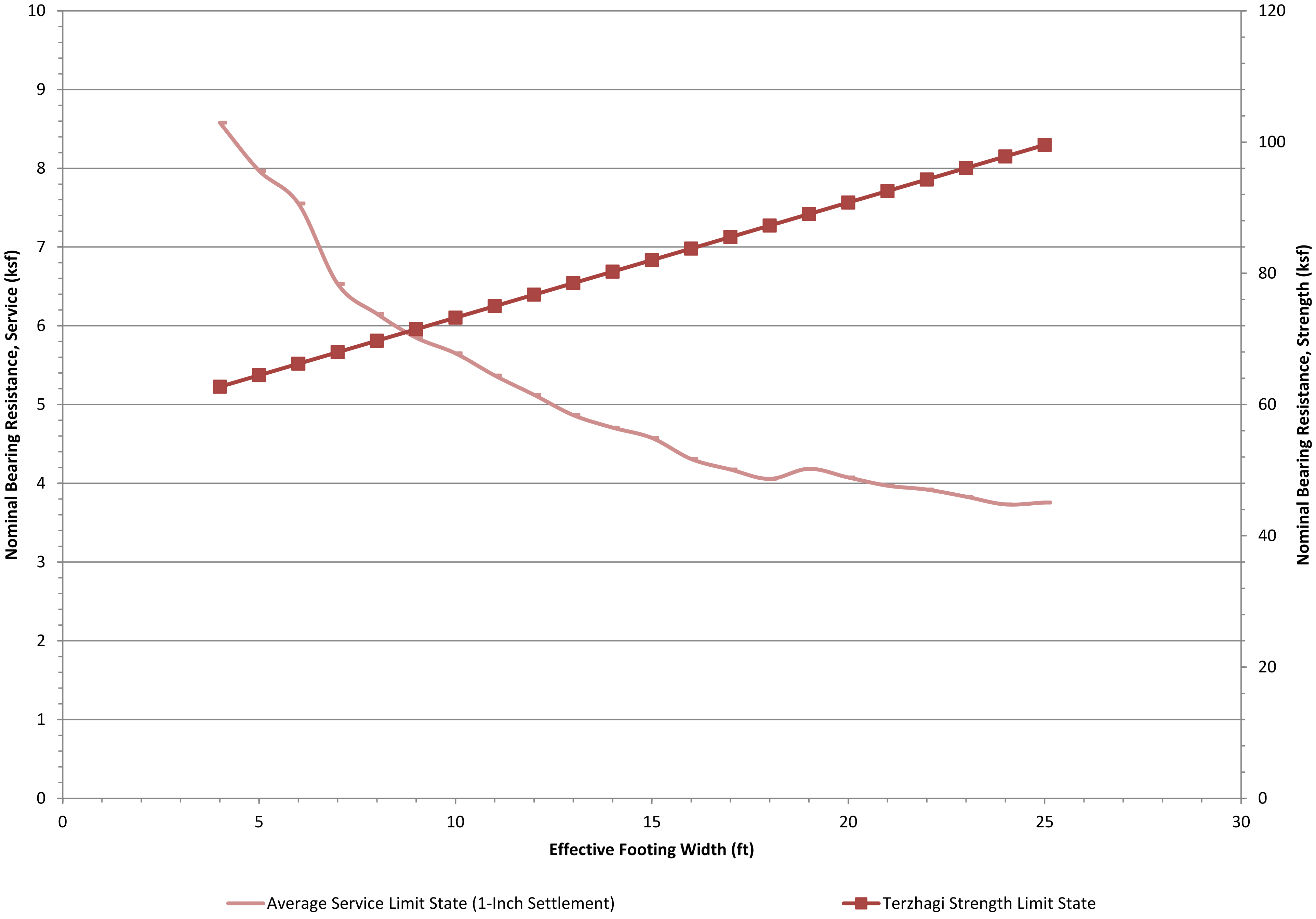
SHEET 2 of 2

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2069SB**	**922.0** *(Surveyed)*

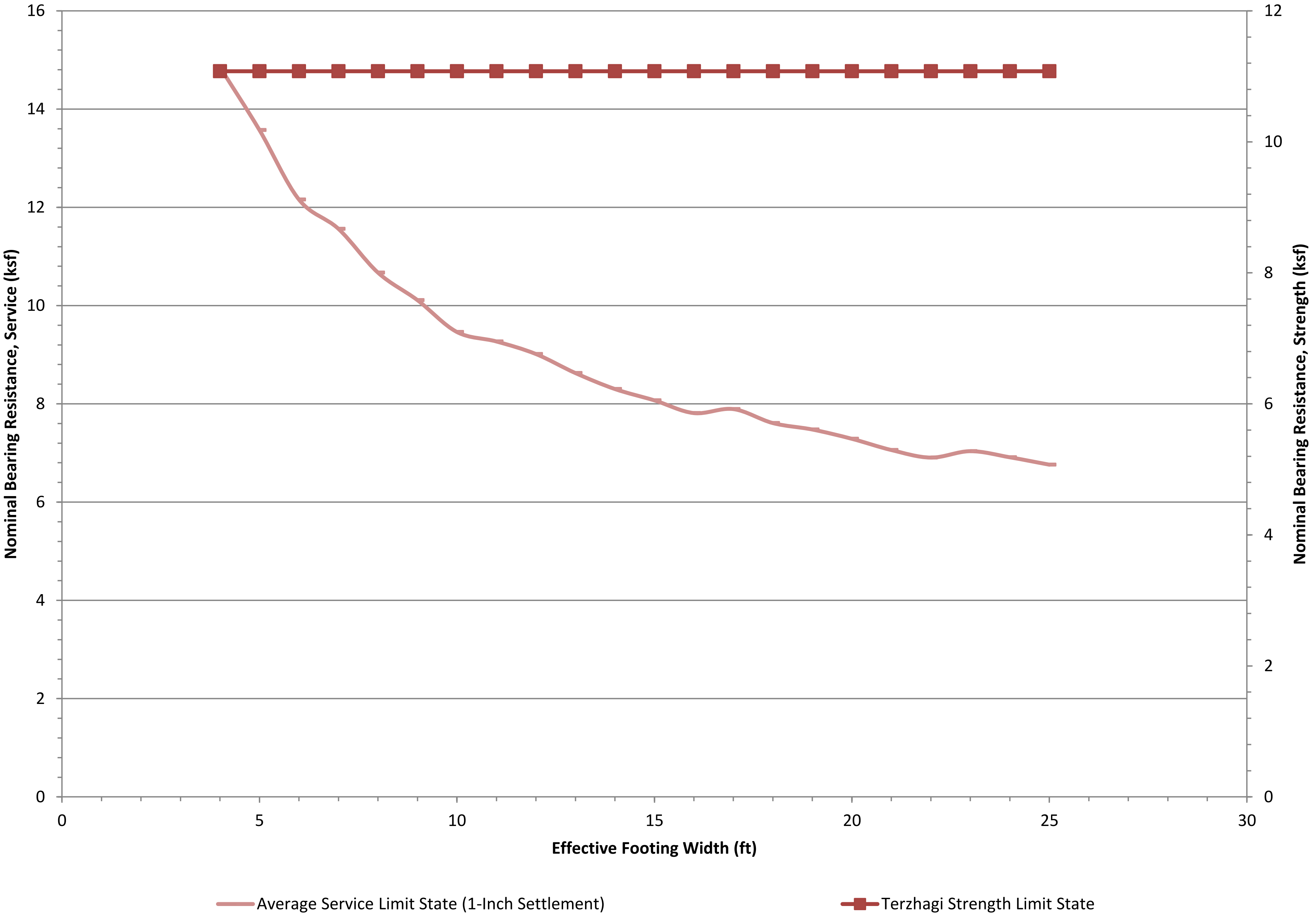
DEPTH	*Depth* *Elev.*	*Lithology*	*Classification*	*Drilling Operation*	*SPT N60* *REC (%)*	*MC (%)* *RQD (%)*	*COH (psf)* *ACL (ft)*	*γ (pcf)* *Core Breaks*	*Soil* / *Rock*	*Other Tests Or Remarks* *Formation or Member*
				☒	18	16				DD=115 pcf
50				☒	22					qp=3 tsf
			SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to very stiff, (CLS), till *(continued)*							
55				☒	35					
▼ 60	61.0 861.0			☒	27					

Bottom of Hole - 61 feet.
Water not observed with 59 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

Limit State Shallow Foundation Analysis
Feltl Bridge Abutment/Wall RTW-305/RTW-306 (2068SB)



Limit State Shallow Foundation Analysis
Smetana Bridge Abutment/Wall RTW-307B (2069SB)



WALL LOADING CASE:
2' - LIVE LOAD SURCHARGE

WALL GEOMETRICS AND DATA - SPREAD FOOTING							QUANTITIES PER FOOT - SPREAD FOOTING					BASE PRESSURE KIPS/SQ. FT.	
							STRUCTURAL CONCRETE		REINFORCEMENT				
STEM HEIGHT h	STEM WIDTH a	TOE WIDTH b	FOOTING THICKNESS c	FOOTING WIDTH d	SHEAR KEY SIZE e	SHEAR KEY LOCATION f	1A43 (CU.YD.) FOOTING	3Y43 (CU.YD.) STEM	PLAIN (POUND)	EPOXY (POUND)	WALL DETAILING SCHEME ①	TOE	HEEL
5	1'-8½"	1'-0"	1'-5"	3'-6"	N/A	N/A	0.187	0.296	15.38	38.16	SHORT	1.670	0.070
6	1'-9"	1'-2"	1'-5"	4'-0"	N/A	N/A	0.211	0.360	16.43	41.74	SHORT	1.820	0.090
7	1'-9½"	1'-4"	1'-5"	4'-6"	N/A	N/A	0.235	0.425	19.70	45.34	SHORT	1.970	0.120
8	1'-10"	1'-6"	1'-5"	5'-0"	N/A	N/A	0.259	0.492	20.75	48.89	SHORT	2.110	0.150
9	1'-10½"	1'-8"	1'-5"	5'-6"	N/A	N/A	0.283	0.561	24.13	52.69	SHORT	2.250	0.180
10	1'-11"	1'-9"	1'-5"	6'-0"	N/A	N/A	0.306	0.631	25.18	62.49	MEDIUM	2.446	0.199
11	1'-11½"	2'-0"	1'-5"	6'-6"	N/A	N/A	0.331	0.703	31.28	66.85	MEDIUM	2.536	0.239
12	2'-0"	2'-3"	1'-5"	6'-9"	1'-0"	3'-10⅝"	0.380	0.776	35.38	72.23	MEDIUM	2.758	0.156
13	2'-0½"	2'-6"	1'-5"	7'-0"	1'-0"	4'-2⅛"	0.393	0.851	40.30	76.82	MEDIUM	2.986	0.013
14	2'-1"	2'-9"	1'-6"	7'-8"	1'-0"	4'-5¾"	0.477	0.928	40.49	81.74	MEDIUM	3.147	0.078
15	2'-1½"	3'-0"	1'-6"	8'-2"	1'-0"	4'-9¼"	0.506	1.006	40.10	99.57	TALL	3.239	0.111
16	2'-2"	3'-3"	1'-9"	8'-8"	1'-0"	5'-0⅞"	0.615	1.085	41.38	105.97	TALL	3.494	0.056
17	2'-2½"	3'-6"	1'-9"	9'-2"	1'-0"	5'-4⅜"	0.649	1.166	49.02	111.90	TALL	3.586	0.089
18	2'-3"	3'-9"	1'-9"	9'-8"	1'-0"	5'-7⅞"	0.682	1.249	50.52	129.74	TALL	3.679	0.121
19	2'-3½"	4'-0"	2'-0"	10'-2"	1'-0"	5'-11½"	0.810	1.333	54.26	137.41	TALL	3.935	0.066
20	2'-4"	4'-3"	2'-0"	10'-8"	1'-0"	6'-3"	0.875	1.417	61.38	165.51	TALL	4.056	0.090
21	2'-4½"	4'-6"	2'-0"	11'-2"	1'-0"	6'-6½"	0.916	1.504	71.34	174.30	TALL	4.151	0.122
22	2'-5"	4'-9"	2'-3"	11'-8"	1'-0"	6'-10⅛"	1.064	1.593	85.93	183.51	TALL	4.407	0.067
23	2'-5½"	5'-0"	2'-6"	12'-2"	1'-0"	7'-1¾"	1.221	1.683	84.82	224.49	TALL	4.663	0.012
24	2'-6"	5'-3"	2'-9"	12'-9"	1'-0"	7'-5⅜"	1.396	1.775	94.03	234.03	TALL	4.872	0.020
25	2'-6½"	5'-6"	2'-9"	13'-3"	1'-0"	7'-8⅞"	1.449	1.868	100.13	288.16	TALL	4.967	0.052
26	2'-7"	5'-10"	3'-0"	13'-9"	1'-0"	8'-1½"	1.631	1.963	102.26	299.67	TALL	5.189	0.000
27	2'-7½"	6'-2"	3'-3"	14'-4"	1'-0"	8'-6⅛"	1.832	2.059	127.34	315.84	TALL	5.364	0.000
28	2'-8"	6'-6"	3'-3"	15'-0"	1'-0"	8'-10⅝"	1.916	2.157	140.92	394.98	TALL	5.334	0.140
29	2'-8½"	6'-10"	3'-6"	15'-6"	1'-0"	9'-3¼"	2.123	2.257	148.00	407.90	TALL	5.558	0.077
30	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:
EPOXY REINFORCEMENT QUANTITY ASSUMES AN EXPANSION JOINT IS USED ON BOTH PANEL ENDS. THE QUANTITY MUST BE ADJUSTED WHEN CONSTRUCTION JOINTS ARE USED. QUANTITIES ON THIS SHEET DO NOT INCLUDE RAILING. SEE RAILING SHEETS FOR RAIL REINFORCEMENT (EPOXY) AND RAIL CONCRETE (3Y46).

① SEE STANDARD PLANS 5-297.621 TO .623 FOR REINFORCING DETAILS.

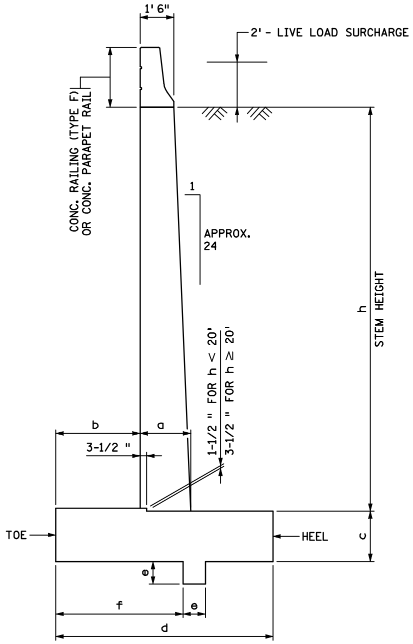
DESIGN CRITERIA

1992 A.A.S.H.T.O. DESIGN SPECIFICATIONS
DESIGN METHOD:
WORKING STRESS - STABILITY, FOUNDATIONS
LOAD FACTOR DESIGN - REINFORCED CONCRETE
f'c = 4,000 PSI
fy = 60,000 PSI

FACTOR OF SAFETY OVERTURNING: 2.0 MINIMUM
FACTOR OF SAFETY SLIDING: 1.5 MINIMUM
LOCATION OF RESULTANT: MIDDLE 1/3 OF FOOTING
NEGLECTING SOIL IN FRONT OF WALL.

SEE FOUNDATION REPORT FOR ALLOWABLE BEARING PRESSURE AND COEFFICIENT OF FRICTION.

BACKFILL CHARACTERISTICS:
INTERNAL ANGLE OF FRICTION: 35°
= 33 PCF EQUIVALENT FLUID PRESSURE ACTIVE STATE
= 53 PCF EQUIVALENT FLUID PRESSURE AT REST STATE
β_e = 1.0
COEFFICIENT OF FRICTION: 0.55
UNIT WEIGHT: 125 PCF



TYPICAL SECTION

REVISED:

APPROVED: MAY 31, 2006

Daniel L. Dorgan
STATE BRIDGE ENGINEER

STANDARD SHEET NO.
5-297.632 (1 OF 4)

STANDARD APPROVED:
MAY 31, 2006

TITLE:
RETAINING WALL (LIVE LOAD SURCHARGE)
SPREAD FOOTING GEOMETRY AND DATA

STATE PROJ. NO. (TH) SHEET NO. OF SHEETS

Table 5. Correlation results for sand. (Column A = Number in Table x Row B.)

B A	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	N bl/ft
E_o tsf	1	0.125	8	1.15	57.5	4
E_R tsf	8	1	64	6.25	312.5	22.7
p^*_L tsf	0.125	0.0156	1	0.11	5.5	0.5
q_c tsf	0.87	0.16	9	1	50	5
f_s tsf	0.0174	0.0032	0.182	0.02	1	0.1
N bl/ft	0.25	0.044	2	0.2	10	1

Table 6. Correlation results for clay. (Column A = Number in Table x Row B.)

B A	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	S_u tsf
E_o tsf	1	0.278	14	2.5	56	100
E_R tsf	3.6	1	50	13	260	300
p^*_L tsf	0.071	0.02	1	0.2	4	7.5
q_c tsf	0.40	0.077	5	1	20	27
f_s tsf	0.079	0.0038	0.25	0.05	1	1.6
S_u tsf	0.010	0.0033	0.133	0.037	0.625	1

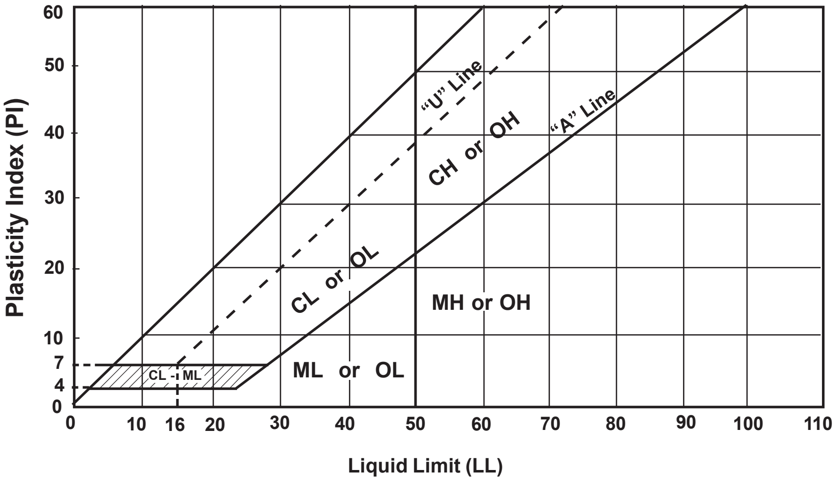
BRAUN
INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	**GW**	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	**GP**	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	**GM**	Silty gravel [d,f,g]
			Fines classify as CL or CH	**GC**	Clayey gravel [d,f,g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	**SW**	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	**SP**	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	**SM**	Silty sand [f,g,h]
			Fines classify as CL or CH	**SC**	Clayey sand [f,g,h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	**CL**	Lean clay [k,l,m]
			PI < 4 or plots below "A" line [j]	**ML**	Silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OL** **OL**	Organic clay [k,l,m,n] Organic silt [k,l,m,o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	**CH**	Fat clay [k,l,m]
			PI plots below "A" line	**MH**	Elastic silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OH** **OH**	Organic clay [k,l,m,p] Organic silt [k,l,m,q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		**PT**	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10} \quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix C

Minnetonka Hopkins Crossing

BRAUN
INTERTEC

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014

Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6545 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Results of Field Exploration and Preliminary Bridge Recommendations
Minnetonka/Hopkins Crossing – 75% Design
STA 2386+00 to STA 2420+00
Southwest LRT, West Segment 3
Minnetonka/Hopkins, Minnesota

Dear Mr. Demers:

This purpose of this letter is to provide you and the design team with the results of our soil borings along the alignment of the proposed Minnetonka/Hopkins Crossing from approximate track STA 2386+00 to STA 2420+00 and to provide preliminary recommendations for the bridge structure (continuous with 3-structure types) and corresponding embankment support. A final geotechnical report should be prepared after final geotechnical borings are completed.

The 3 bridge types are proposed to be constructed along the following Track Alignments:

Table 1. Proposed Bridge Types

Bridge Type	Bridge Type	Approximate Track Station
1	Trestle Bent with Prestressed Concrete Beams	2387+76 to 2393+03 & 2394+51 to 2398+71
2	Trestle Bent with Concrete Slab Spans	2393+03 to 2394+51
3	Pier Bents with Prestressed Concrete Beams	2398+71 to 2413+66

A. Subsurface Investigation Summary

A.1. Summary of Borings Taken

The Southwest Light Rail Transit Project Office (SPO) requested preliminary subsurface soil and groundwater information in the area of the proposed Minnetonka/Hopkins Bridge. Six (6) standard penetration soil borings and six (6) cone penetration test soundings were performed along the proposed crossing alignment. The number, location and function of the borings and soundings are provided below:

Table 2. SPT Boring Location and Function

Boring	Soil Boring Function	Approximate Track Station
2007SB	Bridge	2387+70
2008SB	Bridge	2392+50
2009SB	Bridge	2402+75
2091SB	Bridge	2407+60
2010SB	Bridge	2412+00
2011SB	Bridge/Embankment	2419+50

Table 3. CPT Boring Location and Function

Sounding	Soil Boring Function	Approximate Track Station
2084CB	Bridge	2395+00
2085CB	Bridge	2395+90
2086CB	Bridge	2398+60
2087CB	Bridge	2401+50
2088CB	Bridge	2404+00
2089CB	Bridge	2405+00

A.2. Description of Foundation Soil Conditions

Borings 2007SB, 2010SB, and 2011SB generally encountered sandy lean clay, clayey sand, and silty sand fill soils at the surface to depths ranging from 4 to 9 feet below grade or approximate elevation 885.5 to 896.3. The majority of the fill appears to be non-organic to slightly organic; however, Boring 2091SB encountered organic topsoil to a depth of 4 feet from the surface.

Fill was not encountered at boring locations 2008SB and 2009SB, which encountered lean clay topsoil ranging in thickness of 1 to 2 feet or to approximate elevation 891.5 to 896.9.

Beneath the fill, glacial deposited sands and clay soils were encountered in Borings 2007SB, 2008SB, 2009SB, 2010SB and 2011SB to their termination depths ranging from 51 to 101 feet below grade, which corresponds to approximate elevations 847 to 791 1/2. The penetration resistances recorded in the cohesionless soils (poorly graded sand, poorly graded sand with silt, silty sand, sandy silt and silt soils) ranged from 4 to 100 blows per foot (BPF) indicating very loose to very dense relative densities. The penetration resistance recorded in the cohesive deposits (sandy lean clay and clayey sand soils) ranged from 3 to 61 BPF indicating soft to hard consistencies.

Peat and organic clay swamp deposits were encountered at Borings 2091SB to a depth of 12 feet (elevation 886 1/2) underlain by alluvium lean clay to a depth of 25 feet below grade (elevation 873 1/2). Glacial deposited sands, gravels and clays were encountered below the alluvium to the boring termination depth of 86 feet corresponding to elevation 812.6. The penetration resistances recorded in the native cohesionless soils (well-graded gravel, poorly graded sand with silt and silty sand) ranged from 9 to 150 BPF indicating loose to very dense relative densities. The penetration resistance recorded in the native cohesive deposits (silt, lean clay with sand, clayey sand, and sandy lean clay) ranged from weight of hammer (WH) to 42 BPF, indicating very soft to hard consistencies.

The CPT soundings performed as identified above are generally interpreted as a combination of clays and sands to the sounding termination depths ranging from 50 to 78 feet. Plots of tip resistance, sleeve friction, pore pressure, and friction ratio versus depth are shown on the CPT sounding logs included in the Appendix. The soil types were interpreted from the friction ratio plots in accordance with a methodology given in Robertson CPT, 1990.

Although limited swamp deposits were encountered in the SPT borings performed along the crossing, swamp deposits to depths ranging from 5 to 30 feet thick should be anticipated in areas between the completed boring locations. The completed boring locations were performed at the most accessible (best geotechnical) locations. We recommend that additional borings be completed at a later date for final design to further quantify the full extent of the organic soils.

A.3. Groundwater

Groundwater was encountered at all of the SPT boring locations at depths ranging from 5 to 15 feet beneath the surface corresponding to approximate elevations ranging from 880 to 895 1/2. The elevation of water measured in Borings 2007SB and 2091SB was lower (elevation ranging from 880 to 883 1/2) and in Boring 2011SB was higher (approximate elevation 895) than the other four locations, which were generally measured between elevations 888 1/2 and 890 1/2. The variation in groundwater levels was likely due to the borehole not being left open long enough for water to reach its hydrostatic level and the use of mud-rotary drilling methods. Piezometers may be valuable to more accurately determine the groundwater elevation along the proposed crossing.

Annual and seasonal fluctuations in the groundwater level should be anticipated.

B. Design and Construction Considerations

This letter provides preliminary recommendations for the foundation system for the abutments and piers of the proposed Minnetonka/Hopkins crossing bridge. Based on multiple email and phone correspondences with the design team and our understanding of the desired factored pile loads, the bridge is recommended to be supported on 16-inch closed end (CE) pipe pile with a wall thickness of 0.25-inches. Therefore, recommendations for this size pile are included in this letter.

To construct the crossing, embankment grade increases between the bridges ranges from about 10 to 20 feet. Grade raises of this magnitude will influence the design and construction of the proposed bridge abutment foundation types and the effects of the embankment stresses (drag load) have been accommodated in our design recommendations through the use of a waiting period.

At this time, we understand retaining walls are proposed to support the side slopes of the approach embankments north of Bridge at approximate STA 2413+72 to STA 2417+49. Due to site constraints in this area, we understand these walls are anticipated to be supported on spread footings. Please reference our track report for STA 2413+65 to 2450+22 for additional recommendations regarding the retaining walls adjacent to the north abutment.

Due to proposed grade remaining consistent with existing grade elevations at the bridge pier locations, a waiting period is not anticipated at those substructures.

C. Preliminary Recommendations

C.1. Embankment and Slopes

The bridges along the Minnetonka/Hopkins crossing will consist of a new bridge structure and require the construction of new embankments. As stated above, retaining walls are proposed to support the side slopes of the north embankment adjacent to the bridge at approximate STA 2413+72 to STA 2417+49.

Based on the Preliminary Engineering plan and profile pages, finished grade (outside of the bridge structures) along the crossing are anticipated to increase from about 10 to 20 feet above existing grade. We have assumed the moist unit weight of the anticipated fill soils is 120 pounds per cubic foot (pcf). Outside of the retaining walls, we recommend that side slopes and end slopes be constructed at a 1V:3H (vertical:horizontal) or flatter and 1V:2H or flatter, respectively, for the embankments.

The existing sandy foundation/embankment soils generally have internal friction of 30 degrees or greater while the existing clayey foundation/embankment soils are anticipated to have undrained shear strengths of 500 pounds per square foot (psf) or greater. The permanent slopes can match the existing slopes, except they must be not steeper than 1V:2H. Select granular borrow is anticipated to have an angle of internal friction of approximately 35 degrees. This soil could be temporarily placed at a slope of 1V:1.5H, but must be limited to 1V:2H or flatter for the permanent condition.

We recommend designing permanent slopes of approximately 1V:2H. With the proposed slope protection, these slopes have a Factor of Safety against global failure in excess of 1.5. Areas of poor soils may require less steep slopes. Final design borings may identify areas requiring slope stability analysis.

C.2. Settlement

Based on the anticipated fill height ranging from 10 to 20 feet for the embankments proposed along the crossing, total settlement magnitudes of 2 1/2 to 3 1/2 inches are estimated.

Due to the amount of settlement anticipated, along with the relatively clayey nature of the underlying soils at the embankment locations, preliminary estimates for the time rate of consolidation under the full embankment height indicate that it could take about 3 months to reduce the long-term settlement of the embankment to under one-inch.

C.3. Waiting Periods, Surcharge, Downdrag, and Lateral Squeeze

Because of the new fill being placed for the embankments throughout the crossing, we recommend constructing the embankments to the dimensions identified on MnDOT plan Sheet 5-297.233, however, to allow for additional consolidation of the foundation soils below the approach fills, we recommend extending the approach fill length an additional 50 feet (100 feet total) behind the back face of the abutment as measured along the centerline of the tracks. The waiting period duration recommended for each embankment is identified in the table below.

Table 4. Embankment Waiting Periods

Embankment Location	Approximate Raise in Grade (feet)	Approximate Station	Approximate Waiting Period Duration
South	10	2387+70	31-2 months
North	18	2415+75	1-3 months

Geotechnical instrumentation should be installed to monitor the consolidation of the embankment foundation soils. The preload embankment should not be removed until settlement has leveled off to a tolerable limit and the geotechnical engineer has provided approval to remove the preload.

By constructing the foundations after a waiting period, the foundation design can utilize battered pile. However, downdrag can occur with even an incremental amount of movement, therefore, we recommend the unfactored downdrag load be included in the structural analysis to verify the dead load plus drag load condition does not exceed the pile's structural capacity limits. Based on the proposed fill height for each embankment locations, the estimated unfactored downdrag (negative skin friction) for design of the bridge abutments are provided in the table below.

Table 5. Downdrag Load and Influence Elevation

Embankment	Approximate Station	Approximate Raise in Grade (feet)	Estimated, Nominal Downdrag Load (tons)	Downdrag Influence Elevation (feet)
South	2387+70	15	45	860
North	2415+75	18	20	870

No raise in grade is anticipated in the area of the proposed piers, therefore, we do not anticipate downdrag forces contributing additional load to the piles.

Lateral squeeze can occur if the unit weight of the fill multiplied by the fill height is greater than three times the undrained shear strength of the soft soils. At the south and north abutments, we tested the undrained shear strength of the clay deposits to be at least 1,000 pounds per square foot (psf). Using an estimated unit weight of 120 pounds per cubic foot for the embankment fill height up to 20 feet; we do not anticipate lateral squeeze will be an issue.

C.4. Subcut and Dewatering Recommendations and Backfill Requirements

We recommend removing topsoil, and soft clayey soils encountered below the fill along the embankments prior to constructing the preloads as identified in the table below.

Table 6. Subcut Recommendations

Embankment	Approximate Station	Boring Number	Approximate Existing Grade Elevation (feet)	Anticipated Subcut Depth below Existing Grade (feet)	Bottom of Subcut Elevation (feet)
South	2387+70	2007SB	890	8	886
North	2415+75	2010SB	900	12	890 1/2

The extent of the excavation should extend horizontally beyond the embankment limits a distance equal to the depth of the subcut.

Please note deeper swamp deposits ranging from 5 to as much as 30 feet thick are anticipated away from the boring and sounding locations and excavation depth recommendations likely will change once borings are completed for final design to further quantify the organics and compressible soils along the crossing.

As the bridge piers are anticipated to be constructed within a cut, we do not anticipate a need for subcutting below the substructure since a driven pile foundation system will support the structure.

Based on the anticipated subcut depths and bridge substructures, some of these elevations will be near or below the encountered groundwater elevations. For construction of the pile caps, temporary dewatering with sumps and pumps may be needed, along with the placement of crushed rock to provide a stable working platform during construction.

We recommend backfilling below the substructures and embankment fills with Granular Borrow or Select Granular borrow and compacting the soils to meet the requirements from MnDOT 2105. Soils placed as backfill may not be saturated or frozen at time of placement. Do not place new backfill material on frozen soil.

Backfill against the retaining structures should be placed after the abutments are cured. Use Select Granular Modified 10% for Structure Backfill. Select Granular Modified 10% shall comply with Specification 3149.2B2, modified to 10% or less passing the 0.075 mm (#200) sieve.

C.5. Pile Foundations

C.5.a. Design Methodologies

We used the computer program, *DRIVEN 1.2,* a Federal Highway Administration software developed by Blue-Six Software to estimate the geotechnical static resistances (R_n) of CIP 16–inch outside-diameter pipe piles at the bridge substructure locations. The aforementioned software uses the α - Tomlinson Method to determine pile resistance in cohesive soil and Nordlund Method to determine pile resistance in granular soil. The nominal geotechnical resistance required during driving is obtained by dividing the factored load per pile by the appropriate pile driving resistance factor. Using the American Association of State Highway and Transportation Officials' (AASHTO) parlance and notation, the required nominal geotechnical resistance, R_{ndr}, is the factored load per pile, $\Sigma\gamma_i Q_i$, divided by a pile driving resistance factor, φ_{dyn}, i.e., $R_{ndr} = (\Sigma\gamma_i Q_i) / \varphi_{dyn}$. Using the parlance and notation in MnDOT's Bridge Construction manual, the total drive resistance, $R_{n,}$ is the factored load per pile, $\Sigma\gamma Q_n$, divided by a pile driving resistance factor, φ_{dyn}, i.e., $R_n = (\Sigma\gamma Q_n) / \varphi_{dyn}$. We recommend that φ_{dyn} be related to the degree of construction control. Please refer to the section below for proposed φ_{dyn} parameters.

We established soil and rock parameters using Peck, Hanson, Thornburn, 1974, relationship between corrected blow count, N_{60}, and friction angle.

C.5.b. Nominal Bearing Capacities and Associated Resistance Factors

For situations where subsurface exploration and static calculations have been completed, we recommend that the following φ_{dyn} factors be used.

Table 7. Recommended Pile Driving Resistance Factors (ϕ_{dyn})

Specified Construction Control	ϕ_{dyn}
MnDOT Pile Formula 2012 (MPF12) for Pipe Pile Sections	0.50
Wave Equation and Pile Driving Analyzer (PDA)	0.65

We calculated the nominal resistance of the piles in compression. Please refer to the attached nominal bearing capacity graphs for a detailed profile of pile capacities as a function of depth. The following tables summarize the anticipated pile depths based on the factored load ($\Sigma\gamma Q_n$) for 16-inch CE pile sections based on a factored design load of 140 tons per pile. The tables provide a PDA length (i.e., φ_{dyn} of 0.65) and a MnDOT Pile Formula 2012 (MPF12) for Pipe Pile Sections (i.e., φ_{dyn} of 0.50) for each location.

Table 8. Summary of Anticipated Pile Lengths, CIP 16" CE, $\Sigma\gamma Q_n$=140 tons, PDA

Boring	Approximate Grade Elevation (feet)	R_n (tons)	Approximate Tip Elevation (feet)	Approximate Pile Length below Existing Grade (feet)
2007SB	896	215 [430 kips]	831	65
2008SB	894	215 [430 kips]	834	60
2009SB	898	215 [430 kips]	818*	80*
2010SB	900	215 [430 kips]	840	60
2011SB	903	215 [430 kips]	823	80

Note: The above table assumes the waiting period, as recommended, is performed prior to pile installation for any of the bridge abutment locations.
*The estimated tip elevation and approximate length exceed the depth of exploration at these locations. We extrapolated the soil properties below the depth of exploration.

Table 9. Summary of Anticipated Pile Lengths, CIP 16"CE, $\Sigma\gamma Q_n$=140 tons, MPF12

Boring	Grade Elevation (feet)	R_n (tons)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2007SB	896	280 [560 kips]	816	80
2008SB	894	280 [560 kips]	824	70
2009SB	898	280 [560 kips]	808*	90*
2010SB	900	280 [560 kips]	830	70
2011SB	903	280 [560 kips]	823	80

Note: The above table assumes the waiting period, as recommended, is performed prior to pile installation for any of the bridge abutment locations.
*The estimated tip elevation and approximate length exceed the depth of exploration at these locations. We extrapolated the soil properties below the depth of exploration.

C.5.c. Uplift Capacities

Currently, a tension resistance line is not provided on the Nominal Bearing Graphs attached to this report. If piles will experience tension loads, please let us know and we'll revise our recommendations accordingly.

C.5.d. Recommended Design Soil Parameters (e.g. Coefficient of Friction, Lateral Earth Pressure Coefficients, etc.)

The recommended soil parameters to be used for design are as follows:

Table 10. Recommended Soil Design Parameters

Soil Type	Angle of Internal Friction (degrees)	Effective unit Weight (pcf)	Coefficient of Sliding Friction Rough Concrete	Active Earth Pressure Coefficient	At-Rest Earth Pressure Coefficient
Select Granular Borrow	35	125	0.6	0.27	0.43
Granular Borrow	30	120	0.5	0.33	0.50

C.6. Lateral Earth Pressure Calculations for P-Y Curves and Lateral Earth Forces

The following table provides earth pressure soil parameters for lateral pile analysis and p-y curve generation using the current version of the computer program LPILE. Based on the soils encountered in the borings, we recommend using the default lateral modulus of subgrade reaction values included in LPILE. For purposes of our preliminary evaluation, we used the soil parameters encountered in Borings 2007SB, 2008SB, 2009SB, and 2010SB.

Table 11. Lateral Soil Parameters – Boring 2007SB

Layer Top Depth (feet)	Layer Bottom Depth (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction (degrees)	Undrained Shear Strength (psf)	Material Type
0	10	NA	NA	NA	Exposed
10	18.5	120	NA	600	Soft Clay (Matlock)
18.5	29	115	30	NA	Sand (Reese)
29	37	63	NA	750	Stiff Clay with Free Water (Reese)
37	42	63	NA	1,750	Stiff Clay with Free Water (Reese)
42	47	63	NA	2,500	Stiff Clay with Free Water (Reese)
47	52	58	32	NA	Sand (Reese)
52	75	58	35	NA	Sand (Reese)
75	91	58	33	NA	Sand (Reese)

Table 12. Lateral Soil Parameters – Boring 2008SB

Layer Top Depth (feet)	Layer Bottom Depth (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction (degrees)	Undrained Shear Strength (psf)	Material Type
0	10	NA	NA	NA	Exposed
10	14	120	NA	600	Soft Clay (Matlock)
14	19	53	30	NA	Sand (Reese)
19	42	63	NA	1500	Stiff Clay with Free Water (Reese)
42	44	63	NA	2,500	Stiff Clay with Free Water (Reese)
44	47	58	32	NA	Sand (Reese)
47	49	53	36	NA	Sand (Reese)
49	54	63	NA	2500	Stiff Clay with Free Water (Reese)
54	57	53	38	NA	Sand (Reese)
57	99	28	34	NA	Sand (Reese)
99	111	53	36	NA	Sand (Reese)

Table 13. Lateral Soil Parameters – Boring 2009SB

Layer Top Depth (feet)	Layer Bottom Depth (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction (degrees)	Undrained Shear Strength (psf)	Material Type
0	4	120	NA	600	Soft Clay (Matlock)
4	7	115	30	NA	Sand (Reese)
7	17	48	30	NA	Sand (Reese)
17	24	53	36	NA	Sand (Reese)
24	27	28	33	NA	Sand (Reese)
27	29	53	36	NA	Sand (Reese)
29	32	58	35	NA	Sand (Reese)
32	37	53	33	NA	Sand (Reese)
37	51	48	32	NA	Sand (Reese)

Table 14. Lateral Soil Parameters – Boring 2010SB

Layer Top Depth (feet)	Layer Bottom Depth (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction (degrees)	Undrained Shear Strength (psf)	Material Type
0	4	120	NA	300	Soft Clay (Matlock)
4	19	48	32	NA	Sand (Reese)
19	22	63	NA	2200	Stiff Clay with Free Water (Reese)
22	32	53	31	NA	Sand (Reese)
32	47	53	34	NA	Sand (Reese)
47	59	68	NA	6500	Stiff Clay with Free Water (Reese)
59	79	53	36	NA	Sand (Reese)
79	100	48	40	NA	Sand (Reese)

We analyzed the lateral resistance of the pile using a factored axial service load of 140 tons and adjusted the shear load to achieve a pile top deflection of one-inch. Please refer to the attachments for the resulting pile top deflection and bending moments within the pile at the provided service loads. For our lateral analysis, we assumed a fix-head condition and for the proposed bridge that will include pier bents, an unbraced length of 10 feet was included in our lateral analysis.

C.7. Pile Spacing and Group Effect

Given the anticipated cohesive soil conditions at the site, if the pile cap is not in firm contact with the ground and if the soil at the surface is soft, the individual nominal resistance of each pile should be multiplied by an efficiency factor η, take as:

- η = 0.65 for a center-to-center spacing of 2.5 diameters.
- η = 1.0 for a center-to-center spacing of 6.0 diameters.

For intermediate spacing’s, the value of η should be determined by linear interpolation. If the cap is in firm contact with the ground, no reduction in efficiency is required.

The lateral capacity for each pile should be reduced, depending on the actual spacing and the location of the pile within the pile cap. We recommend using pile spacing reductions (group action) for the various pile spacing as identified in the table below.

Table 15. Pile CTC Spacing

Pile CTC Spacing (in the direction of loading)	Row 1	Row 2	Row 3 and Higher
3D	0.8	0.4	0.3
4D	0.9	0.63	0.5
5D	1.0	0.85	0.7

Linearly interpolated from Table 10.7.2.4-1 of the AASHTO LRFD Bridge Design Manual, 6th Edition.

C.8. Pile Driving System and Installation

Using an under- or over-sized pile-driving hammer can be detrimental to the successful installation of piling. Prior to system acceptance, we therefore recommend performing a wave equation analysis modeling prospective contractors’ pile installation systems. The wave equation analysis is used to estimate probable driving stresses and pile penetration resistance based on the type of hammer proposed, the specified pile type/size and the site-specific material conditions which, when combined, help evaluate system suitability. Our firm can discuss the requirements and limitations of wave equation analyses and, if needed, perform them.

D. Procedures

D.1. Penetration Test Borings

The penetration test borings were drilled with an ATV-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout.

D.2. Cone Penetration Test Soundings

The cone penetration test (CPT) soundings were performed by advancing a 1.75-inch diameter Vertek seismic piezocone with an unequal end area ratio of 0.8. A 20-ton track-mounted rig was used to advance the cone into the ground. The soundings were performed in accordance with ASTM D 5778. As the cone was advanced, tip resistance (Q_t), sleeve friction (F_S) and pore pressure (U_2) were measured continuously.

D.3. Material Classification and Testing

D.3.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars, bags or thin wall tubes and returned to our facility for review, storage and laboratory testing.

D.3.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

D.4. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled with a bentonite grout.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

E.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

E.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

E.3. Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F. General

This report should be considered preliminary in nature and may be revised upon final design parameters and the completion of the full geotechnical program. In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If you have any questions about this Addendum, please contact Josh Kirk at 952.995.2222 or jkirk@braunintertec.com or Matt Ruble at 952.995.2224 or mruble@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report
was prepared by me or under my direct supervision
and that I am a duly Licensed Professional Engineer
under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal / Project Engineer
License Number: 45005

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

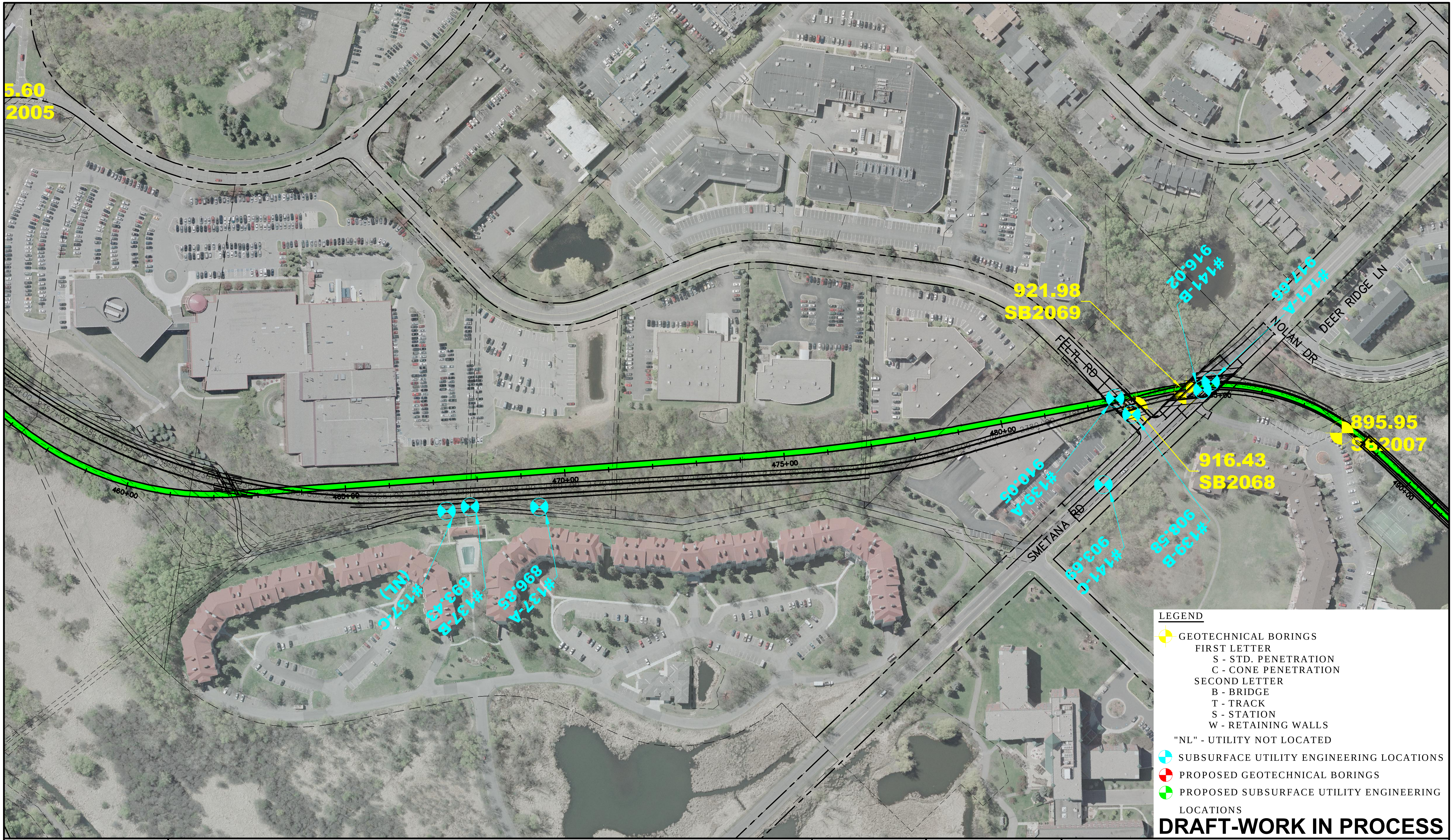
Reviewed by:

Ray A. Huber, PE
Vice President/Principal Engineer

Appendix:
Soil Boring Sketch
Preliminary Plan and Profile Pages for Hopkins-Minnetonka Bridge
Standard Penetration Test Borings: 2007SB, 2008SB, 2009SB, 2010SB, 2011SB and 2091SB
Laboratory Test Results
Cone Penetration Test Soundings: 2084CB through 2089CB
Nominal Bearing Resistance Graphs
Lateral Analysis Results
MnDOT 297.233 Preload Embankment Sketch
Descriptive Terminologies of Soil

c: Mr. Jeff Stewart, SPO
Ms. Laura Amundson, Parsons Brinkerhoff
Mr. Patrick Rivard, AECOM

APPENDIX



LEGEND

- GEOTECHNICAL BORINGS
  - FIRST LETTER
    - S - STD. PENETRATION
    - C - CONE PENETRATION
  - SECOND LETTER
    - B - BRIDGE
    - T - TRACK
    - S - STATION
    - W - RETAINING WALLS

"NL" - UTILITY NOT LOCATED

- SUBSURFACE UTILITY ENGINEERING LOCATIONS
- PROPOSED GEOTECHNICAL BORINGS
- PROPOSED SUBSURFACE UTILITY ENGINEERING LOCATIONS

DRAFT-WORK IN PROCESS

Aug. 28 2014 11:34 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha

SOUTHWEST
Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 10 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

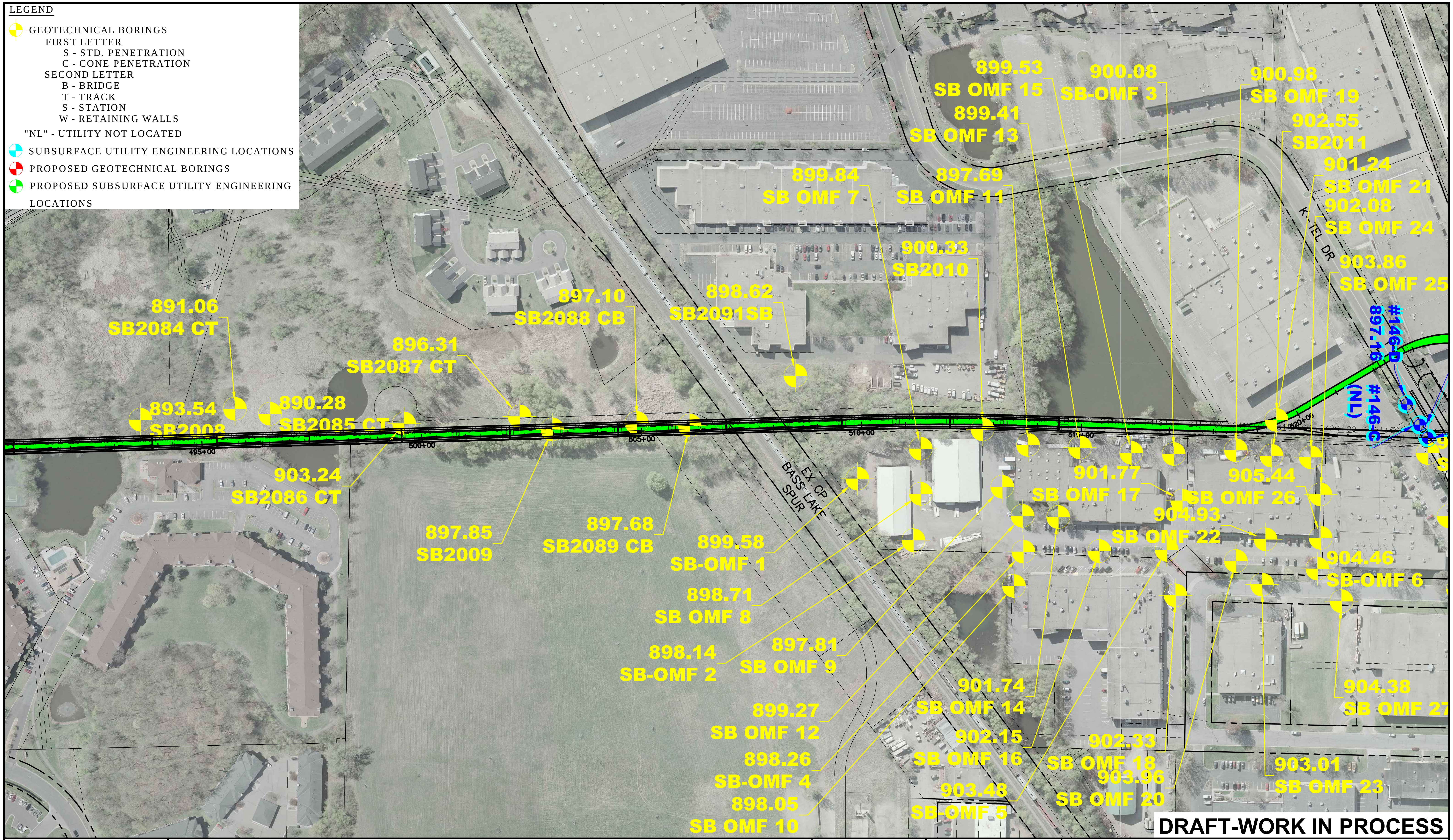
NORTH

0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.



SOUTHWEST
Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 11 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

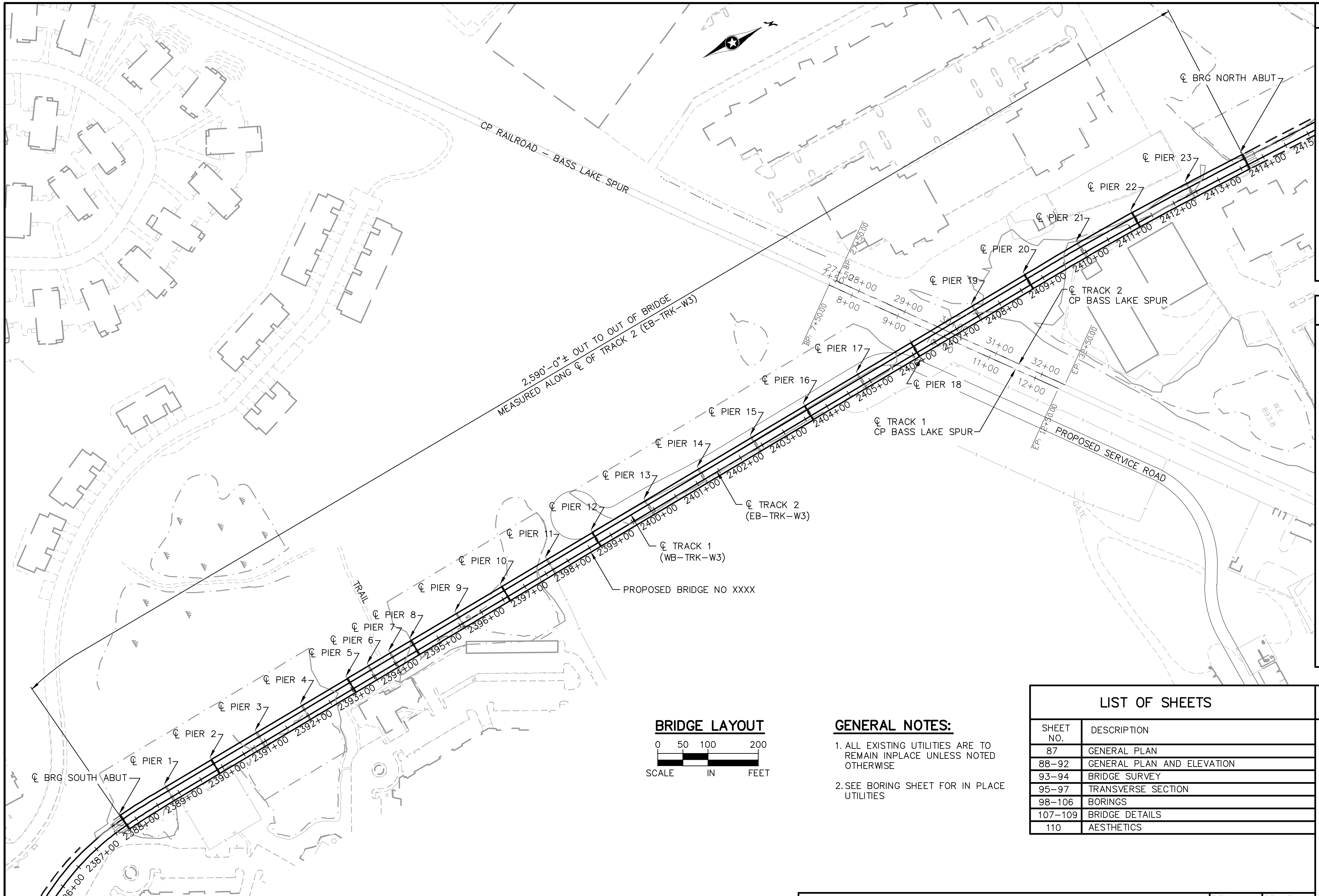
NORTH
0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.

Aug, 28 2014 11:34 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



BRIDGE LAYOUT

0 50 100 200
SCALE IN FEET

GENERAL NOTES:

1. ALL EXISTING UTILITIES ARE TO REMAIN INPLACE UNLESS NOTED OTHERWISE
2. SEE BORING SHEET FOR IN PLACE UTILITIES

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 2.0)

LOAD AND RESISTANCE FACTOR DESIGN METHOD

LRV & MV LOAD DIAGRAM SHOWN ON SHEET 95

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4000 PSI, n = 8
fy = 60000 PSI

PRESTRESSED CONCRETE:
f'c = 9000 PSI, n = 1
fpu = 270 KSI LOW RELAXATION STRANDS
0.75 fpu FOR INITIAL PRESTRESS

DESIGN SPEED: OVER = 30/55 MPH (LRT)
UNDER = 25 MPH

APPROXIMATE DECK AREA: 83,700 SQ FT

PROPOSED TYPE OF STRUCTURE

DECK:
2'-1" REINFORCED CONCRETE SLAB SPAN (CONTINUOUS) AND MN45, MN63 AND 82MW PRESTRESSED CONCRETE BEAMS (SIMPLE SPANS) WITH 9" CAST-IN-PLACE CONCRETE DECK
ALL BARS EPOXY COATED
DIRECT FIXATION TRACK

SUBSTRUCTURE:
PARAPET ABUTMENTS SUPPORTED ON 12" CIP CONCRETE PILES

HAMMERHEAD PIERS SUPPORTED ON 16" CIP CONCRETE PILES

TRESTLE BENT PIERS SUPPORTED ON 16" CIP CONCRETE PILES

DEPTH OF STRUCTURE:
SPANS 1-6, 9-12 & 20-24
±7'-8" TOP OF LOW RAIL TO LOW BRIDGE
4± BEAM LINES

SPANS 6-8
±3'-6" TOP OF LOW RAIL TO LOW BRIDGE

SPAN 19
±9'-3" TOP OF LOW RAIL TO LOW BRIDGE
4± BEAM LINES

AESTHETICS:
TO BE DETERMINED

LIST OF SHEETS

SHEET NO.	DESCRIPTION
87	GENERAL PLAN
88-92	GENERAL PLAN AND ELEVATION
93-94	BRIDGE SURVEY
95-97	TRANSVERSE SECTION
98-106	BORINGS
107-109	BRIDGE DETAILS
110	AESTHETICS

PRELIMINARY PLAN BRIDGE NO. XXXXX

SOUTHWEST LIGHT RAIL OVER CP RAIL AND WETLANDS
1 MI. NORTH OF JCT. TH 61 & TH 62 IN MINNETONKA

REINFORCED CONCRETE SLAB SPANS AND VARIABLE LENGTH PRESTRESSED CONCRETE BEAM SPANS
32'-6" OUT TO OUT DECK
0'-0'-0" SKEW

IDENTIFICATION NO. 501 MAIN & 209 APPRAOCH

GENERAL PLAN

SEC 26 T 117 N R 22 W
CITY OF MINNETONKA HENNEPIN COUNTY

APPROVED: ______________
STATE BRIDGE ENGINEER

MNDOT REVIEW:

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

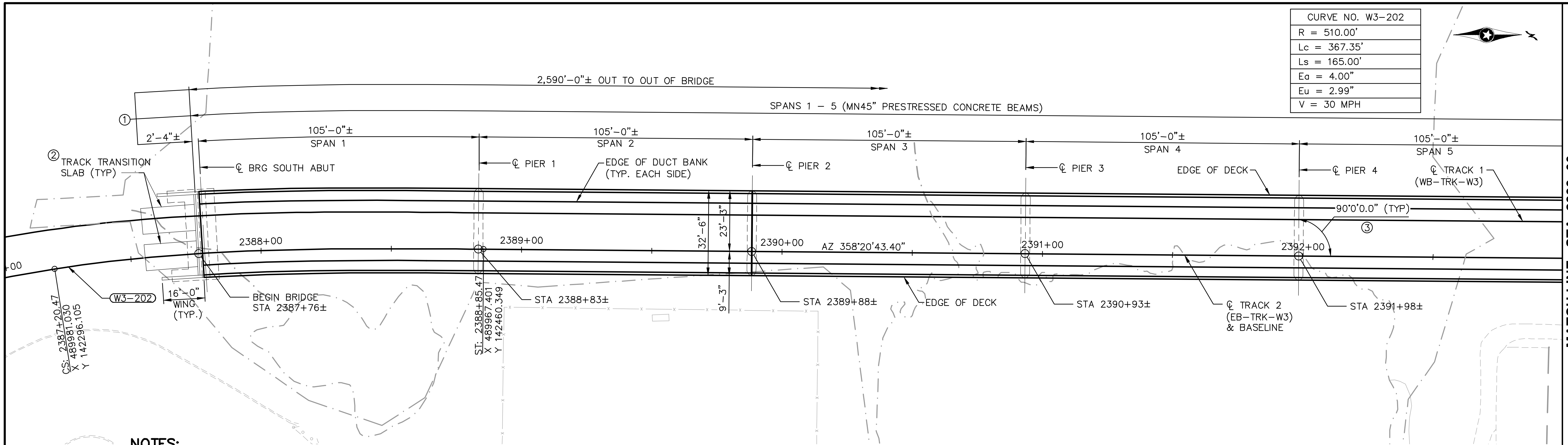
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
GENERAL PLAN

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-GEN

Jun. 13 2014 11:13 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-GPE.dwg By: RieckmBB

CURVE NO. W3-202
R = 510.00'
Lc = 367.35'
Ls = 165.00'
Ea = 4.00"
Eu = 2.99"
V = 30 MPH



NOTES:

①MEASURED ALONG ℄ TRACK 2 (EB-TRK-W3)

②SEE TRACK PLANS FOR TRANSITION SLAB DETAILS

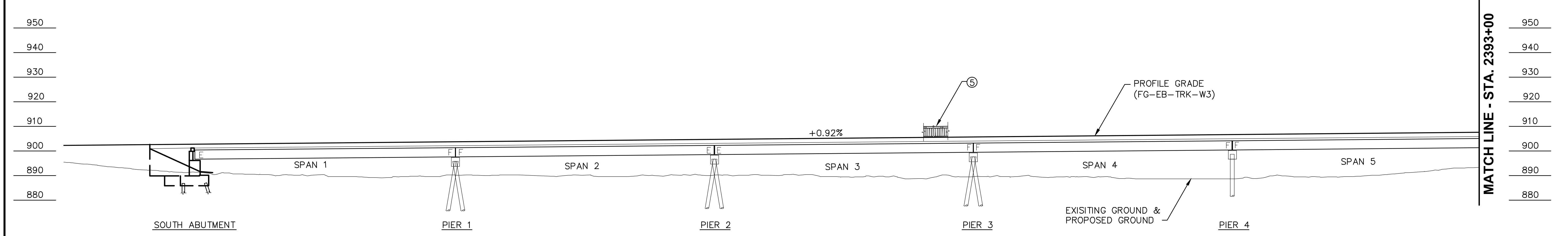
③TTC TYP UNLESS SHOWN OTHERWISE

4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES.

⑤RAILING TYPE TO BE DETERMINED IN FINAL DESIGN.

GENERAL PLAN

0 10 20 40
SCALE IN FEET



GENERAL ELEVATION

0 10 20 40
SCALE IN FEET

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

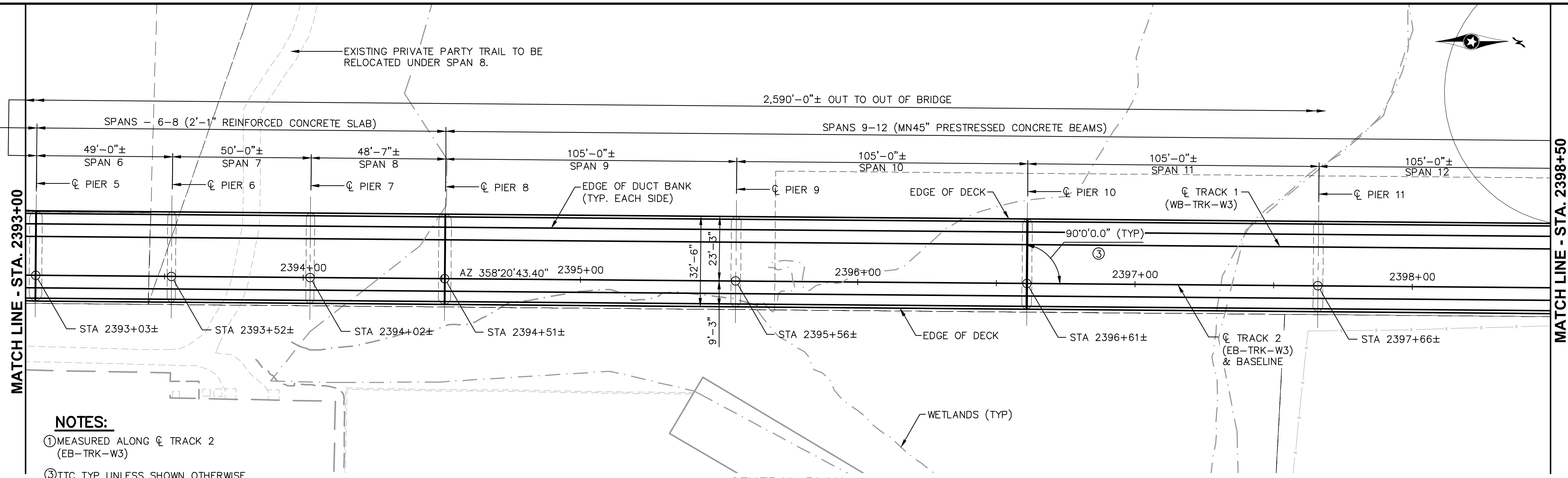
SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-GPE-001

SHEET 88 OF 197



NOTES:

①MEASURED ALONG ℄ TRACK 2 (EB-TRK-W3)

③TTC TYP UNLESS SHOWN OTHERWISE

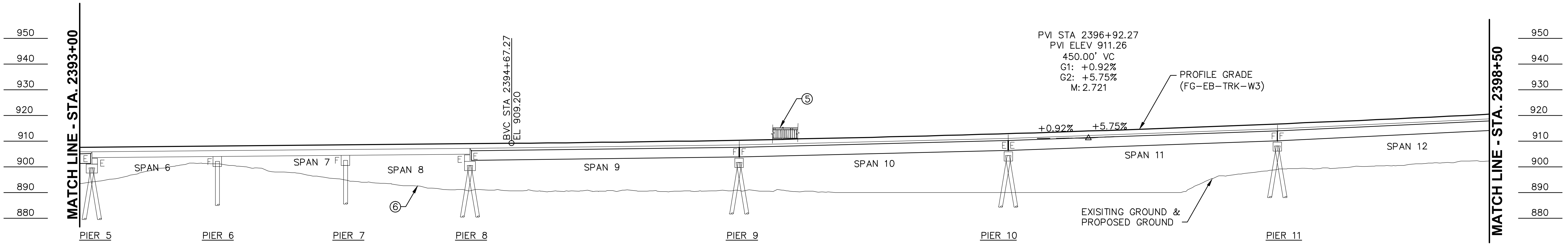
4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES

⑤ RAILING TYPE TO BE DETERMINED IN FINAL DESIGN.

⑥ EXISITNG PRIVATE PARTY TRAIL TO BE RELOCATED. FOR 10' VERTICAL CLEARANCE FROM PATH TO BOTTOM OF STRUCTURE THE ELEVATION OF PATH NEEDS TO BE AT 894.85 FT

GENERAL PLAN

0 10 20 40
SCALE IN FEET



GENERAL ELEVATION

0 10 20 40
SCALE IN FEET

DES: AAM DRA: TAW
CHK: PLR CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

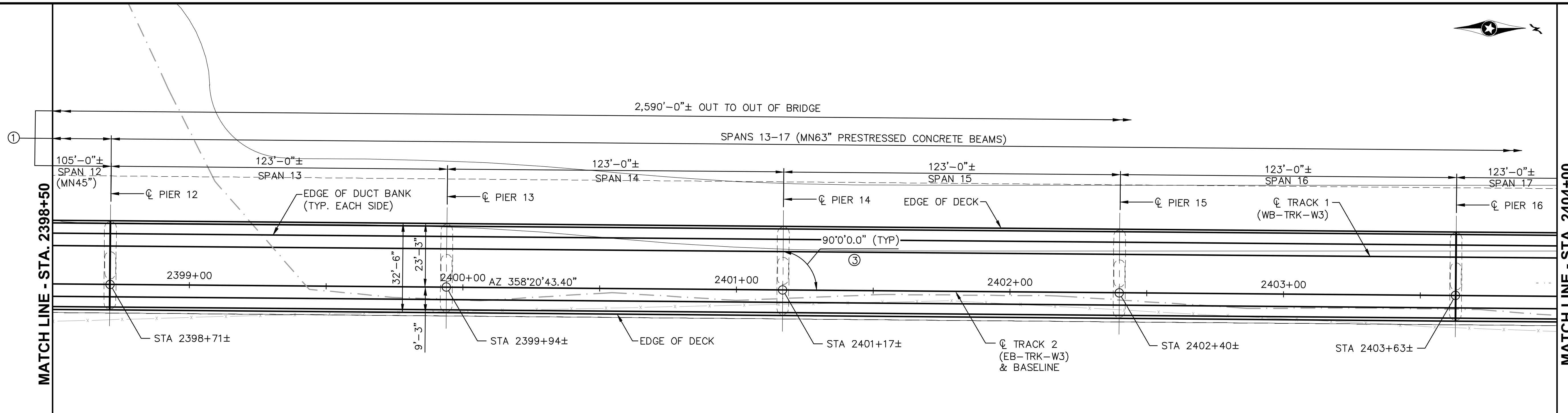
SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-GPE-002

SHEET 89 OF 197



NOTES:

①MEASURED ALONG ℄ TRACK 2 (EB-TRK-W3)

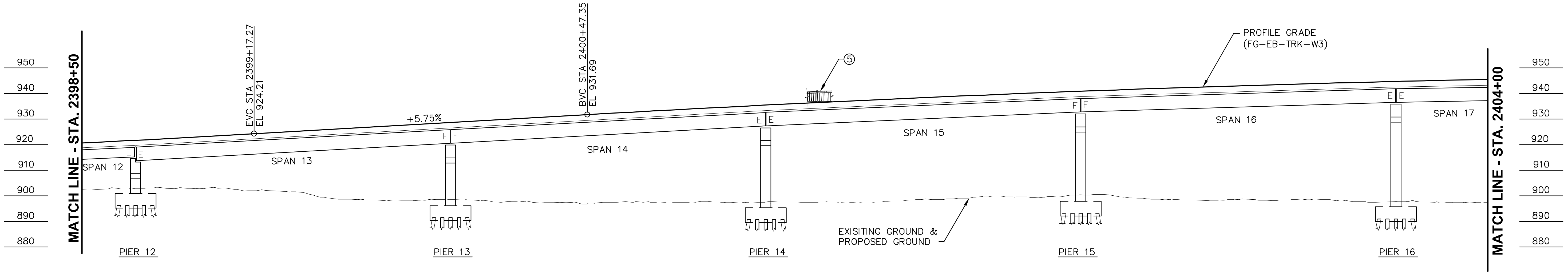
③TTC TYP UNLESS SHOWN OTHERWISE

4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES

⑤ RAILING TYPE TO BE DETERMINED IN FINAL DESIGN.

GENERAL PLAN

0 10 20 40
SCALE IN FEET



GENERAL ELEVATION

0 10 20 40
SCALE IN FEET

DES: AAM
DRA: TAW
CHK: PLR
CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

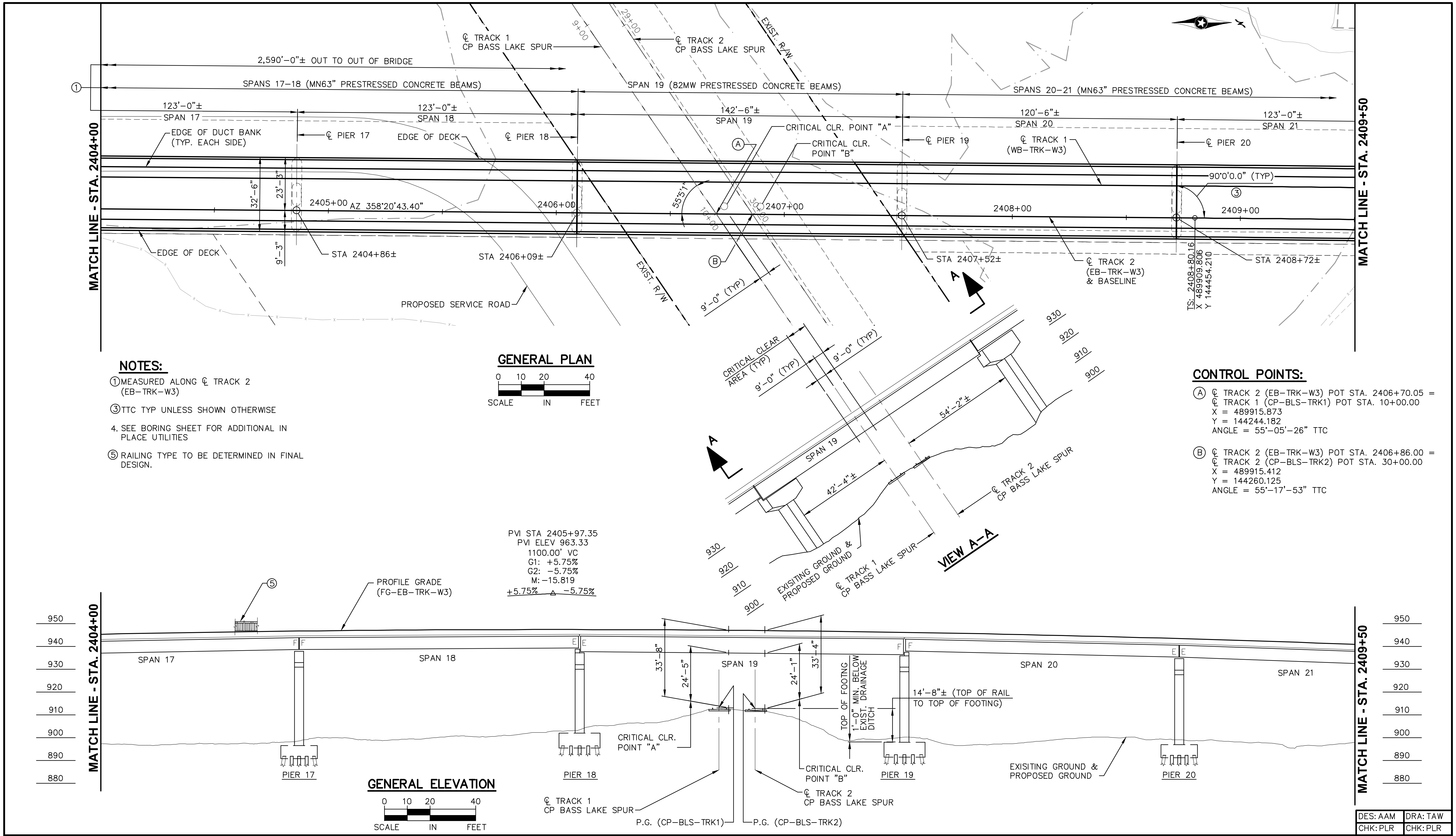
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-GPE-003

SHEET 90 OF 197

Jun, 13 2014 11:13 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-GPE.dwg By: RieckmBB



NOTES:

①MEASURED ALONG ℄ TRACK 2
(EB-TRK-W3)

③TTC TYP UNLESS SHOWN OTHERWISE

4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES

⑤ RAILING TYPE TO BE DETERMINED IN FINAL DESIGN.

CONTROL POINTS:

Ⓐ ℄ TRACK 2 (EB-TRK-W3) POT STA. 2406+70.05 =
℄ TRACK 1 (CP-BLS-TRK1) POT STA. 10+00.00
X = 489915.873
Y = 144244.182
ANGLE = 55°-05'-26" TTC

Ⓑ ℄ TRACK 2 (EB-TRK-W3) POT STA. 2406+86.00 =
℄ TRACK 2 (CP-BLS-TRK2) POT STA. 30+00.00
X = 489915.412
Y = 144260.125
ANGLE = 55°-17'-53" TTC

DES: AAM
DRA: TAW
CHK: PLR
CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-GPE-004

SHEET 91 OF 197

Jun, 13 2014 11:13 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-GPE.dwg By: RieckmBB

CURVE NO. W3-203
R = 5,000.00'
Lc = 170.02'
Ls = 130.00'
Ea = 1.00"
Eu = 1.40"
V = 55 MPH

NOTES:

① MEASURED ALONG ℄ TRACK 2 (EB-TRK-W3)

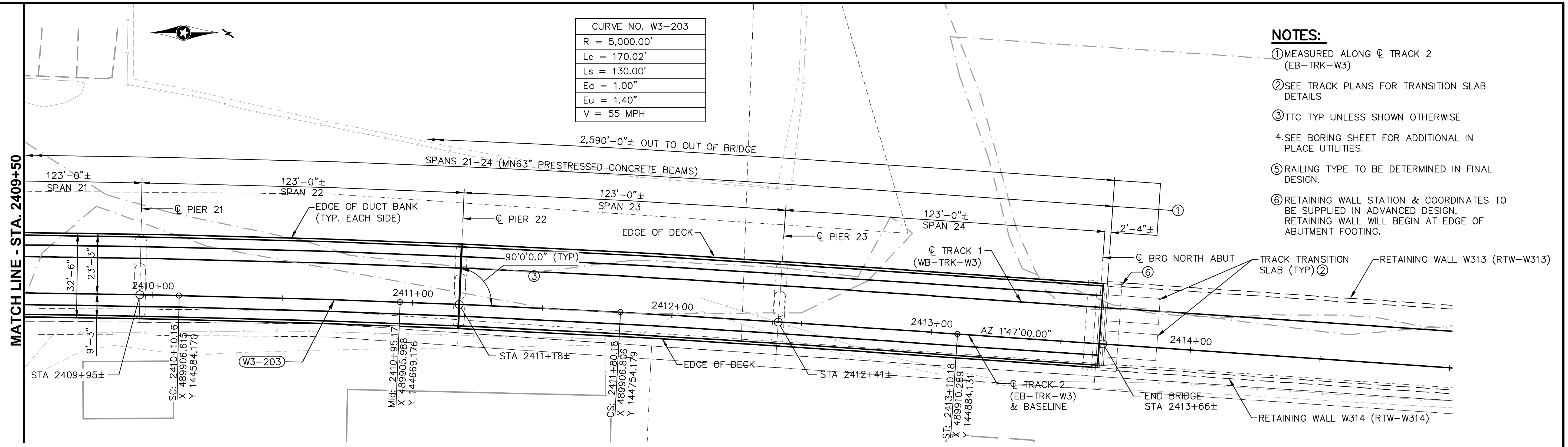
② SEE TRACK PLANS FOR TRANSITION SLAB DETAILS

③ TTC TYP UNLESS SHOWN OTHERWISE

4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES.

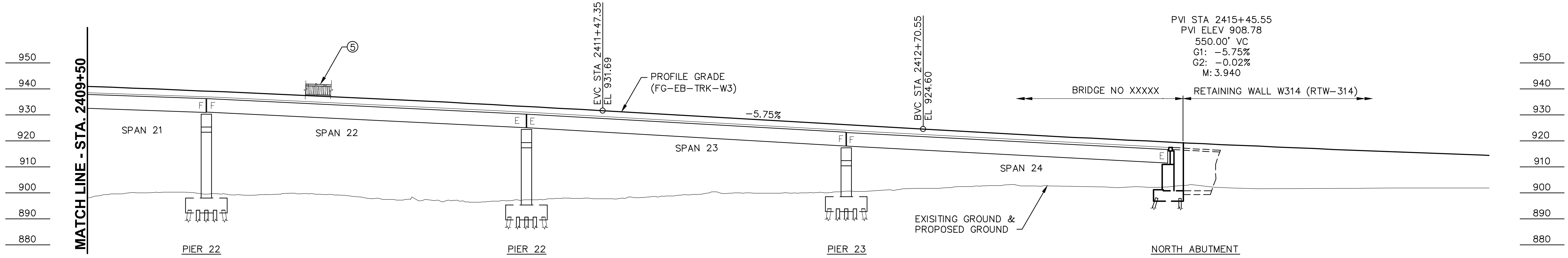
⑤ RAILING TYPE TO BE DETERMINED IN FINAL DESIGN.

⑥ RETAINING WALL STATION & COORDINATES TO BE SUPPLIED IN ADVANCED DESIGN. RETAINING WALL WILL BEGIN AT EDGE OF ABUTMENT FOOTING.



GENERAL PLAN

0 10 20 40
SCALE IN FEET



GENERAL ELEVATION

0 10 20 40
SCALE IN FEET

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extention

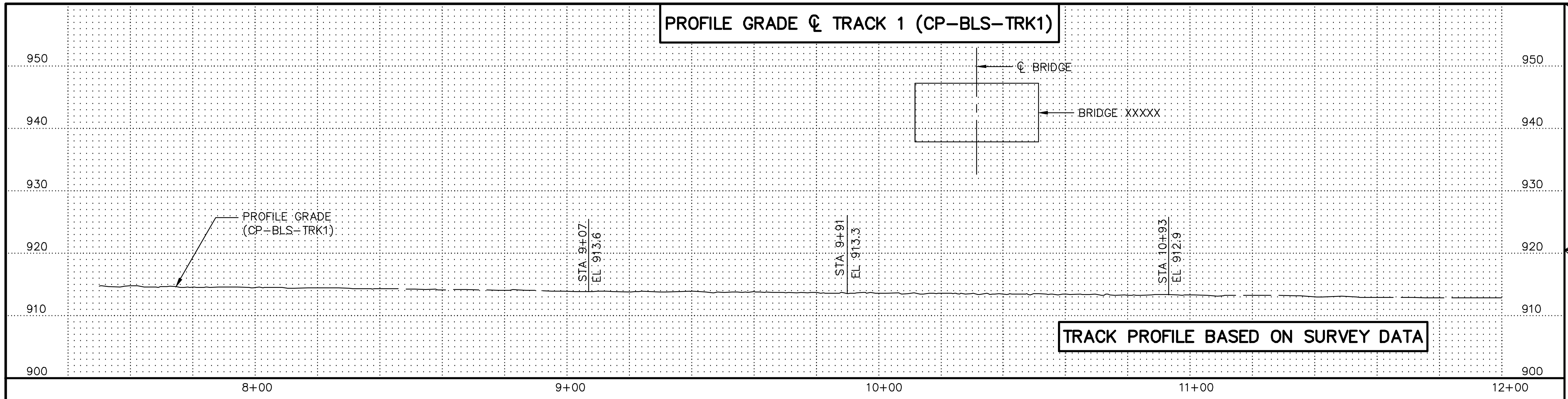
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

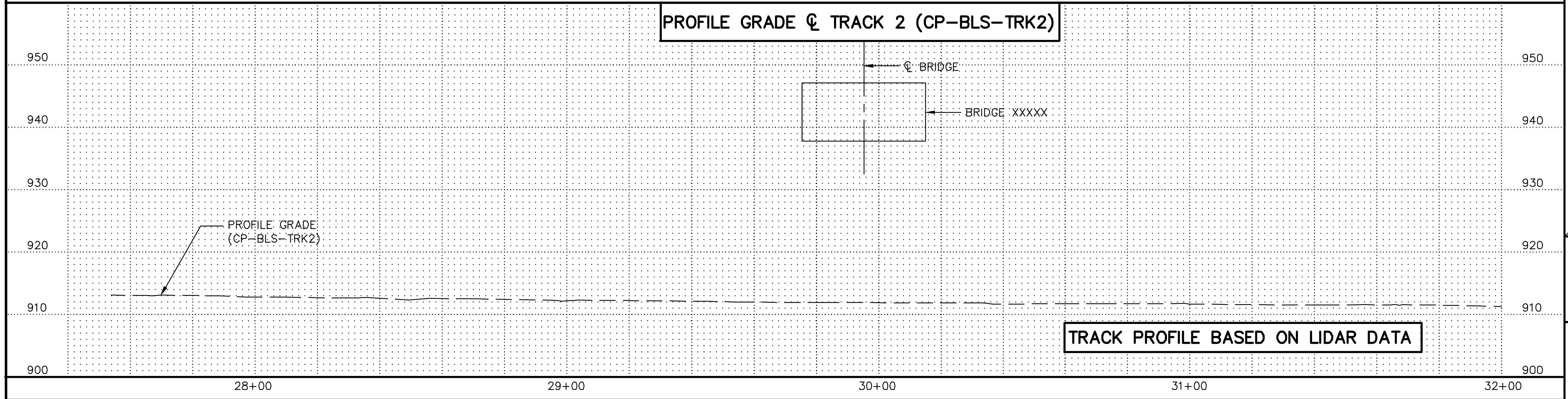
DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-GPE-005

SHEET 92 OF 197

Jun, 13 2014 11:14 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-GPE.dwg By: RieckmBB





LOCATION ENGINEER'S OBSERVATIONS AT BRIDGE SITE

SPECIAL FEATURES: WATERFALLS, DAMS, FLOODS, ICE, DEBRIS, SLIDING BANKS, RECREATIONAL BOATING.

OTHER BRIDGES OR CULVERTS OVER THE SAME STREAM (PARTICULARLY STRUCTURES WHICH CARRY HIGH WATER WITHOUT OVERFLOW OF ROADWAY) : GIVEN LOCATION,TYPE, LENGTH, HEIGHT ABOVE HIGH WATER, CROSS-SECTIONAL AREA ETC.

3.APPARENT HIGHWATER ELEVATION ___________
OBTAINED FROM:

4.OTHER DATA: APPROX. VELOCITY OF WATER AT TIME OF SURVEY.

HYDRAULIC ENGINEERS RECOMMENDATION

DATE: XX-XX-XXXX

STREAM OR DITCH DESIGNATION: XXX

DRAINAGE AREA: XXX SQ. MI.

MAX FLOOD ON RECORD: XXX C.F.S. (XX-XX-XX)

MAXIMUM OBSERVED HIGHWATER ELEVATION: XXX.X FT.

DESIGN FLOOD (XX TR. FREQ.): XXX C.F.S.
HEADWATER ELEVATION: XXX.X FT.
DESIGN MEAN VELOCITY THROUGH STRUCTURE: X.X F.P.S.
TOTAL STAGE INCREASE: XX FT.
LOW MEMBER AT OR ABOVE ELEVATION: XXX.X FT

WATERWAY AREA REQUIRED BELOW ELEV. XXX.X = XXX SQ. FT. AT RIGHT ANGLES TO CHANNEL

BASIC FLOOD (100 YR. FREQ.): XXX C.F.S.
HEADWATER ELEVATION: XXX.X FT.
TOTAL STAGE INCREASE: X.X FT.
MEAN VELOCITY THROUGH STRUCTURE: X.X F.P.S.

FLOWLINE ELEVATION: XXX FT. SKEW ANGLE: XX

ESTIMATED PRELIMINARY TOTAL SCOUR AT PIER EL. XXX.X (500 OR OT YR.FREQ.)

SCOUR CONFIRMATION RECOMMENDATION

DATE: XX-XX-XXXX

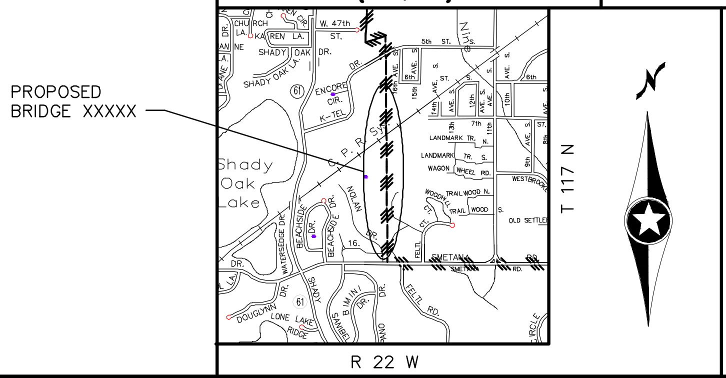
TOTAL SCOUR AT PIER EL. XXX.XX (500 OR OT YR. FREQ.)
SCOUR CODE: OBTAIN FROM HYDRAULIC ENGINEER

BRIDGE SURVEY SHEETS MADE FROM SURVEY AND PHOTOGRAMMETRIC MAPPING.

MONUMENT NAME: CONTROL POINT 6
BENCHMARK ELEVATION (NAVD88): 932.956
NORTHING (HEN. COUNTY COORDINATES NAD83(2007)): 142016.680
EASTING (HEN. COUNTY COORDINATES NAD83(2007)): 489989.960
MONUMENT DESCRIPTION: CAST IRON MONUMENT

MONUMENT NAME: CONTROL POINT 8
BENCHMARK ELEVATION (NAVD88): 919.385
NORTHING (HEN. COUNTY COORDINATES NAD83(2007)): 147263.069
EASTING (HEN. COUNTY COORDINATES NAD83(2007)): 489996.864
MONUMENT DESCRIPTION: CAST IRON MONUMENT

INDEX MAP
(1 SQ. MI.)



BRIDGE SURVEY

1 MI NORTH OF JCT. TH 61 & TH 62 IN MINNETONKA

SOUTHWEST LIGHT RAIL OVER CP RAIL AND WETLANDS

SEC 26 T 117 R 22

CITY OF MINNETONKA HENNEPIN COUNTY

BRIDGE XXXXX

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BRIDGE SURVEY

DISCIPLINE: **STRUCTURES**

SHEET NAME: **W3-STU-BRG-MKHP-LRT-SUR-001**

SHEET 93 OF 197

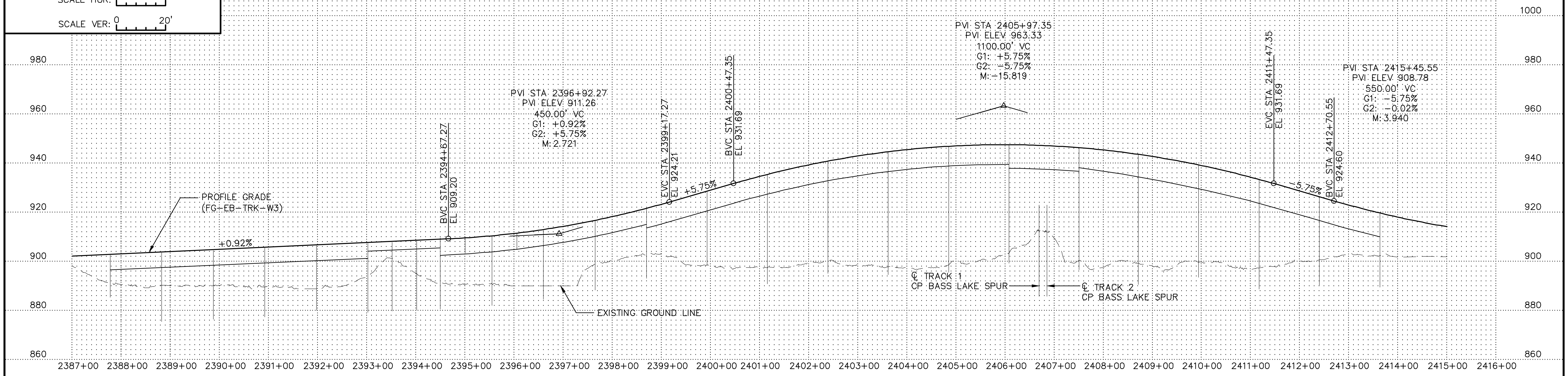
Jun, 13 2014 11:15 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR.dwg By: RieckmBB

CONTRACTED PROFILE

SCALE HOR: 0 200'

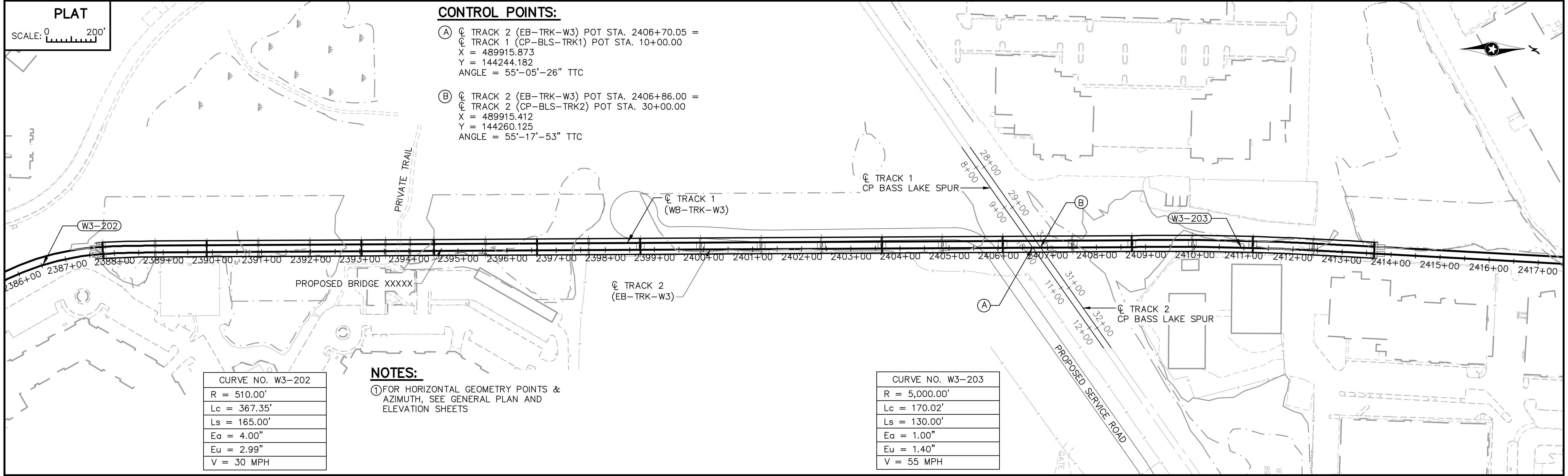
SCALE VER: 0 20'

RPOFILE GRADE SWLRT TRACK 2 (FG-EB-TRK-W3)



PLAT

SCALE: 0 200'



CONTROL POINTS:

Ⓐ ℄ TRACK 2 (EB-TRK-W3) POT STA. 2406+70.05 =
℄ TRACK 1 (CP-BLS-TRK1) POT STA. 10+00.00
X = 489915.873
Y = 144244.182
ANGLE = 55°-05'-26" TTC

Ⓑ ℄ TRACK 2 (EB-TRK-W3) POT STA. 2406+86.00 =
℄ TRACK 2 (CP-BLS-TRK2) POT STA. 30+00.00
X = 489915.412
Y = 144260.125
ANGLE = 55°-17'-53" TTC

CURVE NO. W3-202
R = 510.00'
Lc = 367.35'
Ls = 165.00'
Ea = 4.00"
Eu = 2.99"
V = 30 MPH

NOTES:

① FOR HORIZONTAL GEOMETRY POINTS & AZIMUTH, SEE GENERAL PLAN AND ELEVATION SHEETS

CURVE NO. W3-203
R = 5,000.00'
Lc = 170.02'
Ls = 130.00'
Ea = 1.00"
Eu = 1.40"
V = 55 MPH

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

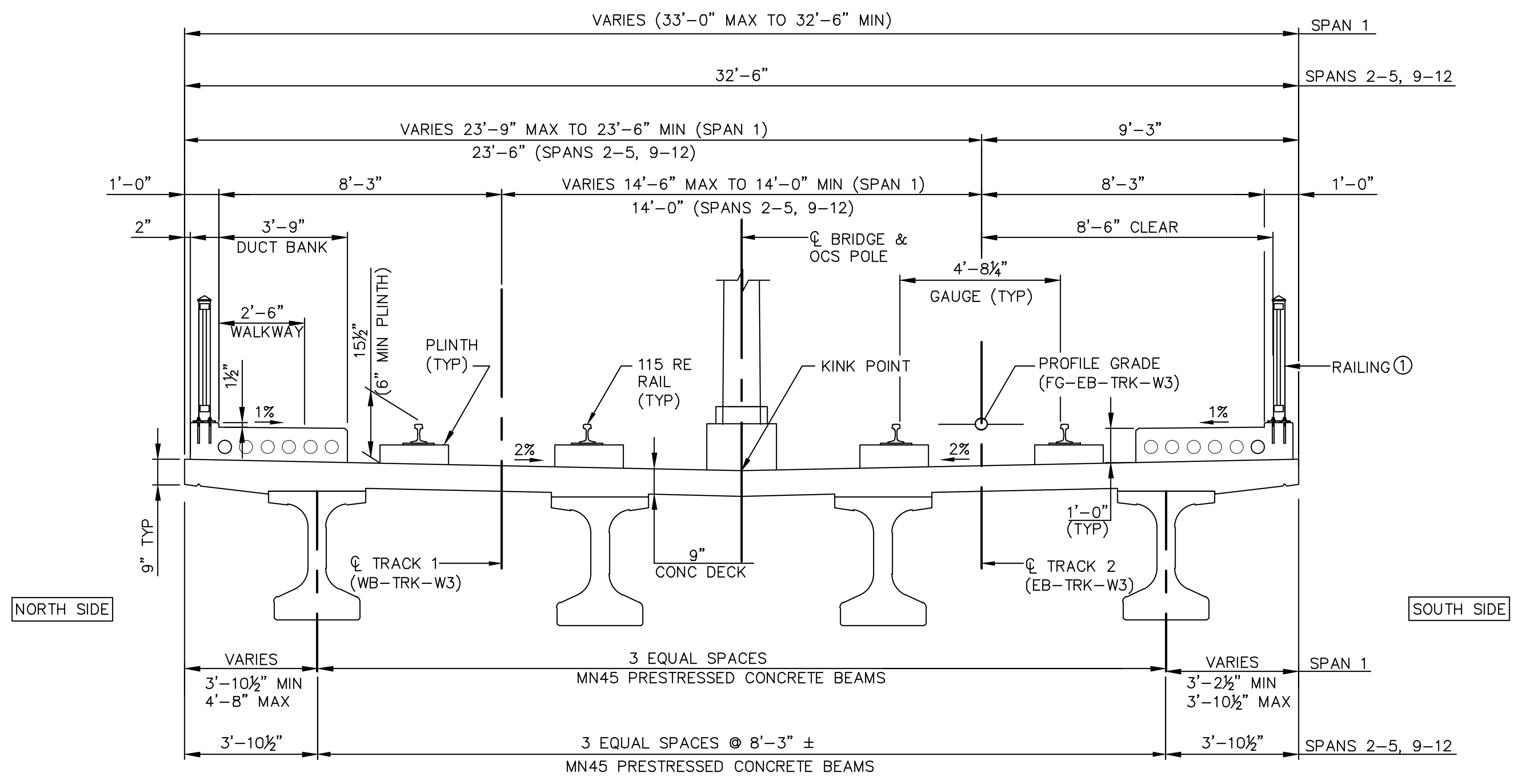
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BRIDGE SURVEY

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-002

SHEET 94 OF 197

Jun, 13 2014 11:15 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR.dwg By: RieckmBB



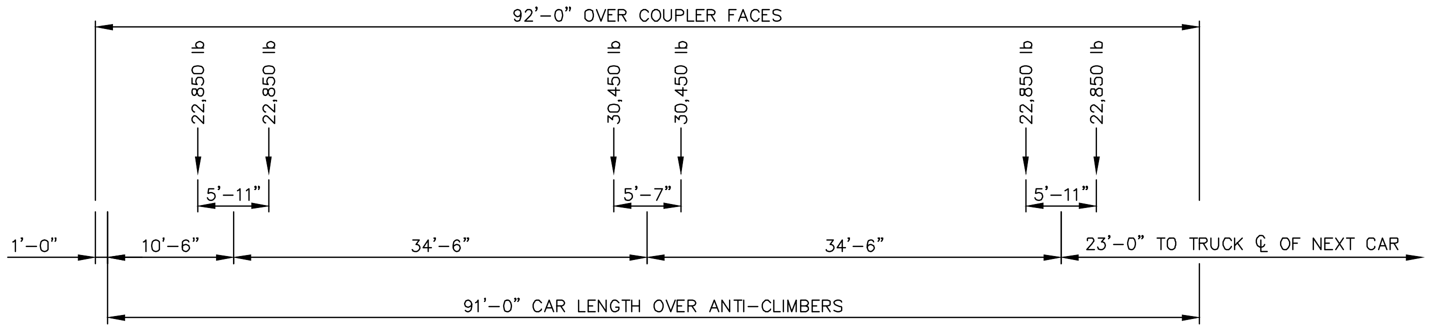
TRANSVERSE SECTION – SPANS 1-5 & 9-12

0 1 3 5
SCALE IN FEET

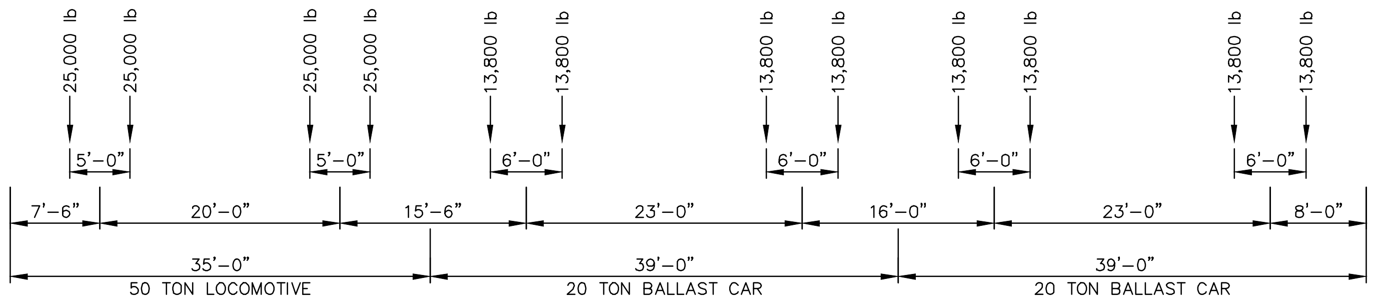
NOTES:

① RAILING TYPE TO BE DETERMINED IN FINAL DESIGN

2. NUMBER AND SPACING OF BEAMS IS APPROXIMATE AND WILL BE SET DURING FINAL DESIGN



LIGHT RAIL VEHICLE LOADING DIAGRAM



MAINTENANCE TRAIN LOADING DIAGRAM

NOTES:

1. THE LRT TRAIN SHALL CONSIST OF EITHER ONE, TWO OR THREE CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.

NOTES:

1. THE MAINTENANCE TRAIN SHALL CONSIST OF ONE LOCOMOTIVE AND ONE, TWO, THREE OR FOUR BALLAST CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. WEIGHT OF EMPTY BALLAST CAR IS 15,000 POUNDS.

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

DES: AAM
DRA: TAW
CHK: PLR
CHK: PLR

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extention

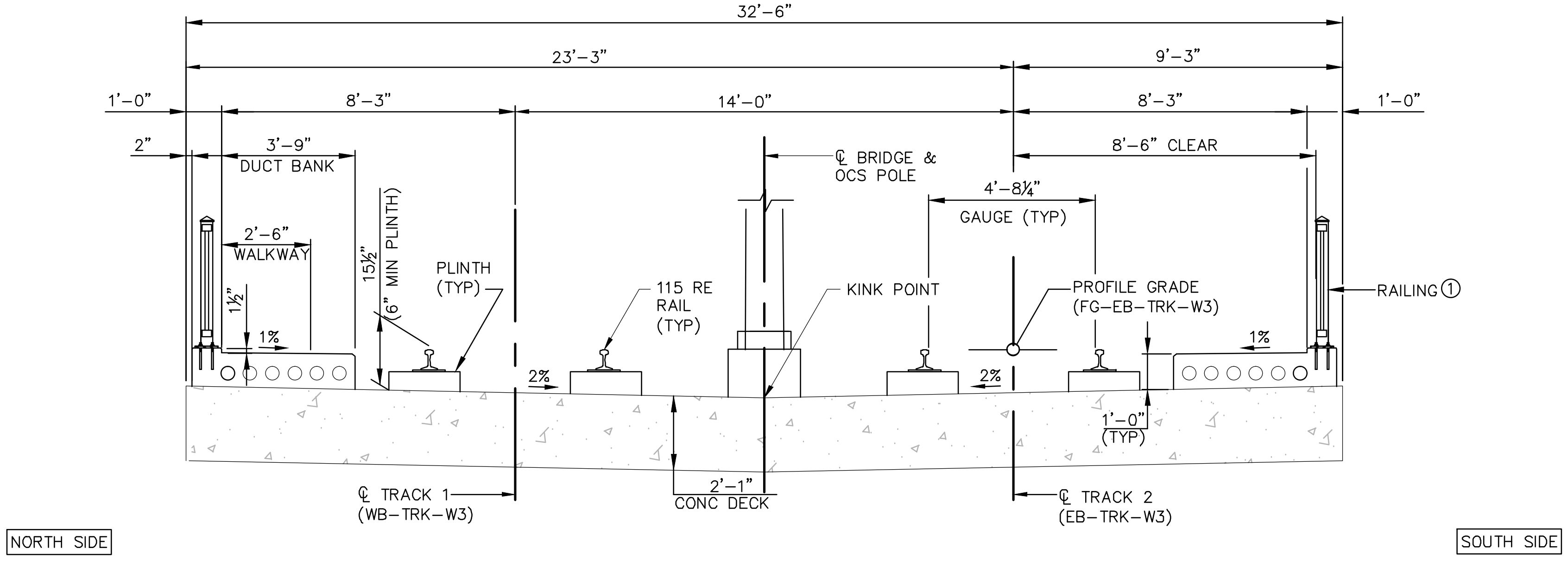
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
TRANSVERSE SECTION

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUP-001

SHEET 95 OF 197

Jun, 13 2014 11:15 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUP.dwg By: RieckmBB



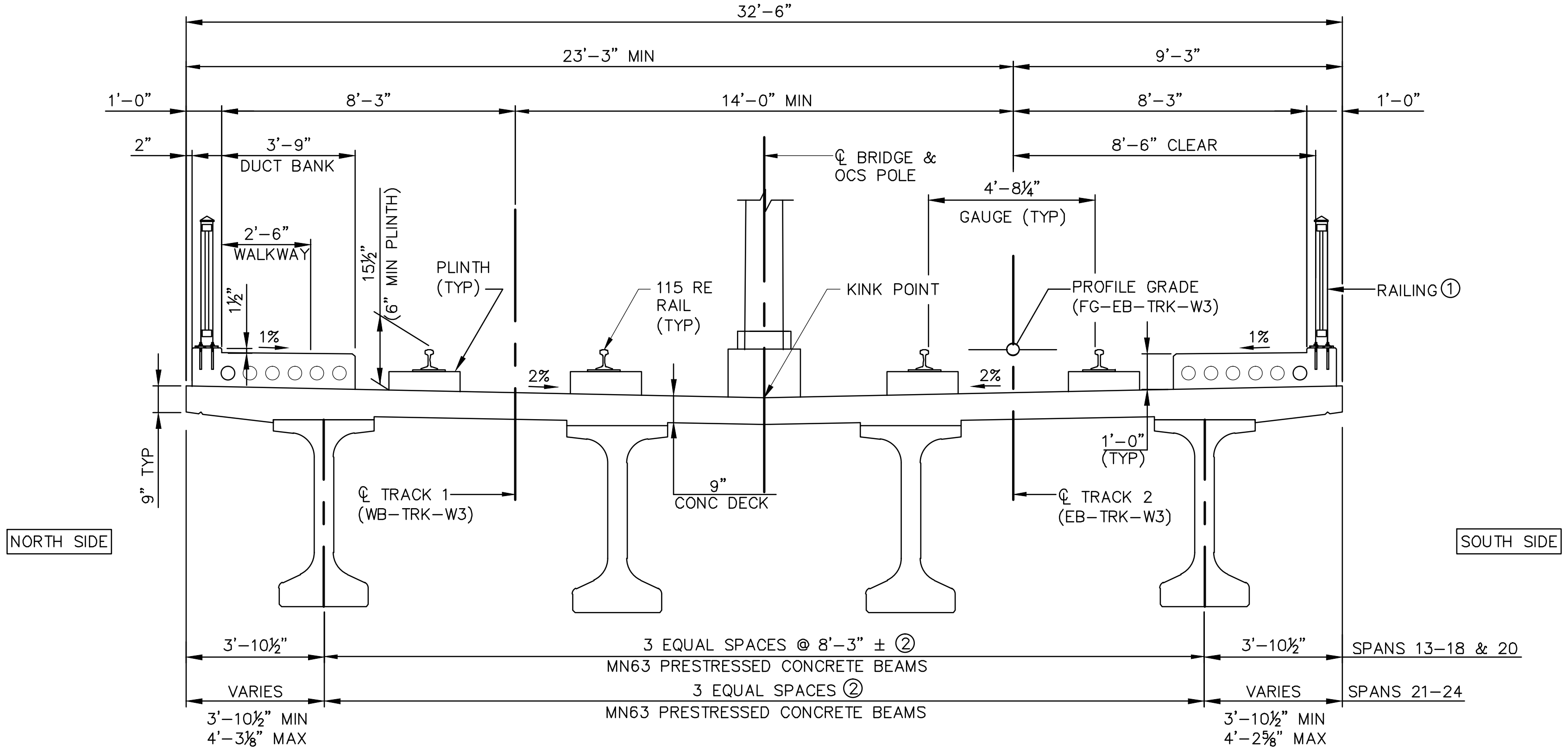
TRANSVERSE SECTION – SPANS 6-8

0 1 3 5
SCALE IN FEET

NOTES:

① RAILING TYPE TO BE DETERMINED IN FINAL DESIGN

② NUMBER AND SPACING OF BEAMS IS APPROXIMATE AND WILL BE SET DURING FINAL DESIGN



TRANSVERSE SECTION – SPANS 13-18 & 20-24

0 1 3 5
SCALE IN FEET

Jun, 13 2014 11:15 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUP.dwg By: RieckmBB

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

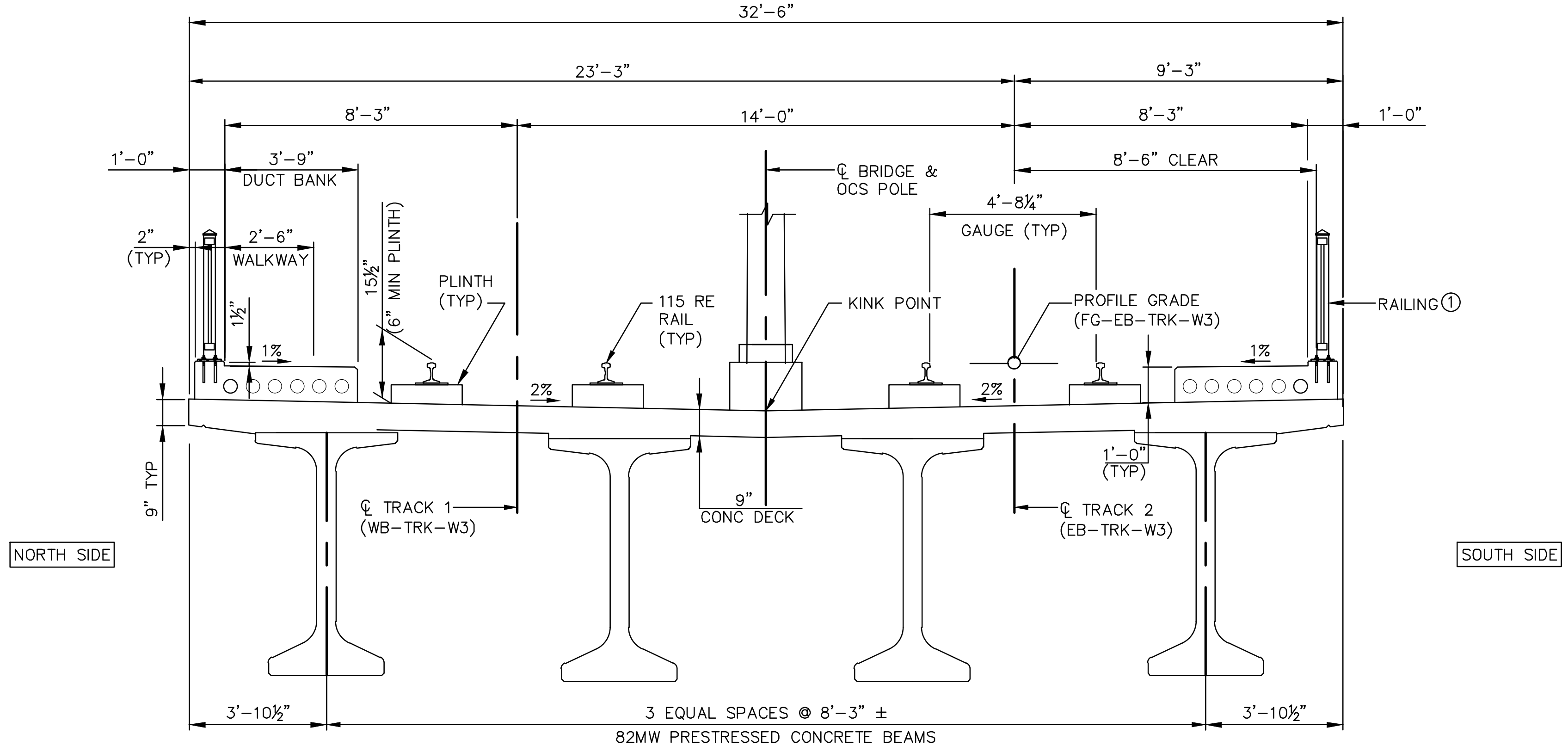
SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
TRANSVERSE SECTION

DISCIPLINE: **STRUCTURES**

SHEET NAME: **W3-STU-BRG-MKHP-LRT-SUP-002**

SHEET 96 OF 197



TRANSVERSE SECTION – SPAN 19

0 1 3 5

SCALE IN FEET

NOTES:

①RAILING TYPE TO BE DETERMINED IN FINAL DESIGN

2.NUMBER AND SPACING OF BEAMS IS APPROXIMATE AND WILL BE SET DURING FINAL DESIGN

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

DES: AAM
DRA: TAW
CHK: PLR
CHK: PLR

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

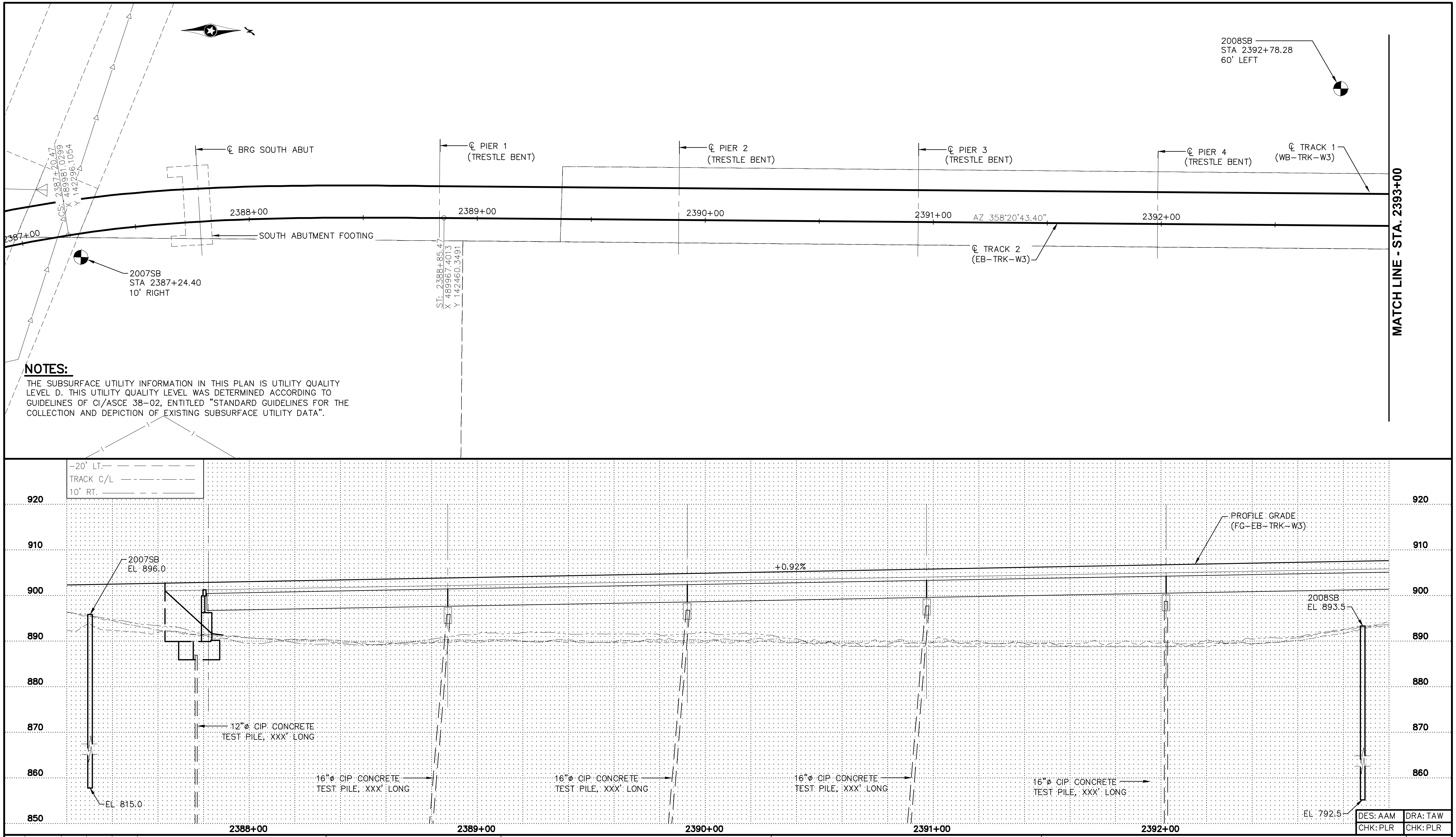
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
TRANSVERSE SECTION

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUP-003

SHEET 97 OF 197

Jun, 13 2014 11:15 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUP.dwg By: RieckmBB



NOTES:

THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

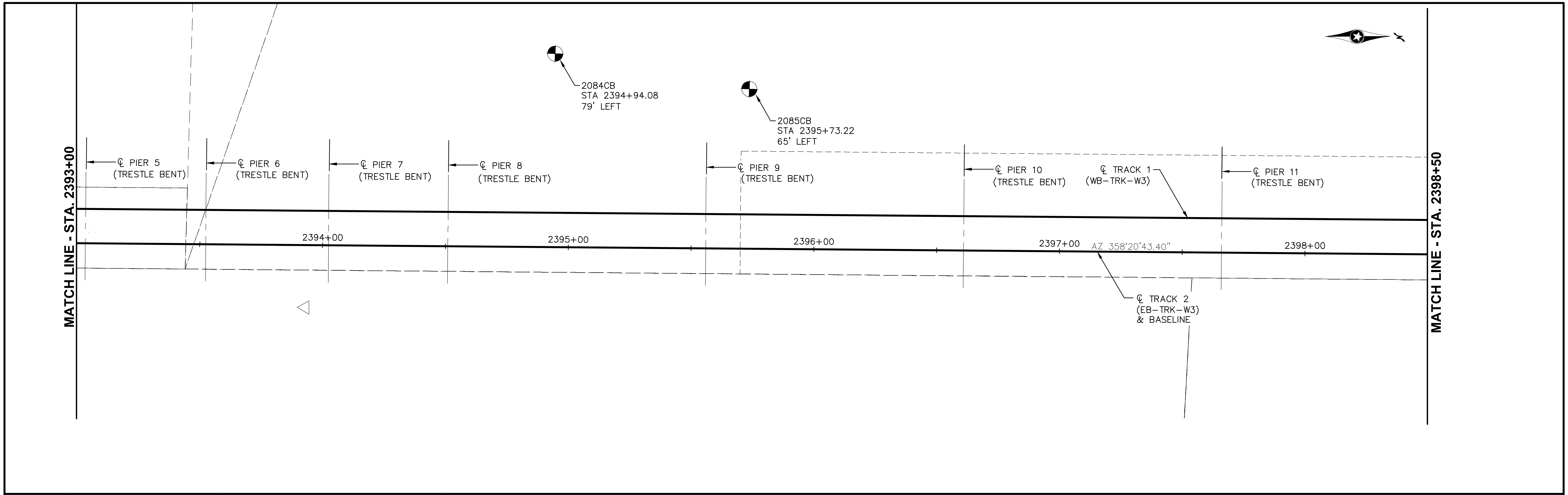
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

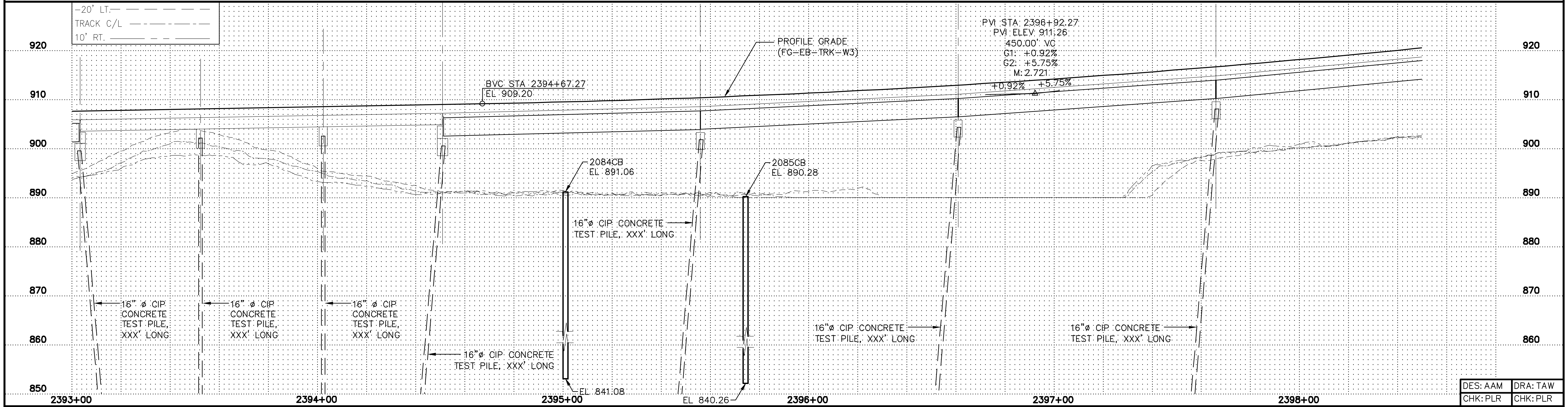
DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-001

SHEET 98 OF 197

Jun, 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB





DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

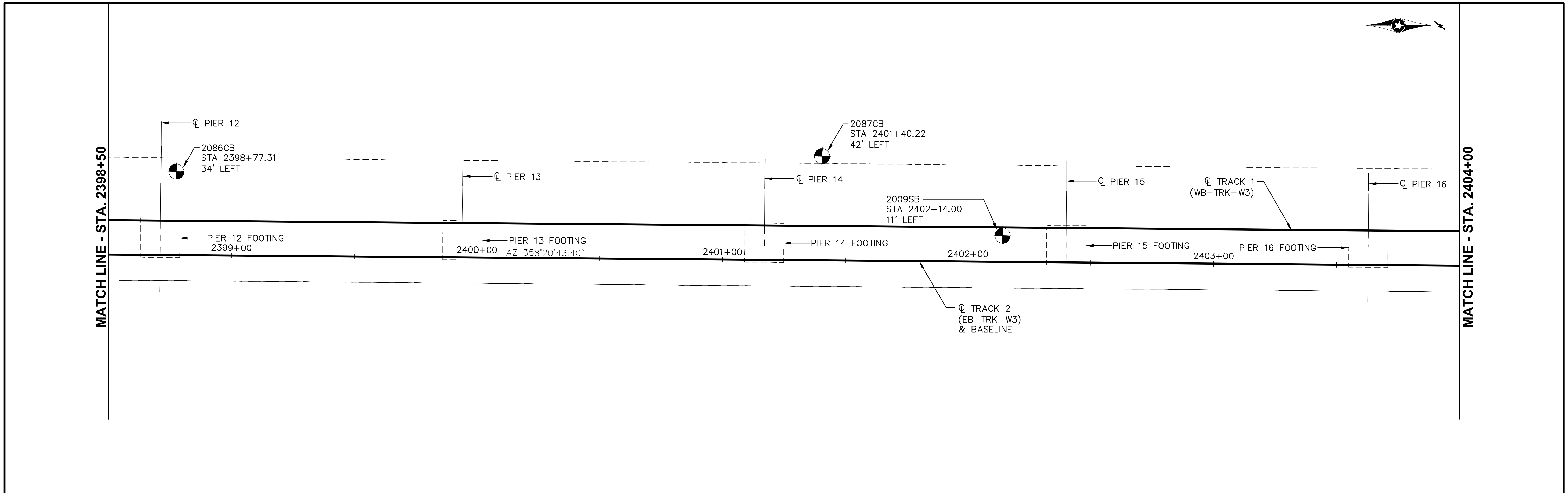
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

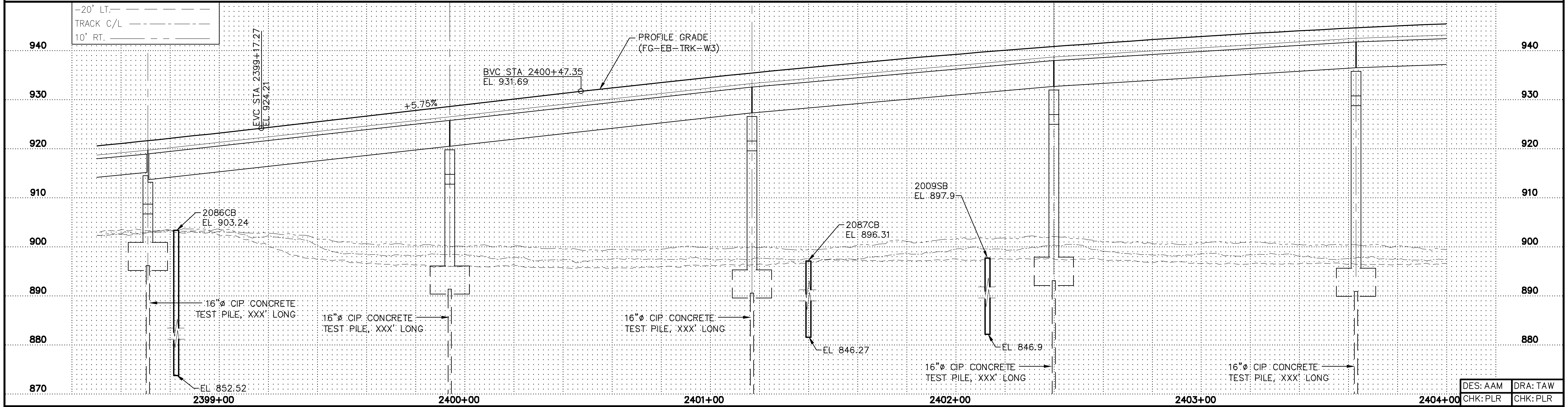
DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-002

SHEET 99 OF 197

Jun, 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB





DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

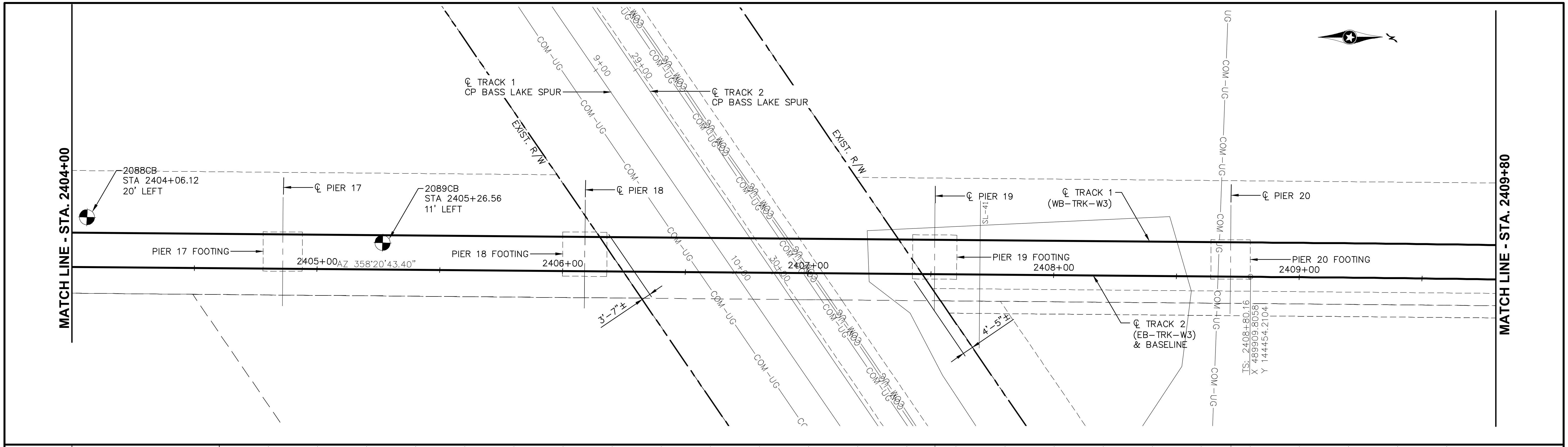
SOUTHWEST Green Line LRT Extention

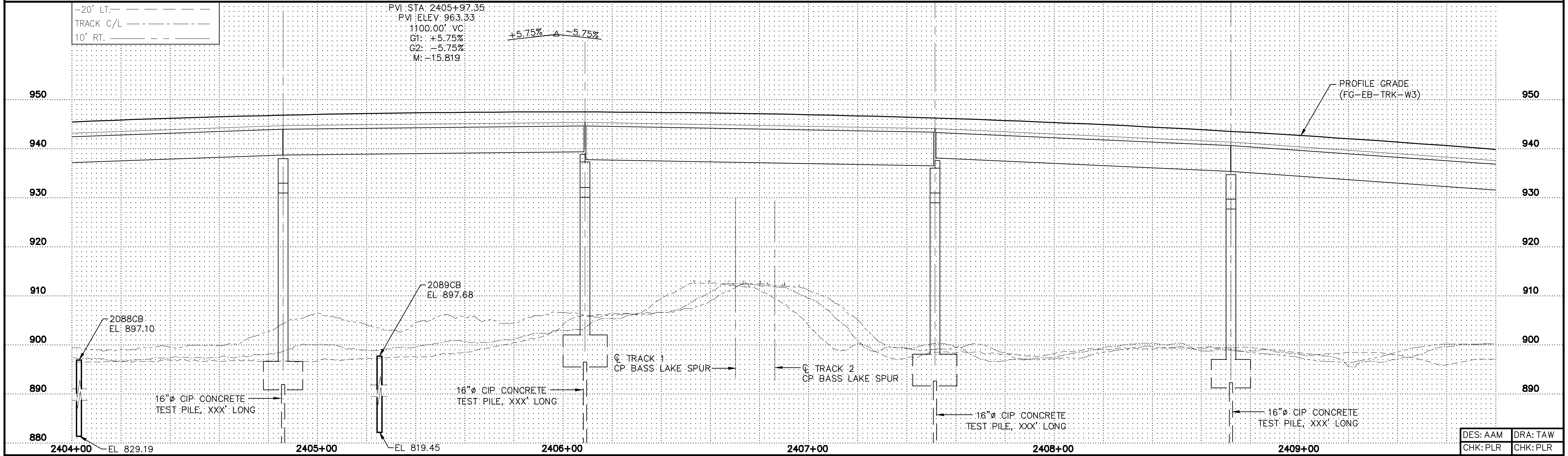
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-003

SHEET 100 OF 197





Jun, 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

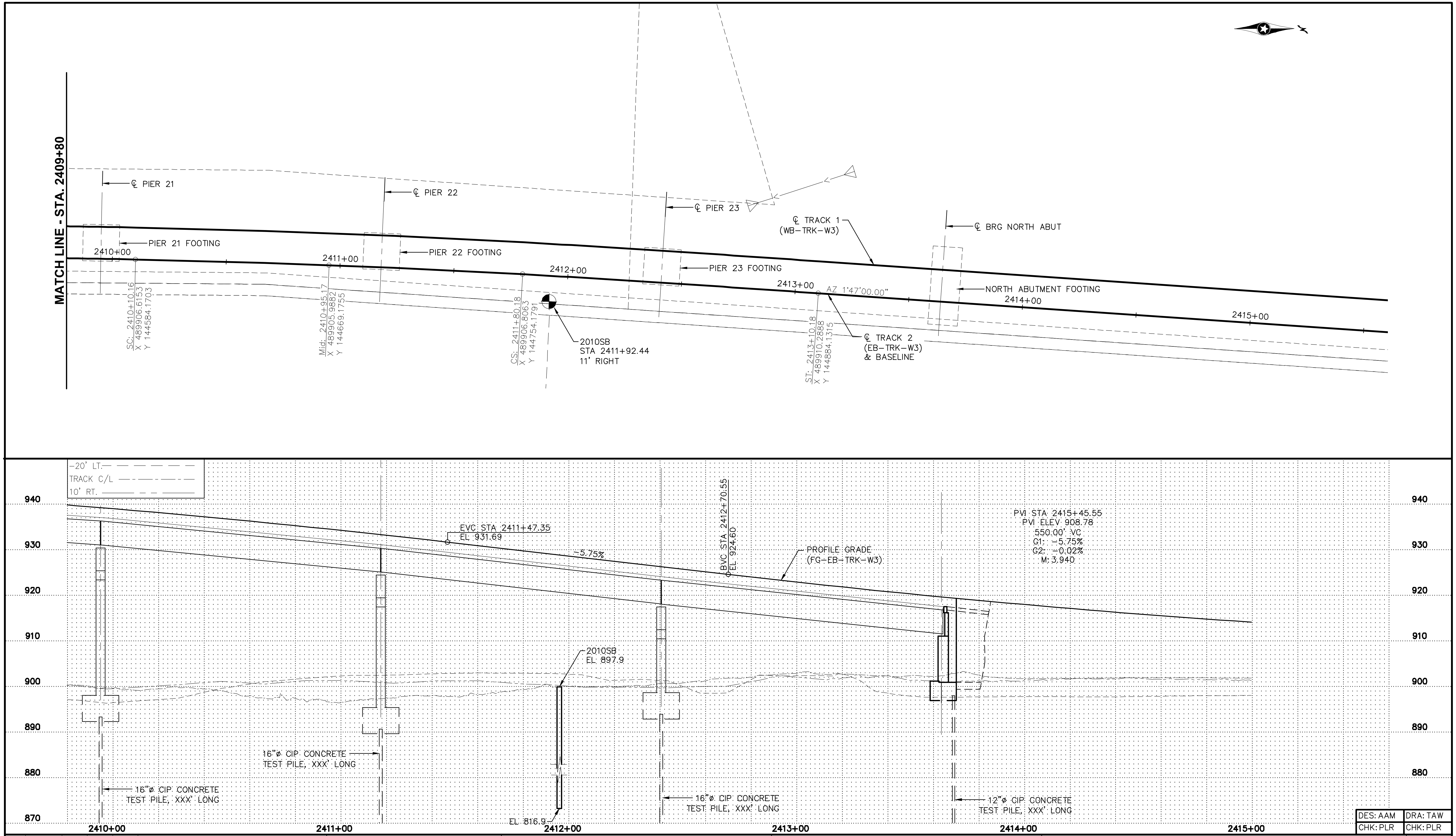
SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-004

SHEET 101 OF 197



DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN
COUNCIL

SOUTHWEST
Green Line LRT Extention

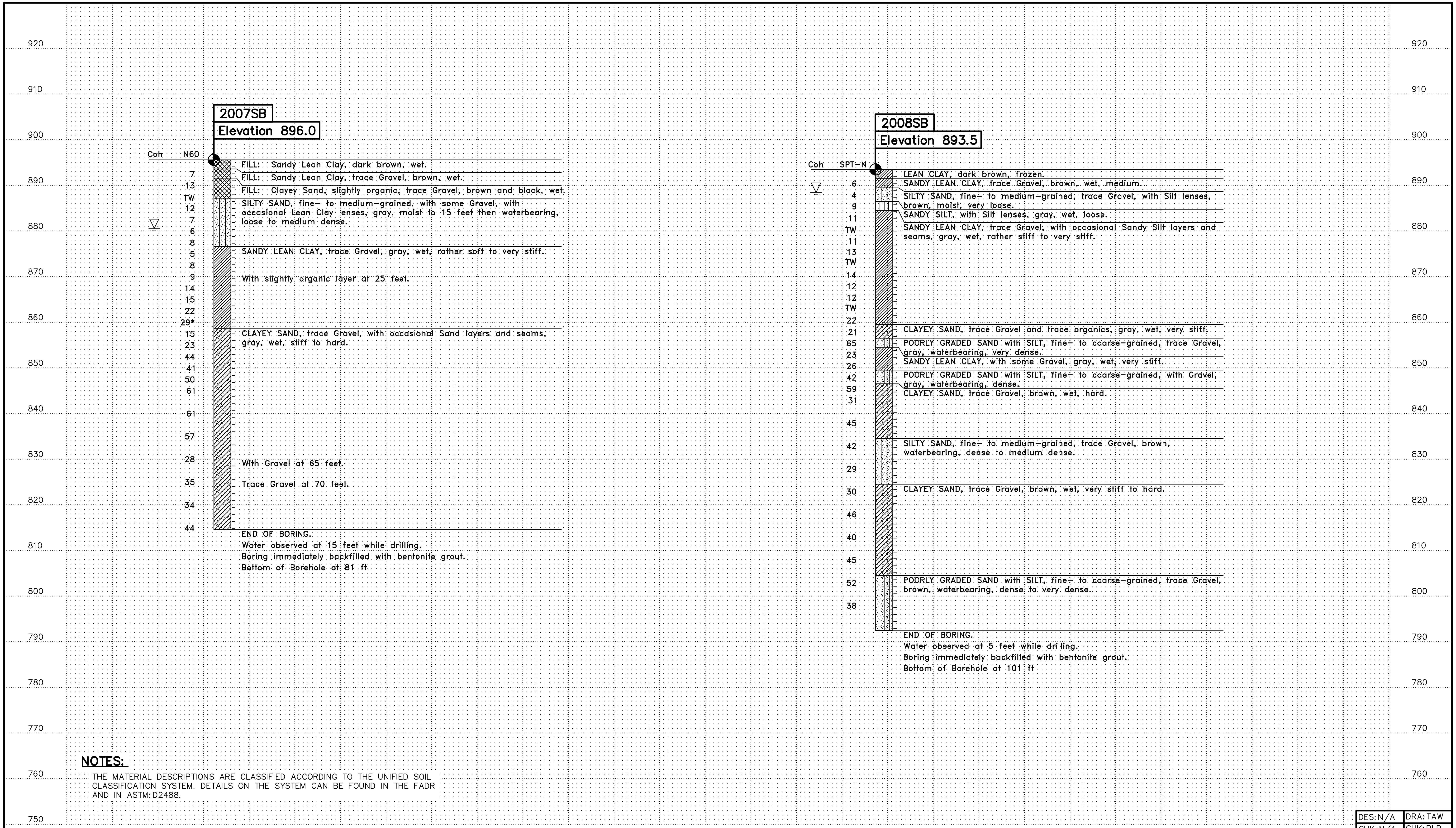
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-005

SHEET 102 OF 197

Jun, 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB



2007SB
Elevation 896.0

FILL: Sandy Lean Clay, dark brown, wet.

FILL: Sandy Lean Clay, trace Gravel, brown, wet.

FILL: Clayey Sand, slightly organic, trace Gravel, brown and black, wet.

SILTY SAND, fine- to medium-grained, with some Gravel, with occasional Lean Clay lenses, gray, moist to 15 feet then waterbearing, loose to medium dense.

SANDY LEAN CLAY, trace Gravel, gray, wet, rather soft to very stiff.

With slightly organic layer at 25 feet.

CLAYEY SAND, trace Gravel, with occasional Sand layers and seams, gray, wet, stiff to hard.

With Gravel at 65 feet.

Trace Gravel at 70 feet.

END OF BORING.
Water observed at 15 feet while drilling.
Boring immediately backfilled with bentonite grout.
Bottom of Borehole at 81 ft

2008SB
Elevation 893.5

LEAN CLAY, dark brown, frozen.

SANDY LEAN CLAY, trace Gravel, brown, wet, medium.

SILTY SAND, fine- to medium-grained, trace Gravel, with Silt lenses, brown, moist, very loose.

SANDY SILT, with Silt lenses, gray, wet, loose.

SANDY LEAN CLAY, trace Gravel, with occasional Sandy Silt layers and seams, gray, wet, rather stiff to very stiff.

CLAYEY SAND, trace Gravel and trace organics, gray, wet, very stiff.

POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, gray, waterbearing, very dense.

SANDY LEAN CLAY, with some Gravel, gray, wet, very stiff.

POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, gray, waterbearing, dense.

CLAYEY SAND, trace Gravel, brown, wet, hard.

SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense to medium dense.

CLAYEY SAND, trace Gravel, brown, wet, very stiff to hard.

POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, waterbearing, dense to very dense.

END OF BORING.
Water observed at 5 feet while drilling.
Boring immediately backfilled with bentonite grout.
Bottom of Borehole at 101 ft

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488.

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

DES: N/A
CHK: N/A
DRA: TAW
CHK: PLR

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extention

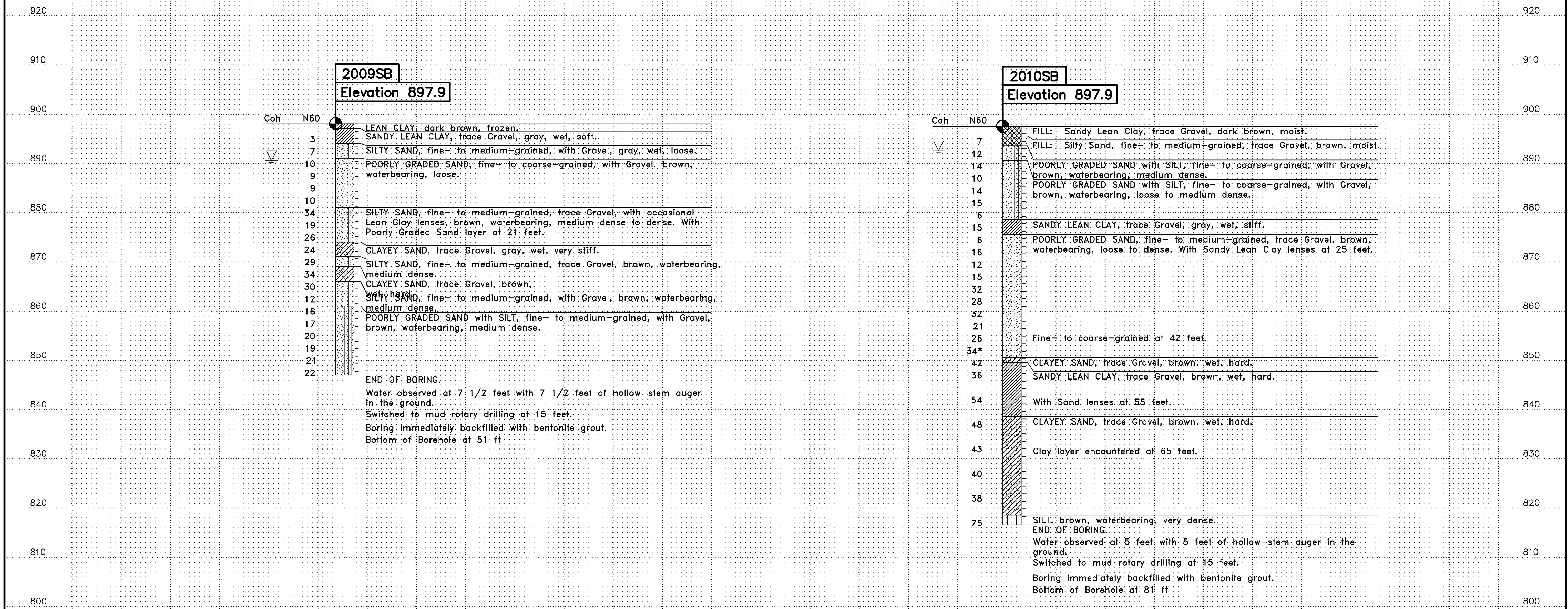
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-006

SHEET
103
OF
197

Jun. 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB



2009SB Elevation 897.9

LEAN CLAY, dark brown, frozen.

SANDY LEAN CLAY, trace Gravel, gray, wet, soft.

SILTY SAND, fine- to medium-grained, with Gravel, gray, wet, loose.

POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose.

SILTY SAND, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, brown, waterbearing, medium dense to dense. With Poorly Graded Sand layer at 21 feet.

CLAYEY SAND, trace Gravel, gray, wet, very stiff.

SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense.

CLAYEY SAND, trace Gravel, brown, wet, hard.

SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense.

POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense.

END OF BORING.

Water observed at 7 1/2 feet with 7 1/2 feet of hollow-stem auger in the ground.

Switched to mud rotary drilling at 15 feet.

Boring immediately backfilled with bentonite grout.

Bottom of Borehole at 51 ft

2010SB Elevation 897.9

FILL: Sandy Lean Clay, trace Gravel, dark brown, moist.

FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.

POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense.

POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense.

SANDY LEAN CLAY, trace Gravel, gray, wet, stiff.

POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, loose to dense. With Sandy Lean Clay lenses at 25 feet.

Fine- to coarse-grained at 42 feet.

CLAYEY SAND, trace Gravel, brown, wet, hard.

SANDY LEAN CLAY, trace Gravel, brown, wet, hard.

With Sand lenses at 55 feet.

CLAYEY SAND, trace Gravel, brown, wet, hard.

Clay layer encountered at 65 feet.

SILT, brown, waterbearing, very dense.

END OF BORING.

Water observed at 5 feet with 5 feet of hollow-stem auger in the ground.

Switched to mud rotary drilling at 15 feet.

Boring immediately backfilled with bentonite grout.

Bottom of Borehole at 81 ft

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488.

DES: N/A	DRA: TAW
CHK: N/A	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

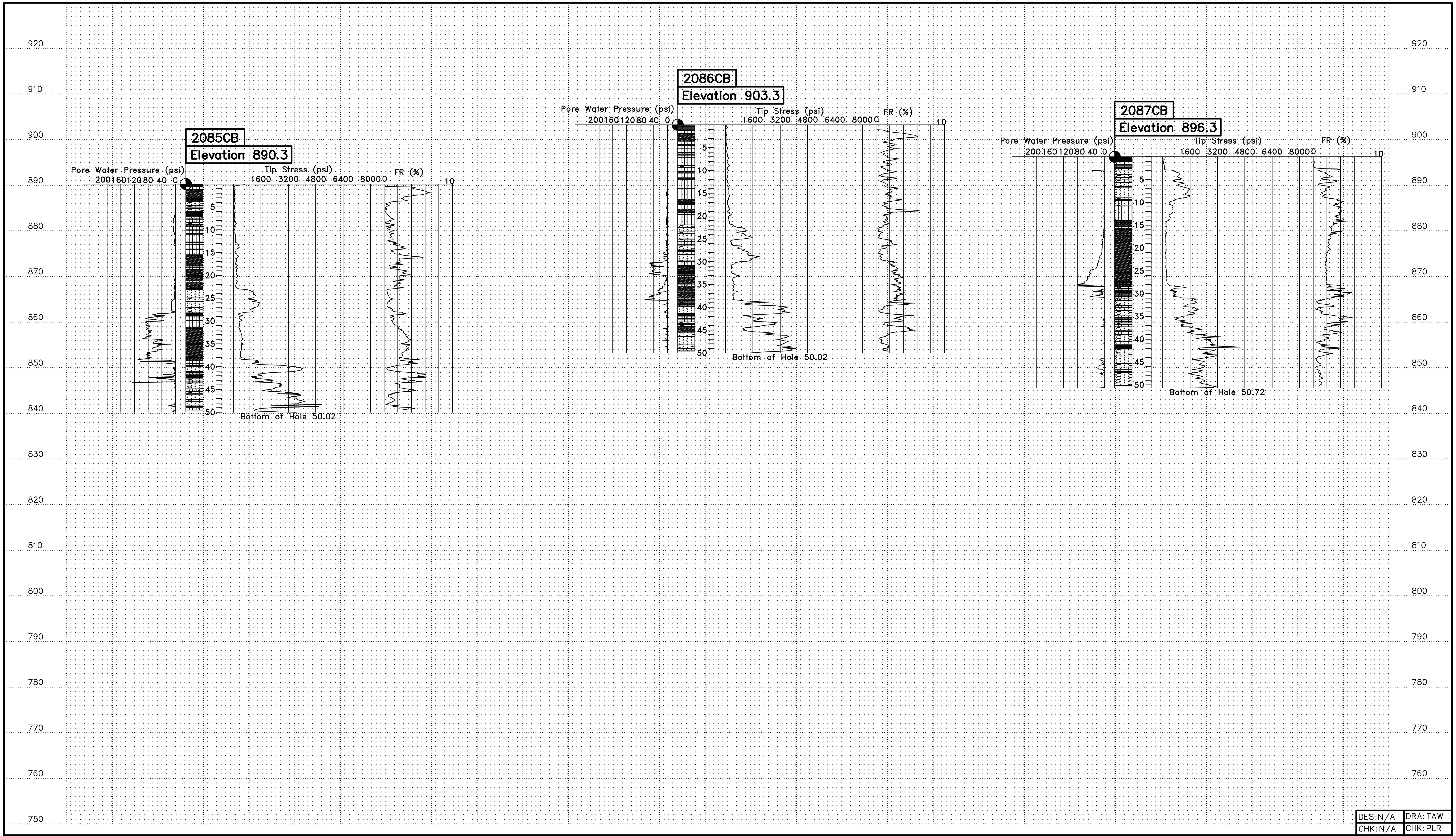
SOUTHWEST
Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-007

SHEET
104
OF
197



DES: N/A	DRA: TAW
CHK: N/A	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

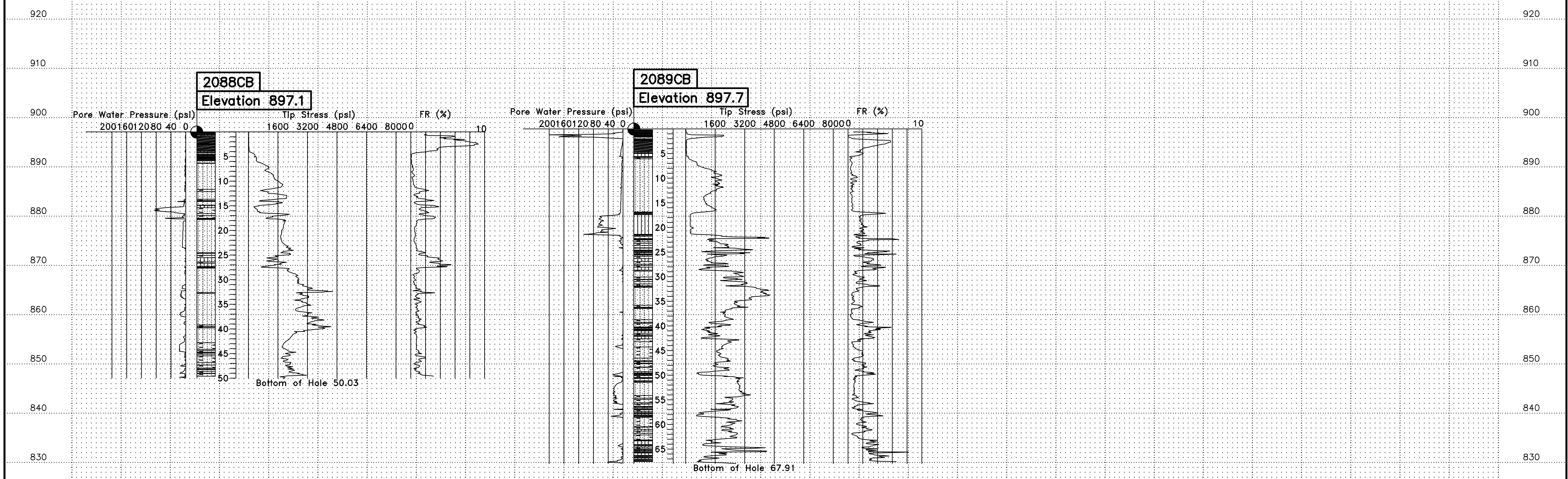
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-008

SHEET 105 OF 197

Jun, 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB



820
810
800
790
780
770
760
750

NOTES:

CB2084 DXF FILE NOT YET RECEIVED FROM BRAUN

Jun, 13 2014 11:16 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-SUR-BOR.dwg By: RieckmBB

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

DES: N/A
DRA: TAW
CHK: N/A
CHK: PLR

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

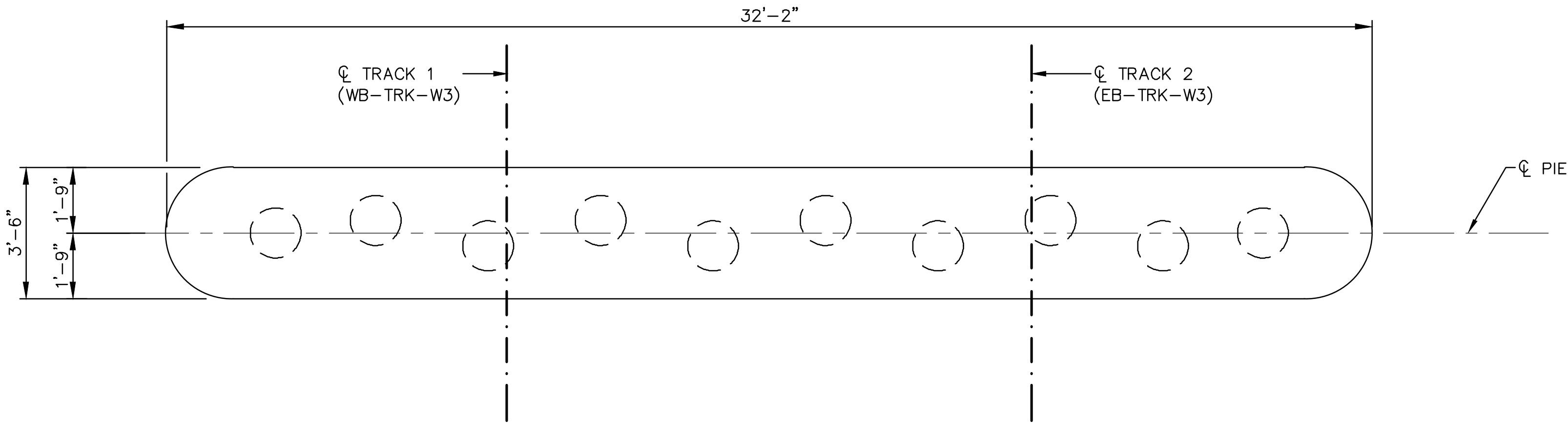
SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BORINGS

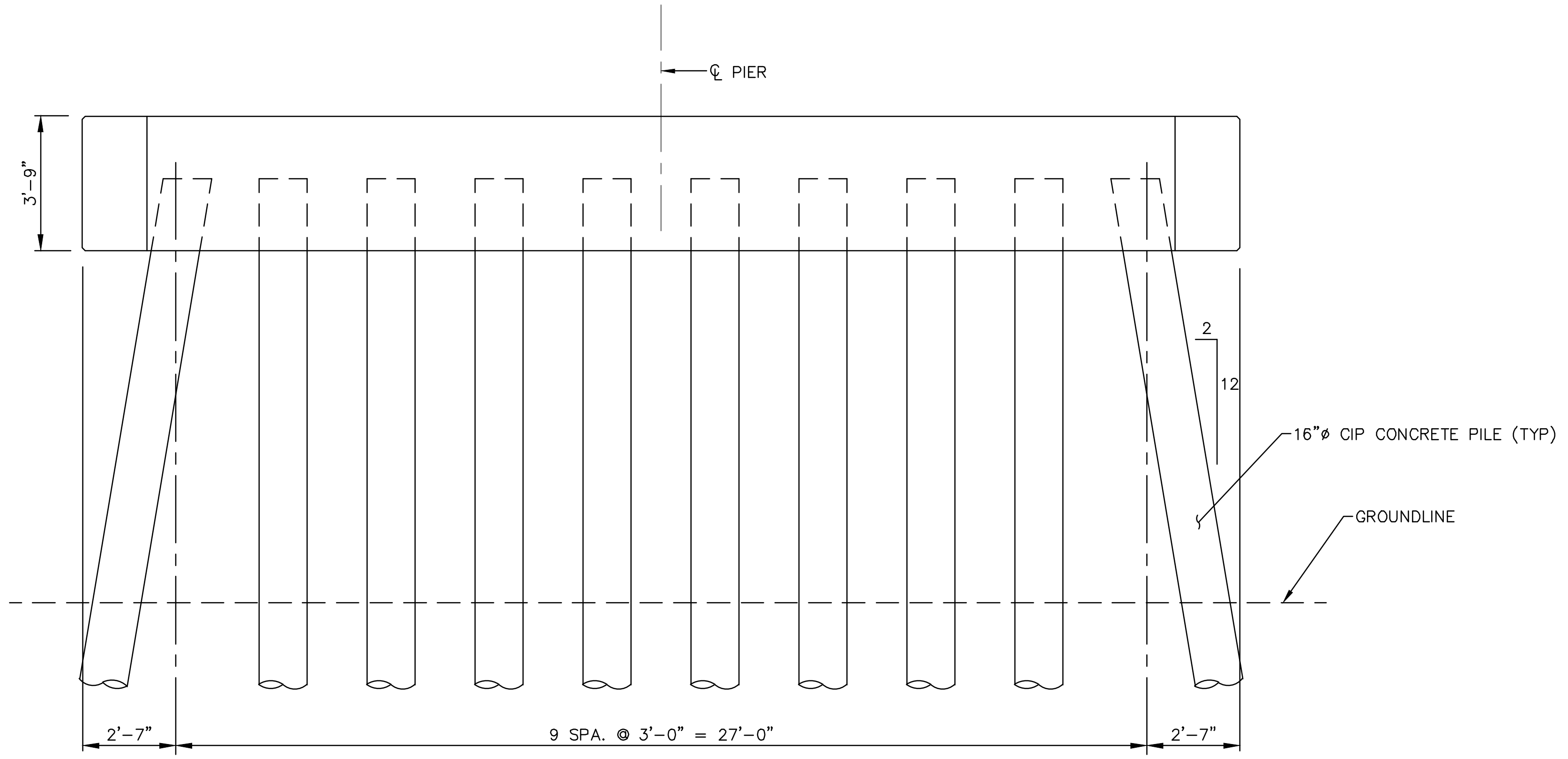
DISCIPLINE: STRUCTURES

SHEET NAME: W3-STU-BRG-MKHP-LRT-SUR-BOR-009

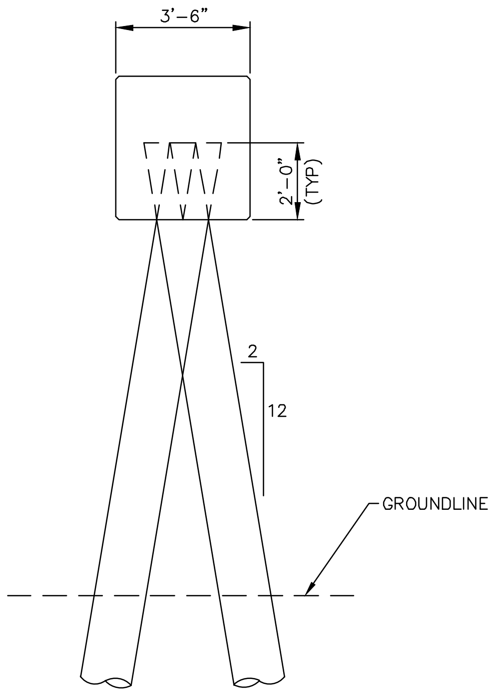
SHEET 106 OF 197



PLAN



ELEVATION



SECTION THRU INTERIOR PILES

PIERS 1-5 & 8-11

NOTES:

1. INTERIOR PILES ARE NOT LONGITUDINALLY BATTERED AT PIER 4.
2. PIER CAP CONFIGURATION WILL BE MODIFIED AT PIERS 5 & 8 TO ACCOMMODATE 45"MN BEAMS AND SLAB SUPERSTRUCTURE.

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

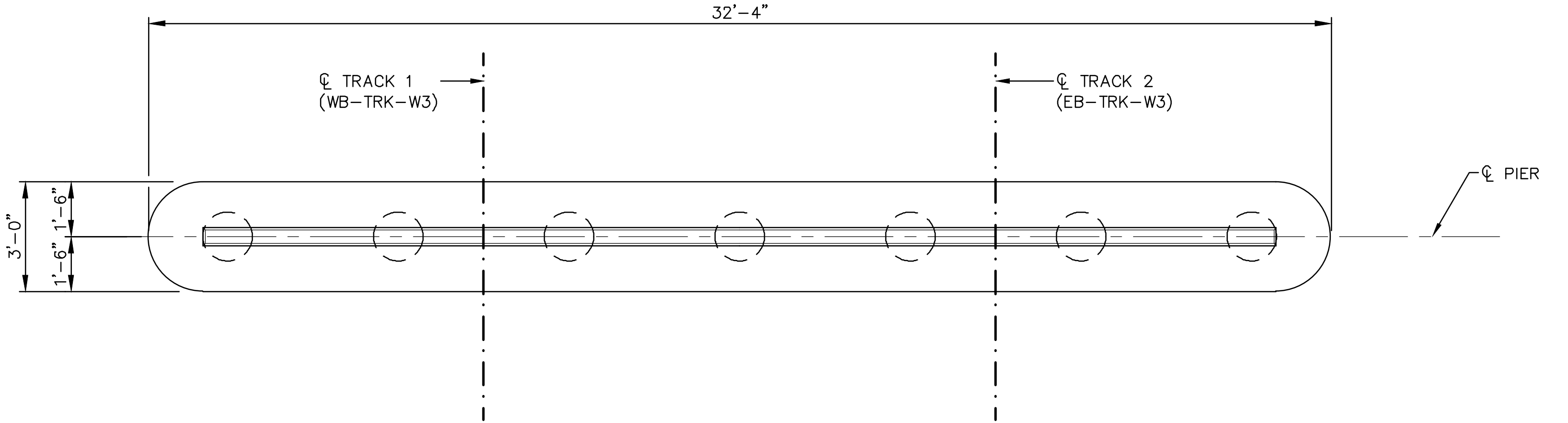
WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BRIDGE DETAILS

DISCIPLINE: STRUCTURES

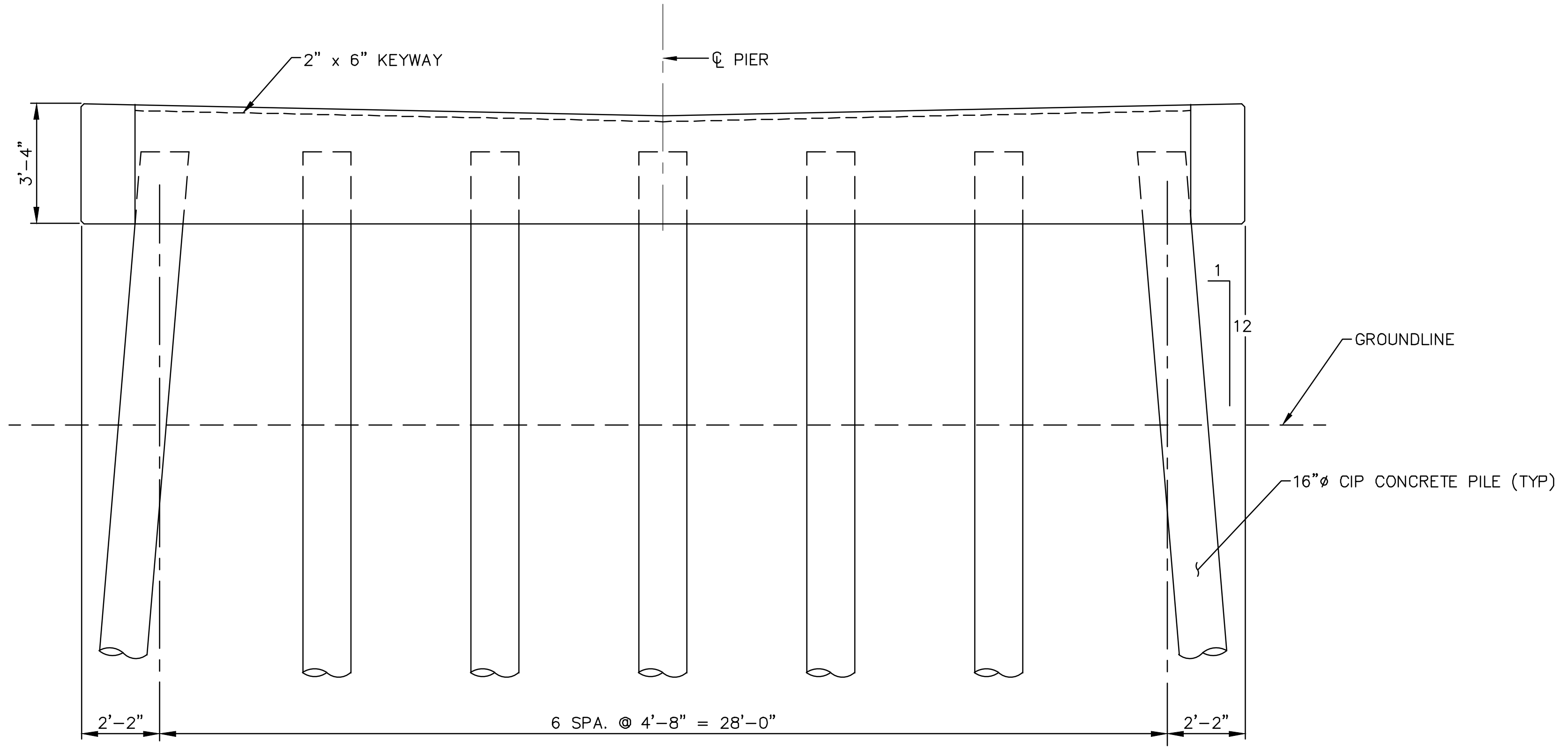
SHEET NAME: W3-STU-BRG-MKHP-LRT-DTL-001

SHEET 107 OF 197

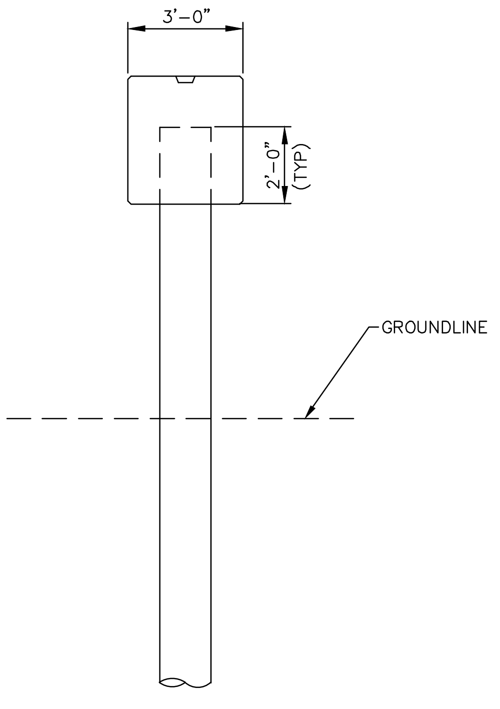
Jun, 13 2014 11:17 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-DTL.dwg By: RieckmBB



PLAN



ELEVATION



END VIEW

PIERS 6 & 7

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN
COUNCIL

SOUTHWEST
Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BRIDGE DETAILS

DISCIPLINE: STRUCTURES

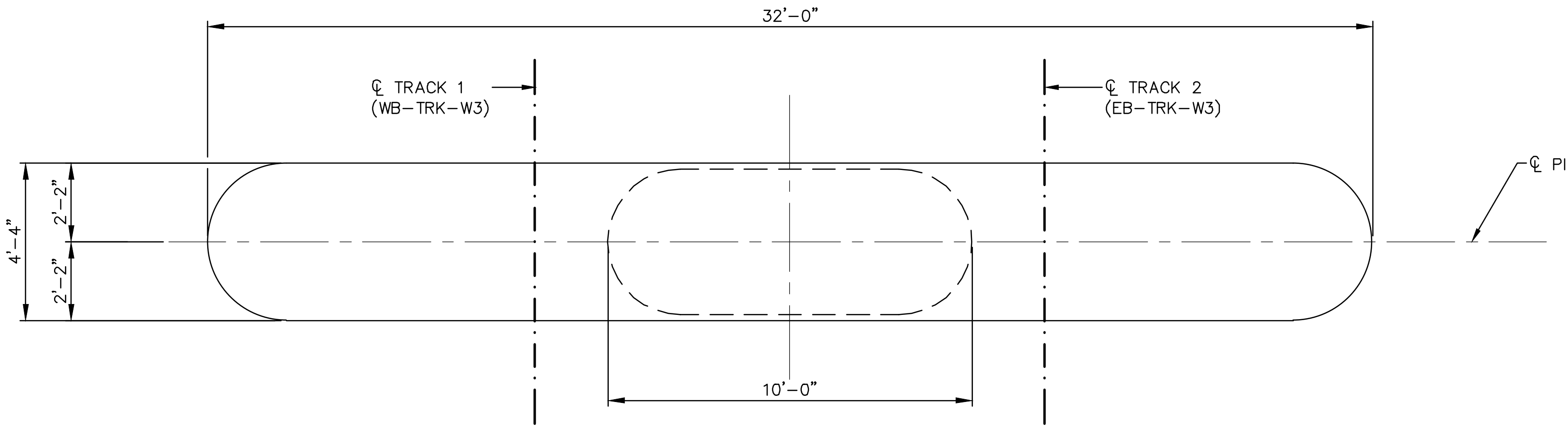
SHEET NAME: W3-STU-BRG-MKHP-LRT-DTL-002

SHEET
108
OF
197

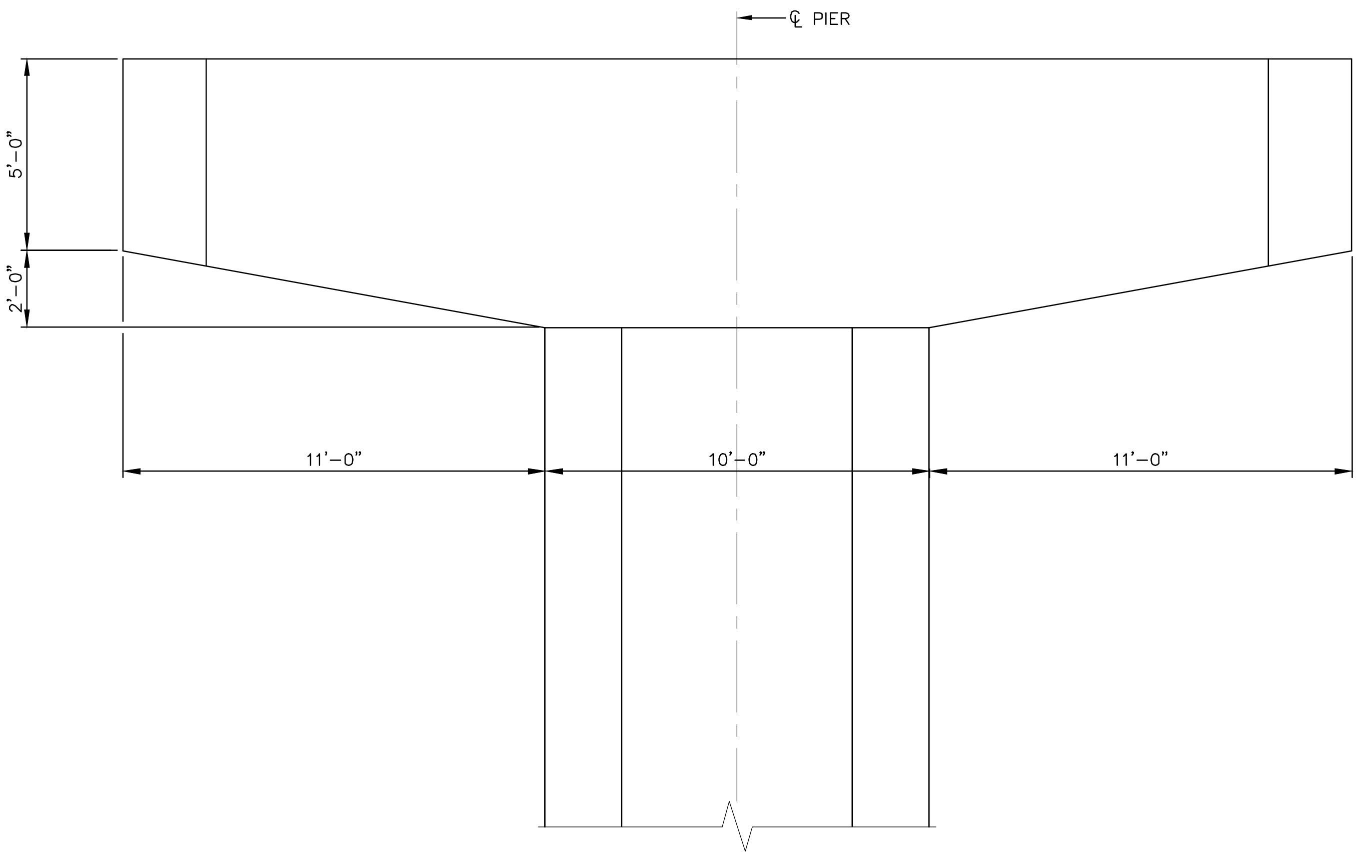
Jun, 13 2014 11:17 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-DTL.dwg By: RieckmBB

NOTES:

1. CAP AND COLUMN TO BE REINFORCED WITH GRADE 60 REINFORCEMENT BARS.

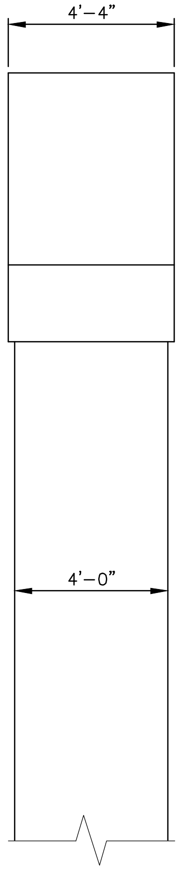


PLAN



ELEVATION

PIERS 12–23



END VIEW

DES: AAM	DRA: TAW
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BRIDGE DETAILS

DISCIPLINE: **STRUCTURES**

SHEET NAME: **W3-STU-BRG-MKHP-LRT-DTL-003**

SHEET 109 OF 197

Jun, 13 2014 11:17 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-LRT-DTL.dwg By: RieckmBB

AESTHETIC DETAILS TO BE DETERMINED DURING ADVANCED DESIGN

1. ABUTMENT SURFACE TREATMENT
2. ABUTMENT/WALL CORNER DETAIL
3. EXPOSED EDGE OF DECK
4. EXPOSED BARRIER
5. EXPOSED FASCIA BEAM
6. BOTTOM OF BEAMS
7. PIER COLUMN SURFACE TREATMENT
8. RAILING AND SCREENING

Jun, 13 2014 11:17 am V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-BRG-MKHP-AES.dwg By: RieckmBB

DES: N/A DRA: TAW
CHK: N/A CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN
COUNCIL

SOUTHWEST
Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
MINNETONKA/HOPKINS
BRIDGE XXXXX (LRT)
BRIDGE AESTHETICS

DISCIPLINE:
STRUCTURES

SHEET NAME:
W3-STU-BRG-MKHP-LRT-AES

SHEET
110
OF
197

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2007SB**

LOCATION: N: 142301.9; E: 489990.5;
Lat.: 445425.64429; Long.: -932519.06825.
See attached sketch.

DRILLER: M. Belch

METHOD: 3 1/4" HSA, Autohammer

DATE: **4/17/13**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 896.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
894.0	2.0	FILL	FILL: Sandy Lean Clay, dark brown, wet. (Topsoil Fill)					
		FILL	FILL: Sandy Lean Clay, trace Gravel, brown, wet.	7				
892.0	4.0							
		FILL	FILL: Clayey Sand, slightly organic, trace Gravel, brown and black, wet.	13		13		OC=1.9%
887.5	8.5			TW		16		OC=2.0% DD=116.2 pcf
		SM	SILTY SAND, fine- to medium-grained, with some Gravel, with occasional Lean Clay lenses, gray, moist to 15 feet then waterbearing, loose to medium dense. (Glacial Till)	12				
				7				
				6	▽			Switched to mud rotary after 15-foot sample.
				8				
877.0	19.0							
		CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather soft to very stiff. (Glacial Till)	5			1/2	
				8			1/2	
			With slightly organic layer at 25 feet.	9			1/2	OC=3.8%
				14			1/2	
				15			1 1/2	

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:35

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2007SB (cont.)**

LOCATION: N: 142301.9; E: 489990.5;
Lat.: 445425.64429; Long.: -932519.06825.
See attached sketch.

DRILLER: M. Belch

METHOD: 3 1/4" HSA, Autohammer

DATE: **4/17/13**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 864.0	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			SANDY LEAN CLAY, trace Gravel, gray, wet, rather soft to very stiff. (Glacial Till) *(continued)*	22				
				29*				*No recovery.
859.0	37.0							
		SC	CLAYEY SAND, trace Gravel, with occasional Sand layers and seams, gray, wet, stiff to hard. (Glacial Till)	15				
				23				
				44			4	
				41				
				50				
				61				
				61			4+	
				57				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:35

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2007SB (cont.)**

LOCATION: N: 142301.9; E: 489990.5;
Lat.: 445425.64429; Long.: -932519.06825.
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **4/17/13**	SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 832.0	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
		▨	CLAYEY SAND, trace Gravel, with occasional Sand layers and seams, gray, wet, stiff to hard. (Glacial Till) *(continued)* With Gravel at 65 feet.	28				
			Trace Gravel at 70 feet.	35			3	
				34				
				44				
815.0	81.0		END OF BORING. Water observed at 15 feet while drilling. Boring immediately backfilled with bentonite grout.					

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:35

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2008SB**

LOCATION: N: 142851.3; E: 489896.1;
Lat.: 445431.06840; Long.: -932520.38321.
See attached sketch.

DRILLER: M. Belch
METHOD: 3 1/4" HSA, Autohammer
DATE: **4/16/13**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 893.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
891.5	2.0	CL	LEAN CLAY, dark brown, frozen. (Topsoil)					
889.5	4.0	CL	SANDY LEAN CLAY, trace Gravel, brown, wet, medium. (Glacial Till)	6				
886.5	7.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with Silt lenses, brown, moist, very loose. (Glacial Till)	4	▽			
884.5	9.0	ML	SANDY SILT, with Silt lenses, gray, wet, loose. (Glacial Till)	9				
		CL	SANDY LEAN CLAY, trace Gravel, with occasional Sandy Silt layers and seams, gray, wet, rather stiff to very stiff. (Glacial Till)	11				
				TW		20		qu=1.075 tsf LL=30; PL=17 PI=13 DD=111.1 pcf
				11			1	
				13			1 1/4	
				TW		19		qu=1.453 tsf LL=36; PL=18 PI=18 DD=110.9 pcf
				14			2	
				12				
				12		21		OC=1.9%
				TW		15		qu=0.986 tsf LL=25; PL=14 PI=11 DD=118.4 pcf

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2008SB (cont.)**

LOCATION: N: 142851.3; E: 489896.1;
Lat.: 445431.06840; Long.: -932520.38321.
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/16/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 861.5	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
				22			2 1/2	
859.5	34.0	SC	CLAYEY SAND, trace Gravel and trace organics, gray, wet, very stiff. (Glacial Till)	21				Switched to mud rotary after 35-foot sample.
856.5	37.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, gray, waterbearing, very dense. (Glacial Outwash)	65				
854.5	39.0	CL	SANDY LEAN CLAY, with some Gravel, gray, wet, very stiff. (Glacial Till)	23			2 1/2	
				26			2 1/2	
849.5	44.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, gray, waterbearing, dense. (Glacial Outwash)	42				
846.5	47.0	SC	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Till)	59				
				31				
				45				
834.5	59.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense to medium dense. (Glacial Till)	42				

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2008SB (cont.)**

LOCATION: N: 142851.3; E: 489896.1;
Lat.: 445431.06840; Long.: -932520.38321.
See attached sketch.

DRILLER: M. Belch
METHOD: 3 1/4" HSA, Autohammer
DATE: **4/16/13**
SCALE: **1" = 4'**

Elev. feet 829.5	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense to medium dense. (Glacial Till) *(continued)*	29				
824.5	69.0	SC	CLAYEY SAND, trace Gravel, brown, wet, very stiff to hard. (Glacial Till)	30				
				46				
				40				Had to re-mud rotary from 78-85 feet to be able to mud rotary down to 90 feet.
				45				
804.5	89.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, waterbearing, dense to very dense. (Glacial Outwash)	52				
				38				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:35

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2008SB (cont.)**

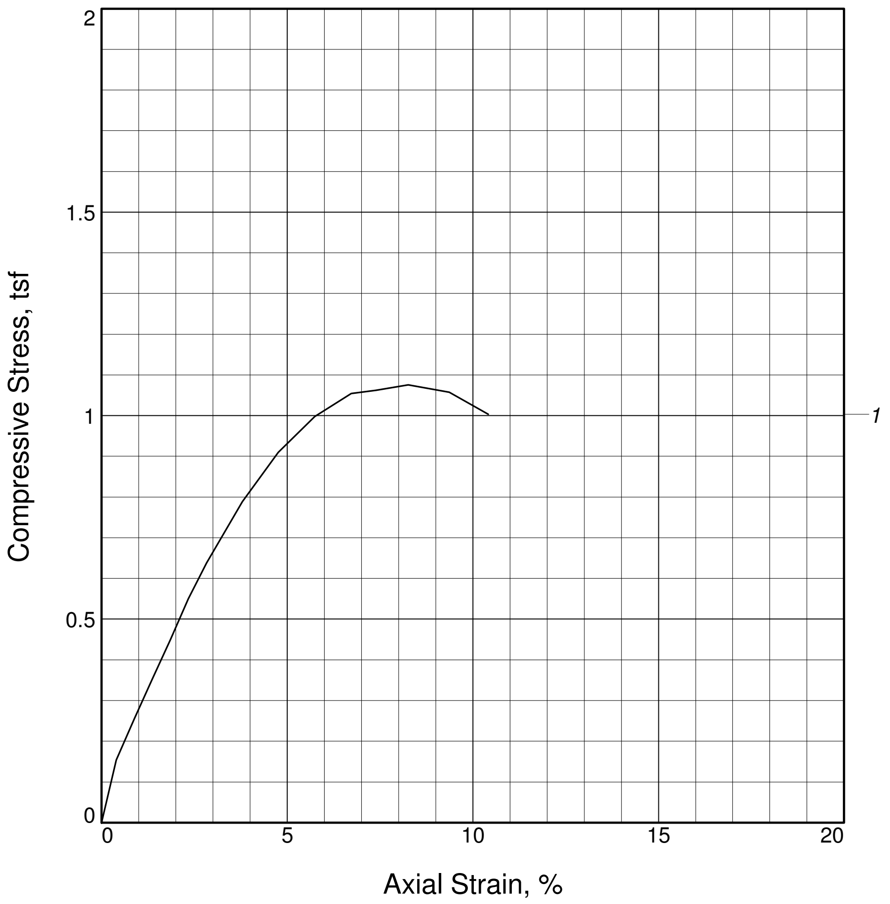
LOCATION: N: 142851.3; E: 489896.1;
Lat.: 445431.06840; Long.: -932520.38321.
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/16/13** | SCALE: **1" = 4'**

Elev. feet 797.5	Depth feet 96.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, waterbearing, dense to very dense. (Glacial Outwash) *(continued)*					
792.5	101.0							
			END OF BORING. Water observed at 5 feet while drilling. Boring immediately backfilled with bentonite grout.					

(See Descriptive Terminology sheet for explanation of abbreviations)

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.075			
Undrained shear strength, tsf	0.538			
Failure strain, %	8.3			
Strain rate, %/min.	1.00			
Water content, %	19.6			
Wet density, pcf	132.9			
Dry density, pcf	111.1			
Saturation, %	99.0			
Void ratio	0.5455			
Specimen diameter, in.	2.83			
Specimen height, in.	5.55			
Height/diameter ratio	1.96			

Description: SANDY LEAN CLAY, gray (CL)

LL = 30	**PL =** 17	**PI =** 13	**Assumed GS=** 2.75	**Type:** Thinwall

Project No.: BL-13-00213
Date Sampled: 4/16/2013
Remarks:

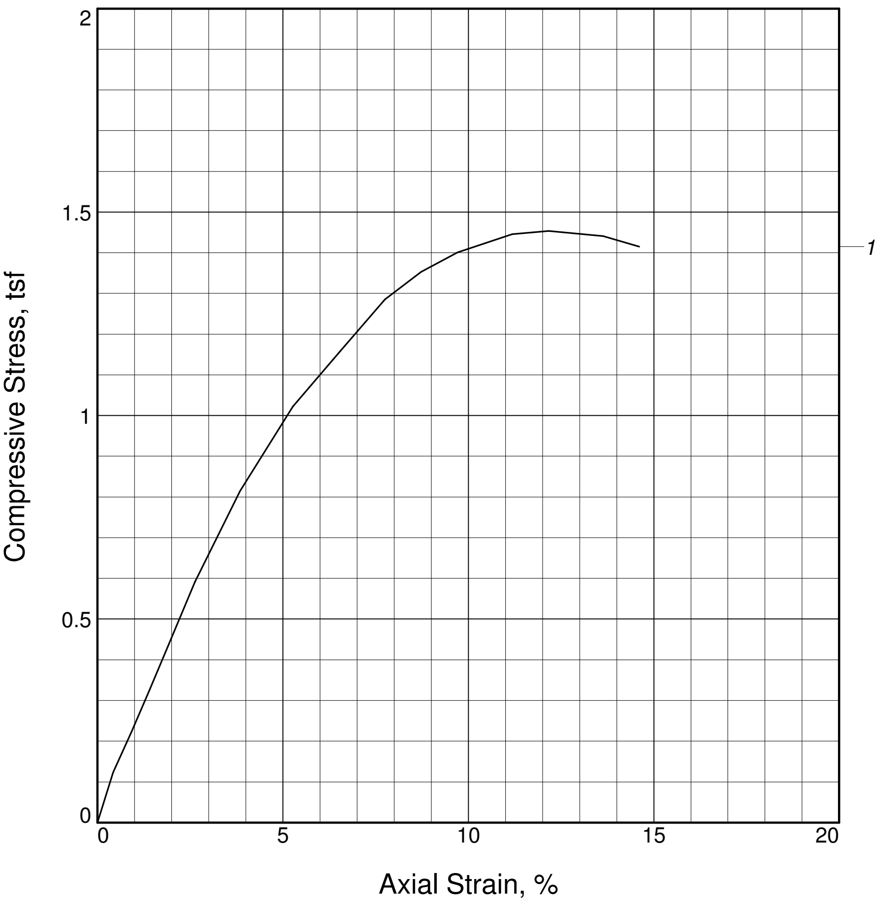
Client: AECOM Technical Services

Project: SWLRT-Eden Prairie & Minnetonka
Minnetonka, MN
Sample Number: 2008 SB **Depth:** 12-14'

BRAUN℠
INTERTEC

Figure 3

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.453			
Undrained shear strength, tsf	0.727			
Failure strain, %	12.2			
Strain rate, %/min.	1.00			
Water content, %	19.1			
Wet density, pcf	132.0			
Dry density, pcf	110.9			
Saturation, %	98.9			
Void ratio	0.5205			
Specimen diameter, in.	2.85			
Specimen height, in.	5.58			
Height/diameter ratio	1.96			

Description: SANDY LEAN CLAY, gray (CL)

LL = 36	**PL =** 18	**PI =** 18	**Assumed GS=** 2.70	**Type:** Thinwall

Project No.: BL-13-00213
Date Sampled: 4/16/2013
Remarks:

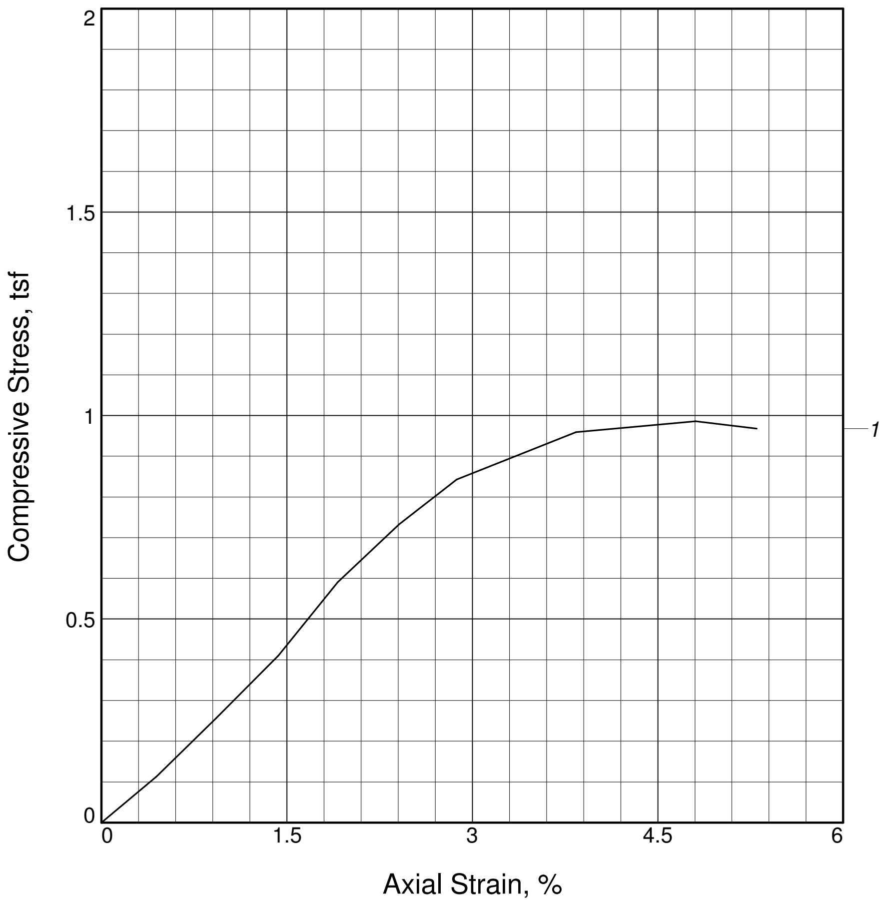
Client: AECOM Technical Services

Project: SWLRT-Eden Prairie & Minnetonka
Minnetonka, MN
Sample Number: 2008 SB **Depth:** 19-21'

BRAUN INTERTEC

Figure 4

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	0.986			
Undrained shear strength, tsf	0.493			
Failure strain, %	4.8			
Strain rate, %/min.	1.00			
Water content, %	15.3			
Wet density, pcf	136.5			
Dry density, pcf	118.4			
Saturation, %	97.4			
Void ratio	0.4241			
Specimen diameter, in.	2.85			
Specimen height, in.	5.57			
Height/diameter ratio	1.95			

Description: SANDY LEAN CLAY, gray (CL)

LL = 25	**PL =** 14	**PI =** 11	**Assumed GS=** 2.70	**Type:** Thinwall

Project No.: BL-13-00213
Date Sampled: 4/16/2013
Remarks:

Client: AECOM Technical Services

Project: SWLRT-Eden Prairie & Minnetonka
Minnetonka, MN
Sample Number: 2008 SB **Depth:** 29-31'

BRAUN℠
INTERTEC

Figure 5

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2009SB**

LOCATION: N: 143788; E: 489918.3;
Lat.: 445440.31744; Long.: -932520.08059.
See attached sketch.

DRILLER: M. Belch
METHOD: 3 1/4" HSA, Autohammer
DATE: **4/15/13**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 897.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
896.9	1.0	CL	LEAN CLAY, dark brown, frozen. (Topsoil)				
893.9	4.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, soft. (Glacial Till)	3			
890.9	7.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, gray, wet, loose. (Glacial Outwash)	7			
880.9	17.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose. (Glacial Outwash)	10	▽		
				9			
				9		16	See attached Grain Size Accumulation Curve.
				10			Switched to mud rotary after 15-foot sample.
873.9	24.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, brown, waterbearing, medium dense to dense. (Glacial Till)	34			
				19			
			With Poorly Graded Sand layer at 21 feet.	26		10	See attached Grain Size Accumulation Curve.
870.9	27.0	SC	CLAYEY SAND, trace Gravel, gray, wet, very stiff. (Glacial Till)	24			
868.9	29.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense. (Glacial Till)	29			
865.9	32.0	SC	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Outwash)	34			

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:36

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2009SB (cont.)**

LOCATION: N: 143788; E: 489918.3;
Lat.: 445440.31744; Long.: -932520.08059.
See attached sketch.

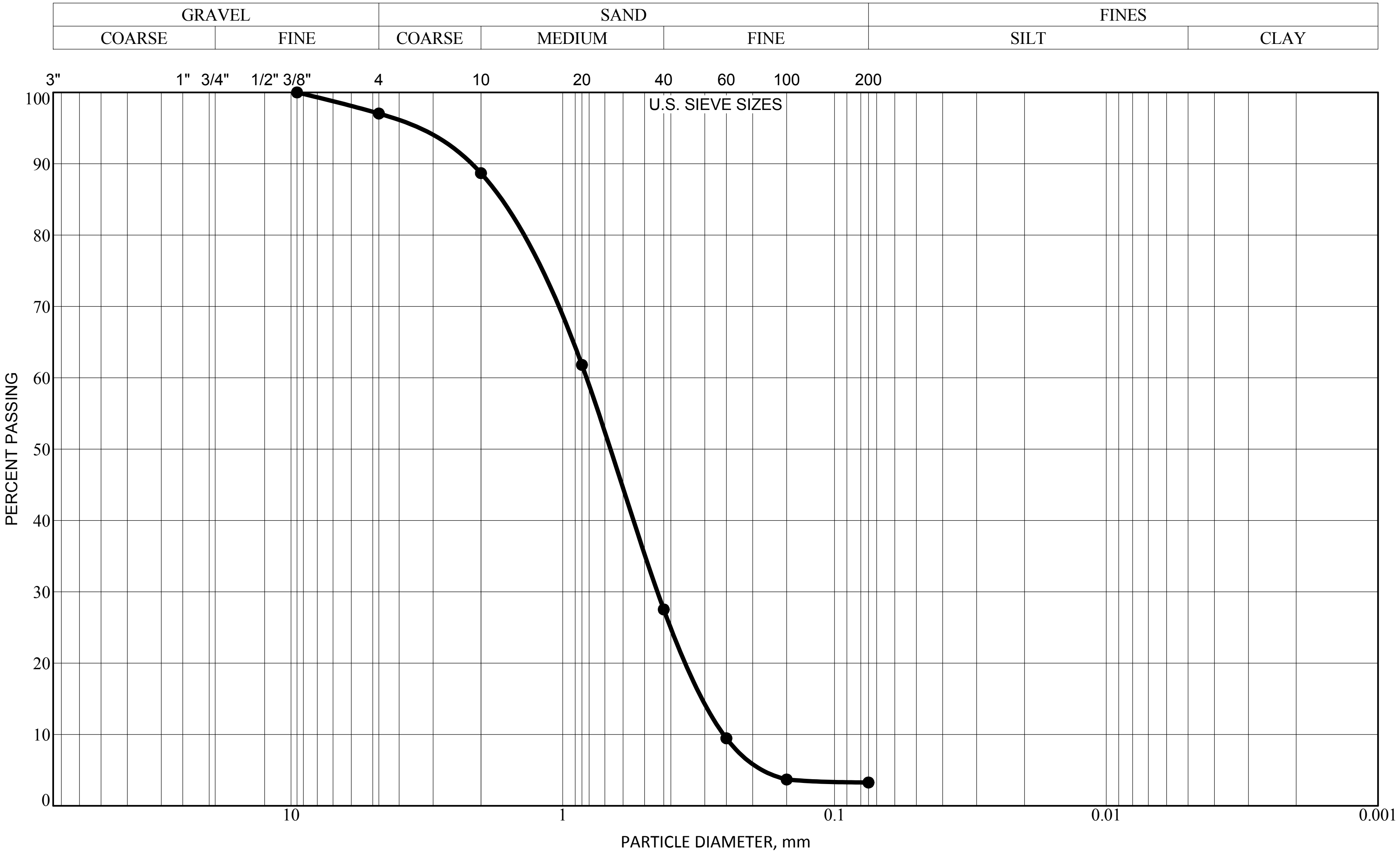
DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **4/15/13**	SCALE: **1" = 4'**

Elev. feet 865.9	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	30			
				12			
860.9	37.0						
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	16			
				17			
				20			
				19		20	See attached Grain Size Accumulation Curve.
				21			
				22			
846.9	51.0						
			END OF BORING. Water observed at 7 1/2 feet with 7 1/2 feet of hollow-stem auger in the ground. Switched to mud rotary drilling at 15 feet. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:36

GRAIN SIZE ACCUMULATION CURVE (ASTM)



BRAUN℠
INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: 2009 SB DEPTH: 12.5'

GRAVEL	3.0%
SAND	93.8%
FINES	3.3%

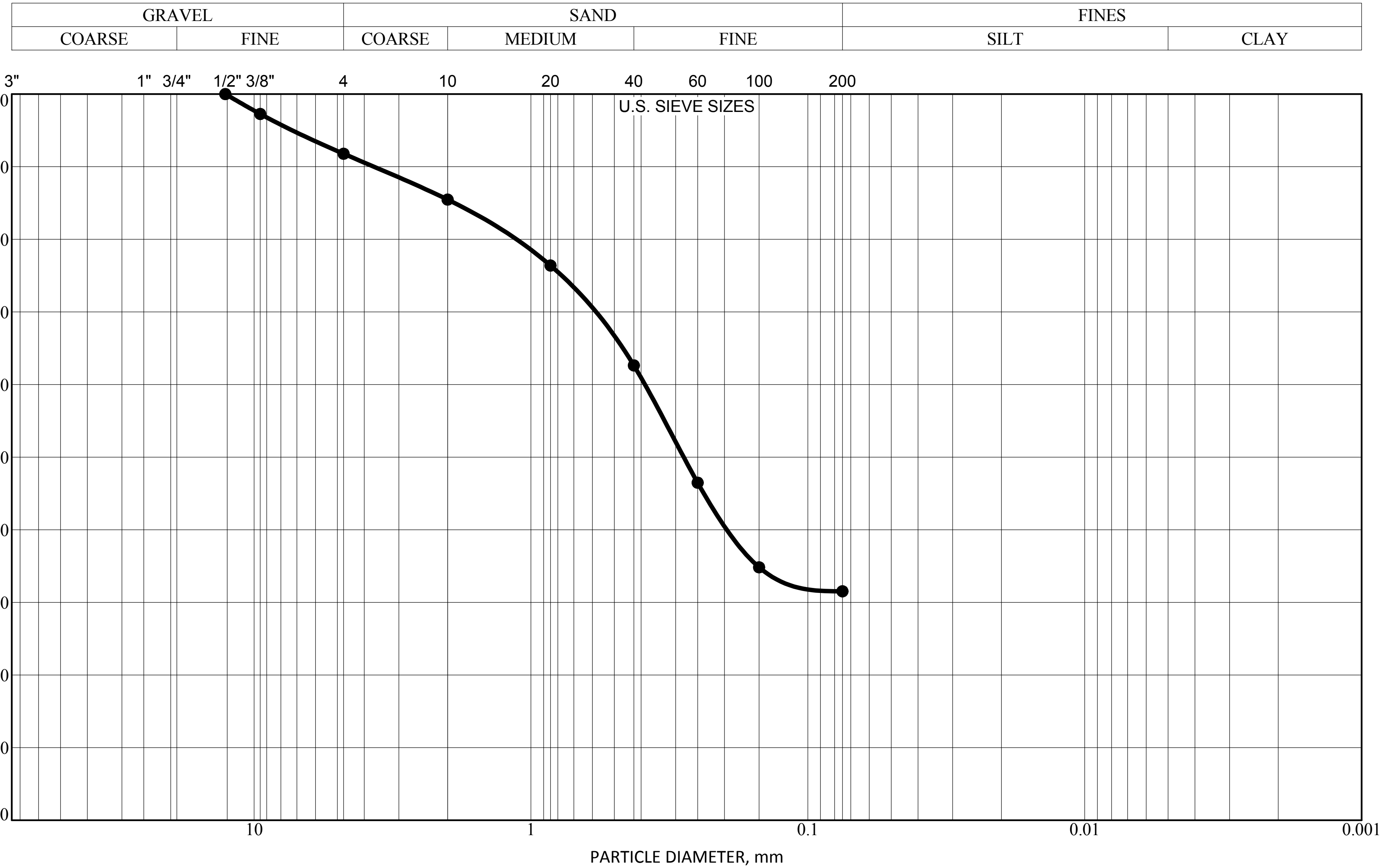
D60=0.820
D30=0.447
D10=0.254

Cu=3.2
Cc=1.0

CLASSIFICATION:
POORLY GRADED SAND(SP)

GS ASTM N:\GINT\PROJECTS\X-GEOLAB\1-GINT FILES\MINNEAPOLIS\2013\BL-13-00213.GPJ BRAUN_V8_CURRENT.GDT 7/24/13 15:27

GRAIN SIZE ACCUMULATION CURVE (ASTM)



BRAUN^SM

INTERTEC

Braun Project BL-13-00213

GEOTECHNICAL EVALUATION

SWLRT

Minnetonka, Minnesota

BORING: 2009 SB DEPTH: 22.5'

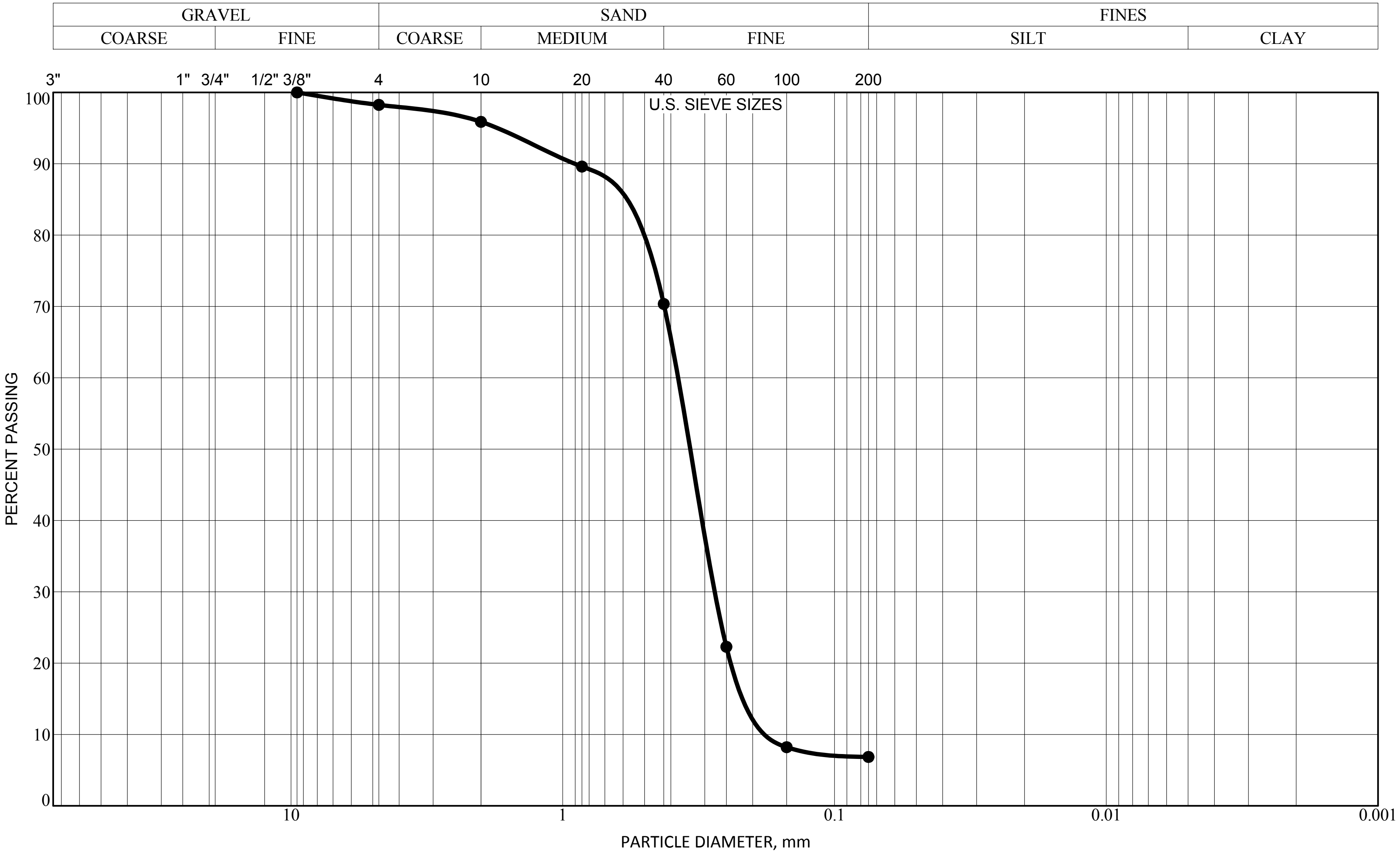
GRAVEL	8.2%
SAND	60.3%
FINES	31.5%

D60=0.390
D30=
D10=

Cu=
Cc=

CLASSIFICATION:
SILTY SAND(SM) with occasional LEAN CLAY lenses

GRAIN SIZE ACCUMULATION CURVE (ASTM)



Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: 2009 SB DEPTH: 45.0'

GRAVEL	1.7%
SAND	91.4%
FINES	6.9%

D60=0.379
D30=0.272
D10=0.160

Cu=2.4
Cc=1.2

CLASSIFICATION:
POORLY GRADED SAND with SILT(SP-SM)

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213

GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2010SB**

LOCATION: N: 144766.2; E: 489918.3;
Lat.: 445449.97533; Long.: -932520.08712.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **5/15/13**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 900.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		FILL	FILL: Sandy Lean Clay, trace Gravel, dark brown, moist. (Topsoil Fill)				
898.3	2.0						
		FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.	7		14	P200=19.7%
896.3	4.0						
		SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	12	▽	12	P200=7.2%
893.3	7.0						
		SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	14		12	P200=11.7%
				10			
				14			
				15			
				6		10	P200=5.1%
881.3	19.0						
		CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff. (Glacial Till)	15			
878.3	22.0						
		SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, loose to dense. (Glacial Outwash)	6			
			With Sandy Lean Clay lenses at 25 feet.	16			
				12			
				15			

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2010SB (cont.)**

LOCATION: N: 144766.2; E: 489918.3;
Lat.: 445449.97533; Long.: -932520.08712.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **5/15/13**

SCALE: **1" = 4'**

Elev. feet 868.3	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, loose to dense. (Glacial Outwash) *(continued)*	32			
				28			
				32			
				21			
			Fine- to coarse-grained at 42 feet.	26			
				34*			*No recovery.
853.3	47.0	SC	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Till)	42			
852.3	48.0	CL	SANDY LEAN CLAY, trace Gravel, brown, wet, hard. (Glacial Till)				
				36			
			With Sand lenses at 55 feet.	54			
841.3	59.0	SC	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Till)	48			

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2010SB (cont.)**

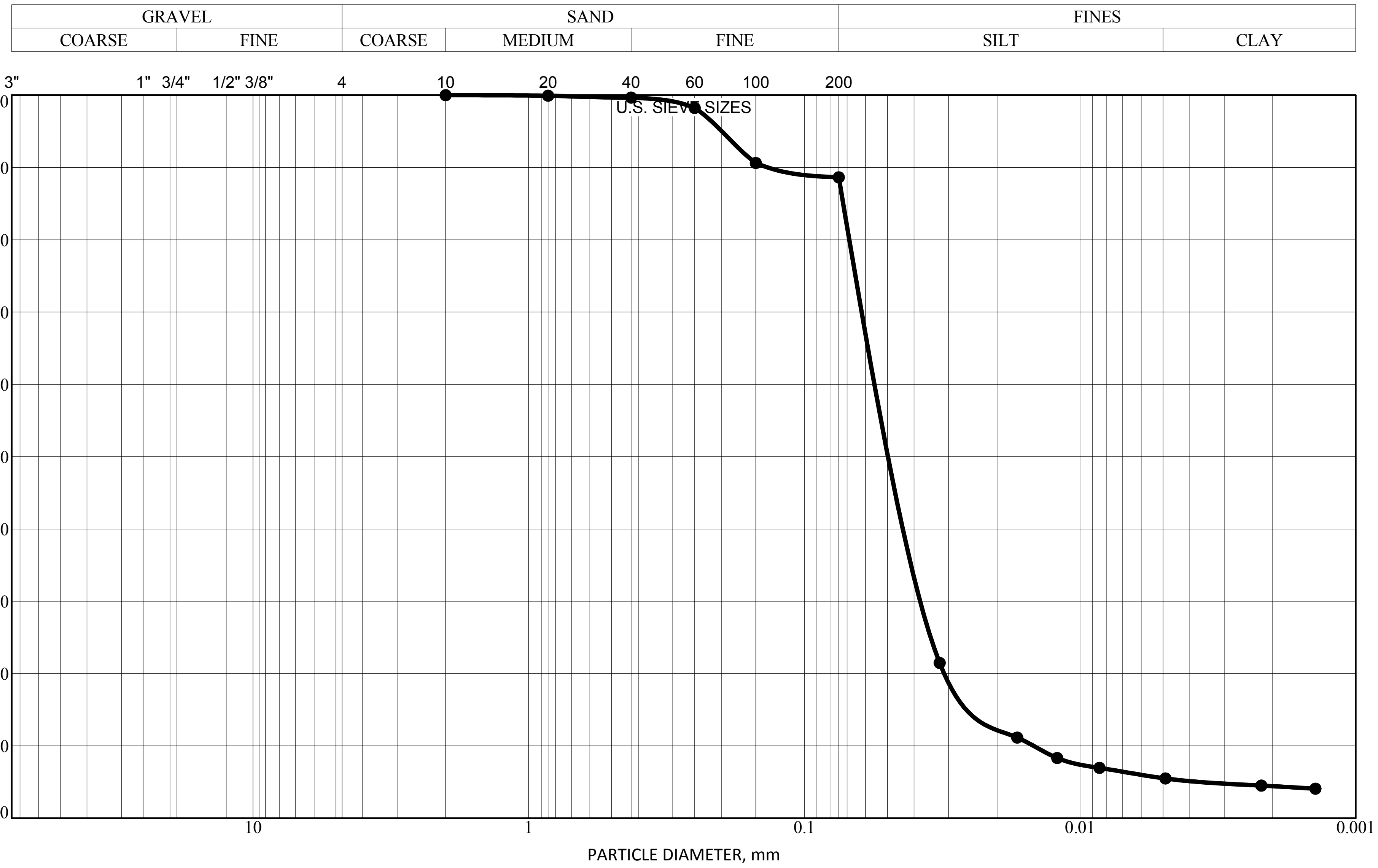
LOCATION: N: 144766.2; E: 489918.3;
Lat.: 445449.97533; Long.: -932520.08712.
See attached sketch.

DRILLER: S. McLean
METHOD: 3 1/4" HSA, Autohammer
DATE: **5/15/13**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 836.3	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		▨	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Till) *(continued)* Clay layer encountered at 65 feet.	43			
				40			
				38			
821.3	79.0	ML	SILT, brown, waterbearing, very dense. (Glacial Till)	75		20	See attached Grain Size Accumulation Curve.
819.3	81.0		END OF BORING. Water observed at 5 feet with 5 feet of hollow-stem auger in the ground. Switched to mud rotary drilling at 15 feet. Boring immediately backfilled with bentonite grout.				

GRAIN SIZE ACCUMULATION CURVE (ASTM)



BRAUN INTERTEC

Braun Project BL-13-00213

GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: 2010 SB DEPTH: 80.0'

GRAVEL	0.0%
SAND	11.4%
SILT	83.1%
CLAY	5.5%
D60=0.052 D30=0.036 D10=0.015	Cu=3.5 Cc=1.7

CLASSIFICATION:
SILT(ML)

GS ASTM N:\GINT\PROJECTS\X-GEOLAB\1-GINT FILES\MINNEAPOLIS\2013\BL-13-00213.GPJ BRAUN_V8_CURRENT.GDT 9/20/13 09:26

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2011SB**

LOCATION: N: 145434.3; E: 489896.4;
Lat.: 445456.57167; Long.: -932520.39576
See attached sketch.

DRILLER: S. McLean
METHOD: 3 1/4" HSA, Autohammer
DATE: **5/14/13**
SCALE: **1" = 4'**

Elev. feet 902.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
900.6	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown and black, moist. (Topsoil Fill)				
898.6	4.0	FILL	FILL: Sandy Lean Clay, trace Gravel, dark brown, wet.	5			
895.6	7.0	FILL	FILL: Clayey Sand, slightly organic, trace Gravel, with Sand lenses, dark brown, wet.	4		17	OC=2.3%
893.6	9.0	FILL	FILL: Sandy Lean Clay, trace Gravel and roots, dark brown to gray, wet.	6			
890.6	12.0	CL	SANDY LEAN CLAY, with occasional Silt lenses and seams, trace Gravel and roots, gray, wet, medium. (Alluvium)	6	▽	19	OC=0.8%
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash)	10			
				23		11	P200=1.0%
			Cobbles layer encountered between 17 to 29 feet.	19			
				20			
				16			
				15		11	P200=2.3%
873.6	29.0			19			
870.6	32.0	SC	CLAYEY SAND, trace Gravel, brown, wet, very stiff. (Glacial Till)	28			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:06

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2011SB (cont.)**

LOCATION: N: 145434.3; E: 489896.4;
Lat.: 445456.57167; Long.: -932520.39576
See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: **5/14/13**	SCALE: **1" = 4'**

Elev. feet 870.6	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff. (Glacial Till)	15			
868.6	34.0	SC	CLAYEY SAND, trace Gravel, brown, wet, medium to very stiff. (Glacial Till)	14			
			With waterbearing Sand lenses at 37 feet.	6		12	See attached Grain Size Accumulation Curve.
				19*			*No recovery.
				27			
858.6	44.0	CL	SANDY LEAN CLAY, trace Gravel, brown, wet, very stiff. (Glacial Till)	24			
			With Sand seams at 47 feet.	25			
				22			
848.6	54.0	SC	CLAYEY SAND, with waterbearing Sand lenses, brown, wet, hard. (Glacial Till)	32			
				31		11	See attached Grain Size Accumulation Curve.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2011SB (cont.)**

LOCATION: N: 145434.3; E: 489896.4;
Lat.: 445456.57167; Long.: -932520.39576
See attached sketch.

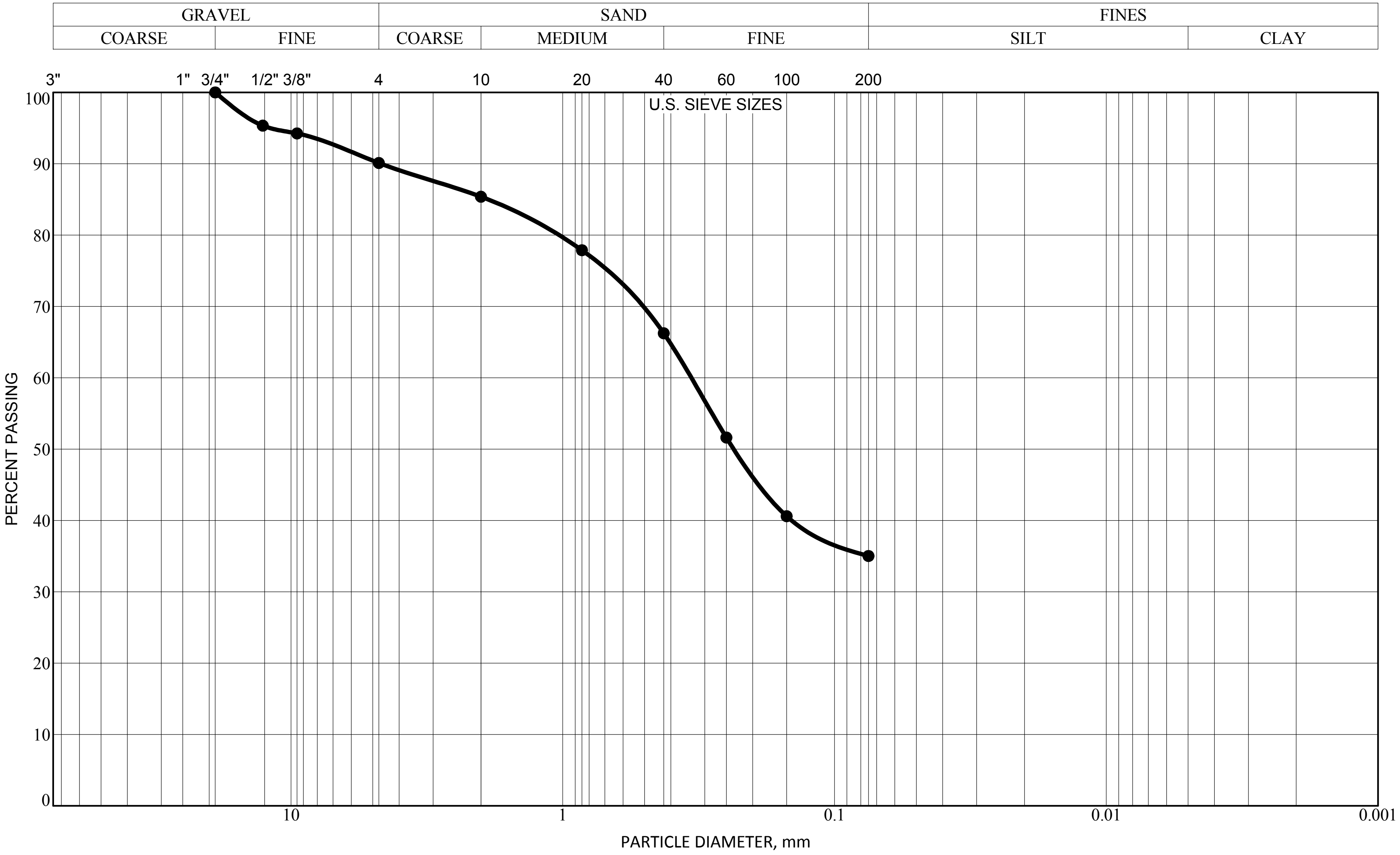
DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: **5/14/13**	SCALE: **1" = 4'**

Elev. feet 838.6	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			CLAYEY SAND, with waterbearing Sand lenses, brown, wet, hard. (Glacial Till) *(continued)*	32 36			
			With Poorly Graded Sand lenses and seams at 75 feet.	37			
823.6	79.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, dense to very dense. (Glacial Till)	67 41			
813.6	89.0	SC	CLAYEY SAND, with Gravel, brown, wet, hard. (Glacial Till)	34			**END OF BORING AT 96 FEET. Water observed at 12 feet with 12 feet of hollow-stem auger in the ground. Switched to mud rotary drilling at 15 feet. Boring immediately backfilled with bentonite grout.
808.6	94.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, greenish brown, waterbearing, very dense.** (Glacial Outwash)	100			
806.6	96.0						

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 3/28/14 15:06

GRAIN SIZE ACCUMULATION CURVE (ASTM)



BRAUN℠
INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: 2011 SB DEPTH: 37.5'

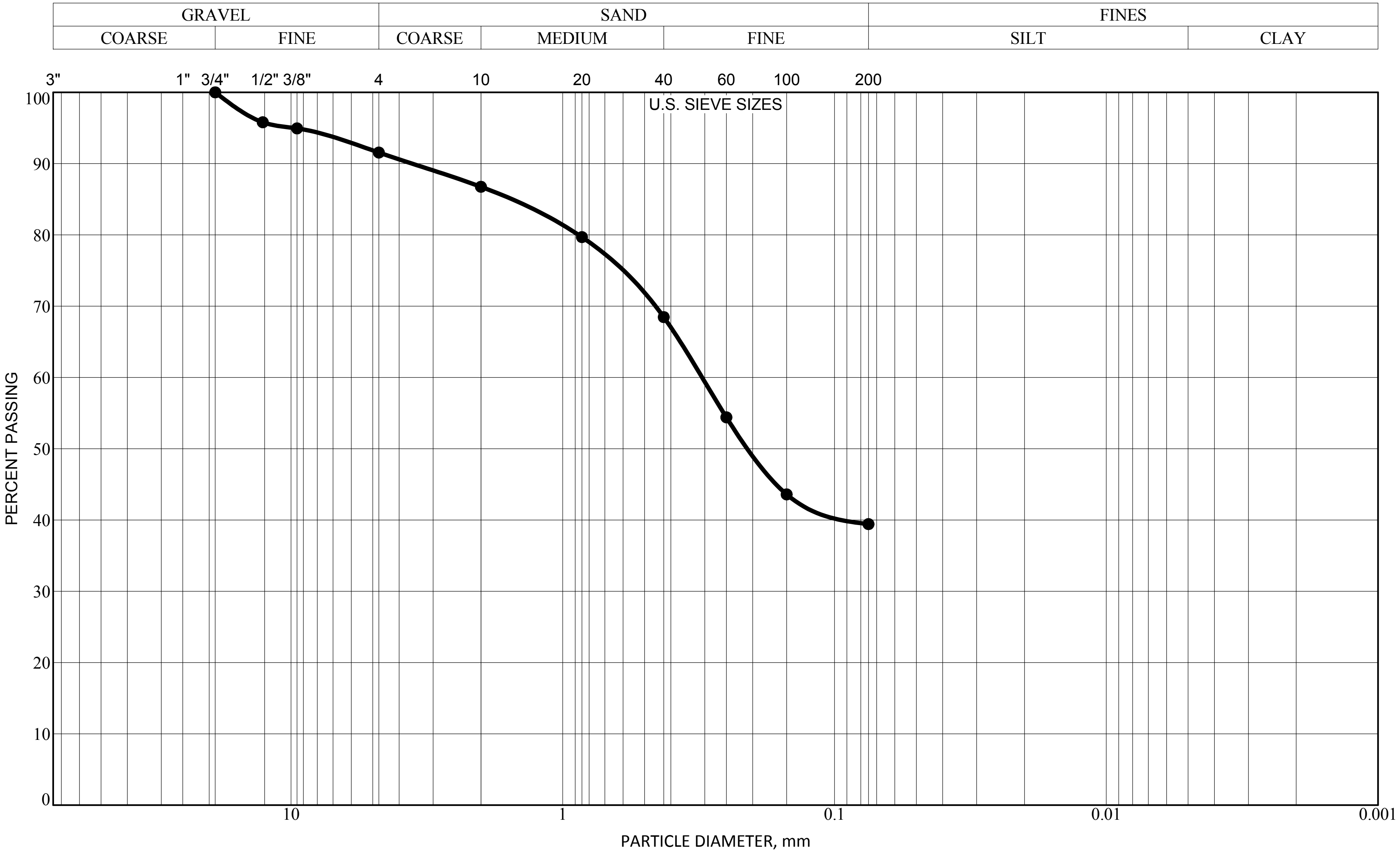
GRAVEL	9.9%
SAND	55.1%
FINES	35.0%

D60=0.339
D30=
D10=

Cu=
Cc=

CLASSIFICATION:
CLAYEY SAND(SC)

GRAIN SIZE ACCUMULATION CURVE (ASTM)



BRAUN INTERTEC

Braun Project BL-13-00213

GEOTECHNICAL EVALUATION

SWLRT

Minnetonka, Minnesota

BORING: 2011 SB DEPTH: 60.0'

GRAVEL	8.4%
SAND	52.1%
FINES	39.4%

D60=0.309
D30=
D10=

Cu=
Cc=

CLASSIFICATION:
CLAYEY SAND(SC)

GS ASTM N:\GINT\PROJECTS\X-GEOLAB\1-GINT FILES\MINNEAPOLIS\2013\BL-13-00213.GPJ BRAUN_V8_CURRENT.GDT 7/24/13 15:28

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2091SB**

LOCATION: N: 144340.7; E: 489795.8;
See attached sketch.

DRILLER: B. Kammermeier	METHOD: 3 1/4" HSA, Autohammer	DATE: **4/21/14**	SCALE: **1" = 4'**

Elev. feet 898.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		FILL	ORGANIC CLAY, with Sand, trace roots, black, moist. (Topsoil)				
				1		131	
894.6	4.0						
		PT	PEAT, well decomposed, trace roots, black, moist. (Swamp Deposit)	4			
				2		386	OC=61% qu=1370 psf
				2			
886.6	12.0						
		ML	SILT, trace fibers, gray, moist, very soft. (Alluvium)	WH		37	WH=Weight of hammer.
884.6	14.0						
		CL	LEAN CLAY, with SAND, with layers of Silt, trace Gravel, layer of Sand, gray, wet, rather soft. (Alluvium)		∇		
				5*			*Switched to mud rotary drilling method after 15-foot sample. An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				15			
				9			
				9			
873.6	25.0						
		GW	WELL-GRADED GRAVEL, with fine-grained Sand, gray, waterbearing, loose. (Glacial Outwash)	10		10	P200=2%
				9*			*No sample recovery.
868.6	30.0						
		SC	CLAYEY SAND, with Gravel, brownish gray, wet, very stiff to hard. (Glacial Till)	26			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 5/30/14 10:15

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2091SB (cont.)**

LOCATION: N: 144340.7; E: 489795.8;
See attached sketch.

DRILLER: B. Kammermeier
METHOD: 3 1/4" HSA, Autohammer
DATE: **4/21/14**
SCALE: **1" = 4'**

Elev. feet 866.6	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
863.6	35.0		CLAYEY SAND, with Gravel, brownish gray, wet, very stiff to hard. (Glacial Till) *(continued)*	42			
861.6	37.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff. (Glacial Till)	26		17	DD=115
858.6	40.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	26			
856.6	42.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff. (Glacial Outwash)	16			
851.6	47.0	SC	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Till)	36 35			
848.6	50.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, dense. (Glacial Outwash)	36			
843.6	55.0	SC	CLAYEY SAND, trace Gravel, brownish gray, wet, hard. (Glacial Till)	37		10	DD=131 pcf
		SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, dense. (Glacial Outwash)	48 38			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 5/30/14 10:15

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2091SB (cont.)**

LOCATION: N: 144340.7; E: 489795.8;
See attached sketch.

DRILLER: B. Kammermeier

METHOD: 3 1/4" HSA, Autohammer

DATE: **4/21/14**

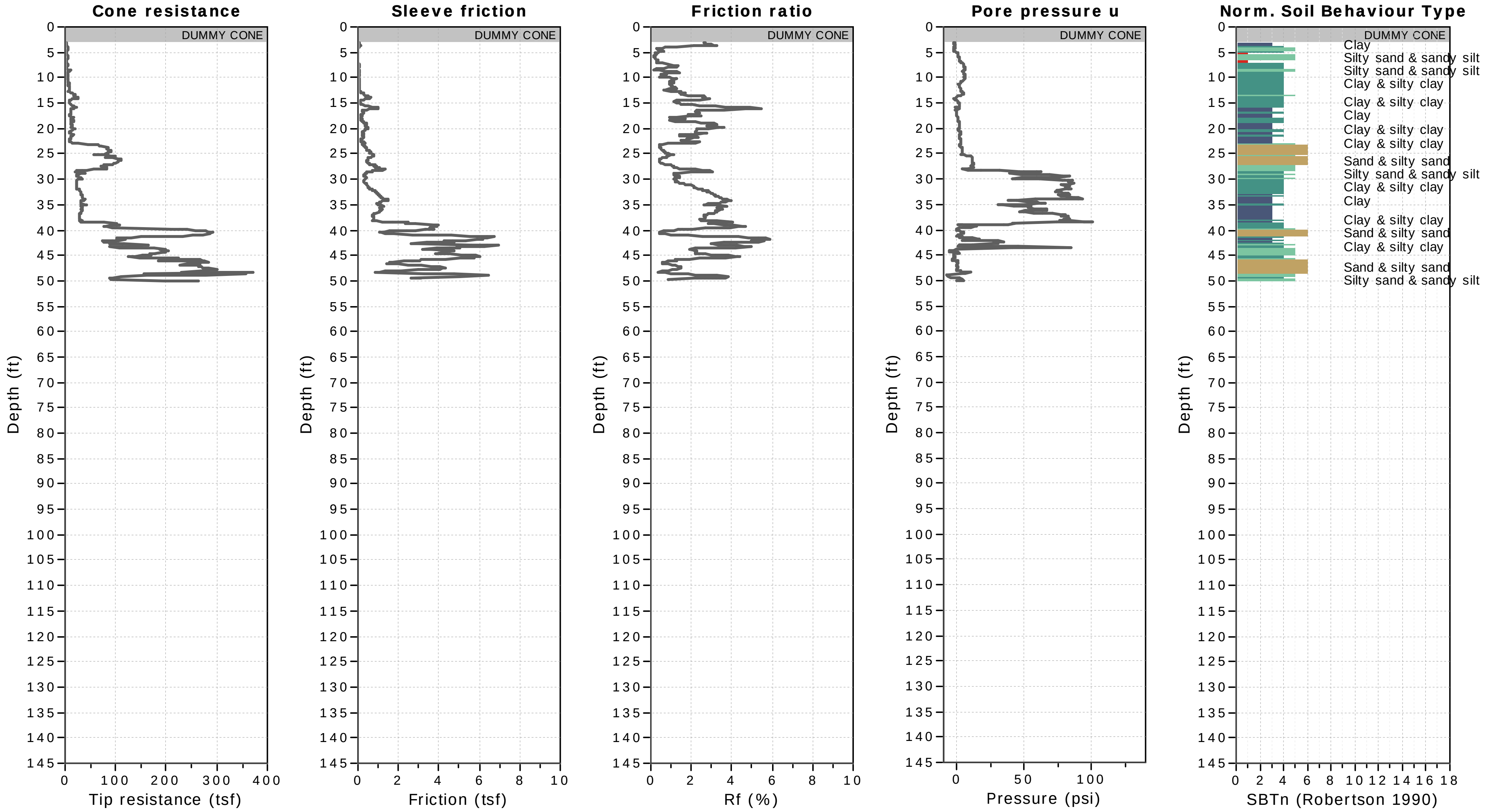
SCALE: **1" = 4'**

Elev. feet 834.6	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
833.6	65.0						
		SC	CLAYEY SAND, with Gravel, brownish gray, wet, hard. (Glacial Till)	32			
828.6	70.0						
		SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, wet, dense to very dense. (Glacial Till)	42			
				47*			*No sample recovery.
				32			
				150			
812.6	86.0						
			END OF BORING. Water observed at 15 feet while drilling. Boring immediately backfilled with bentonite grout.				

Braun Intertec Corporation
11001 Hampshire Ave S
Minneapolis, MN 55438
952-995-2000

Project: **SWLRT**
Location: **Hopkins, MN**
Project Number: BL-13-00213

CPT: 2084CB
Total depth: 50.02 ft, Date: 3/26/2014
Surface Elevation: 891.10 ft
Coords: X:489871.10, Y:143066.40
Cone Type: SCPTu
Cone Operator: Reich/Lee

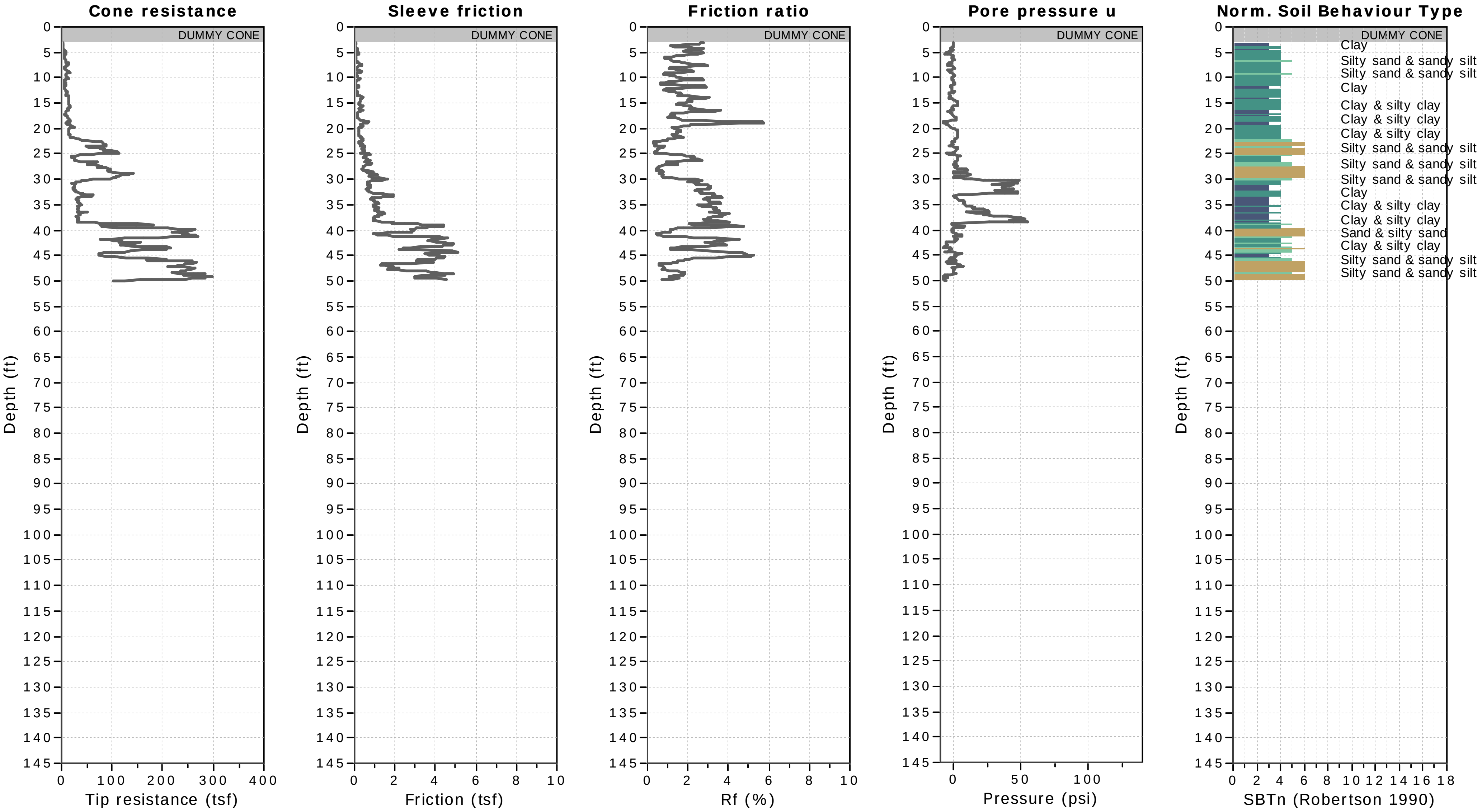


BRAUN INTERTEC

Braun Intertec Corporation
11001 Hampshire Ave S
Minneapolis, MN 55438
952-995-2000

Project: **SWLRT**
Location: **Hopkins, MN**
Project Number: BL-13-00213

CPT: 2085CB
Total depth: 50.02 ft, Date: 3/26/2014
Surface Elevation: 890.30 ft
Coords: X:489882.50, Y:143145.90
Cone Type: SCPTu
Cone Operator: Reich/Lee

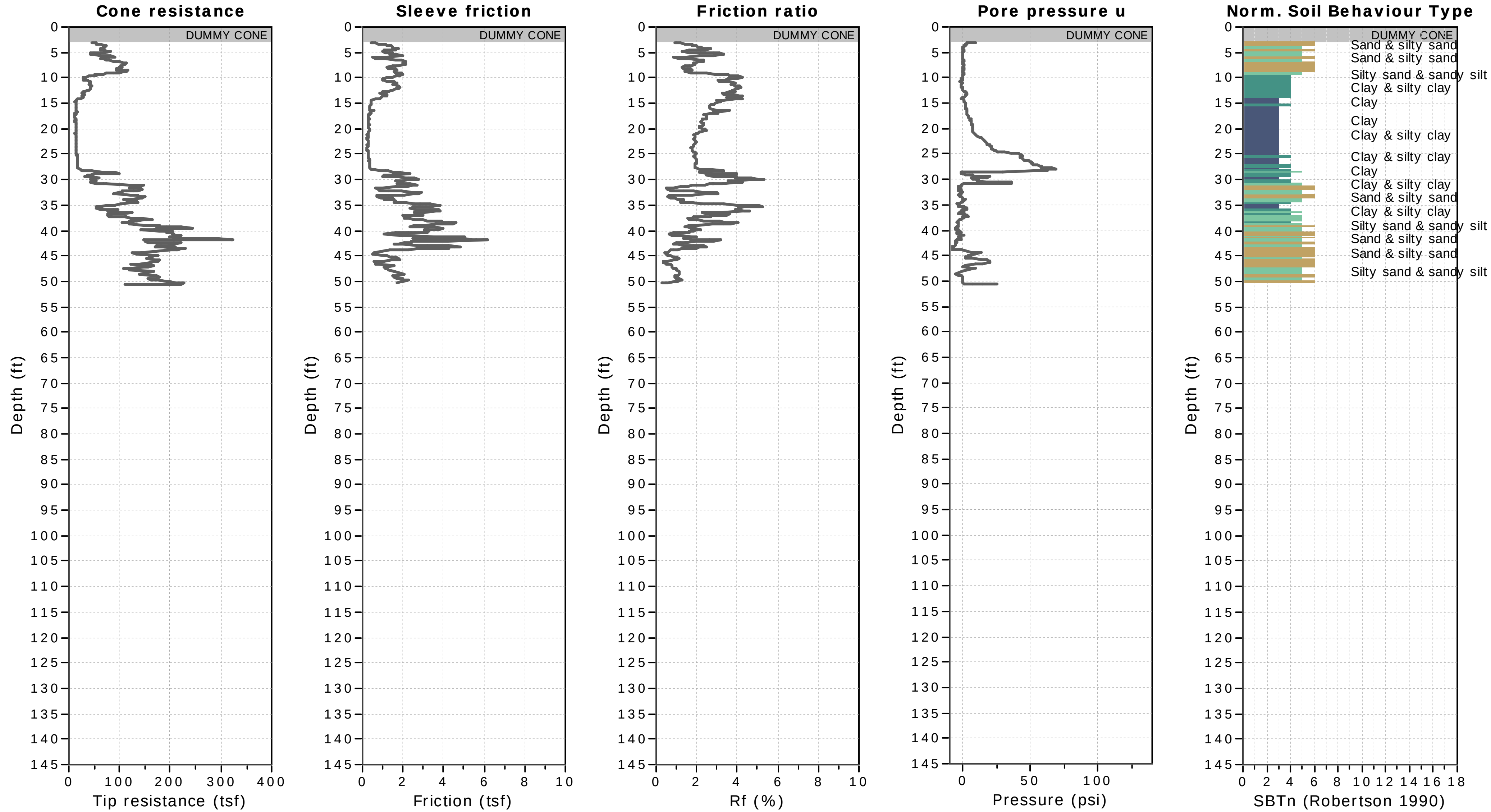


BRAUN INTERTEC

Braun Intertec Corporation
11001 Hampshire Ave S
Minneapolis, MN 55438
952-995-2000

CPT: 2086CB
Total depth: 50.72 ft, Date: 3/26/2014
Surface Elevation: 903.30 ft
Coords: X:489904.80, Y:143145.80
Cone Type: SCPTu
Cone Operator: Reich/Lee

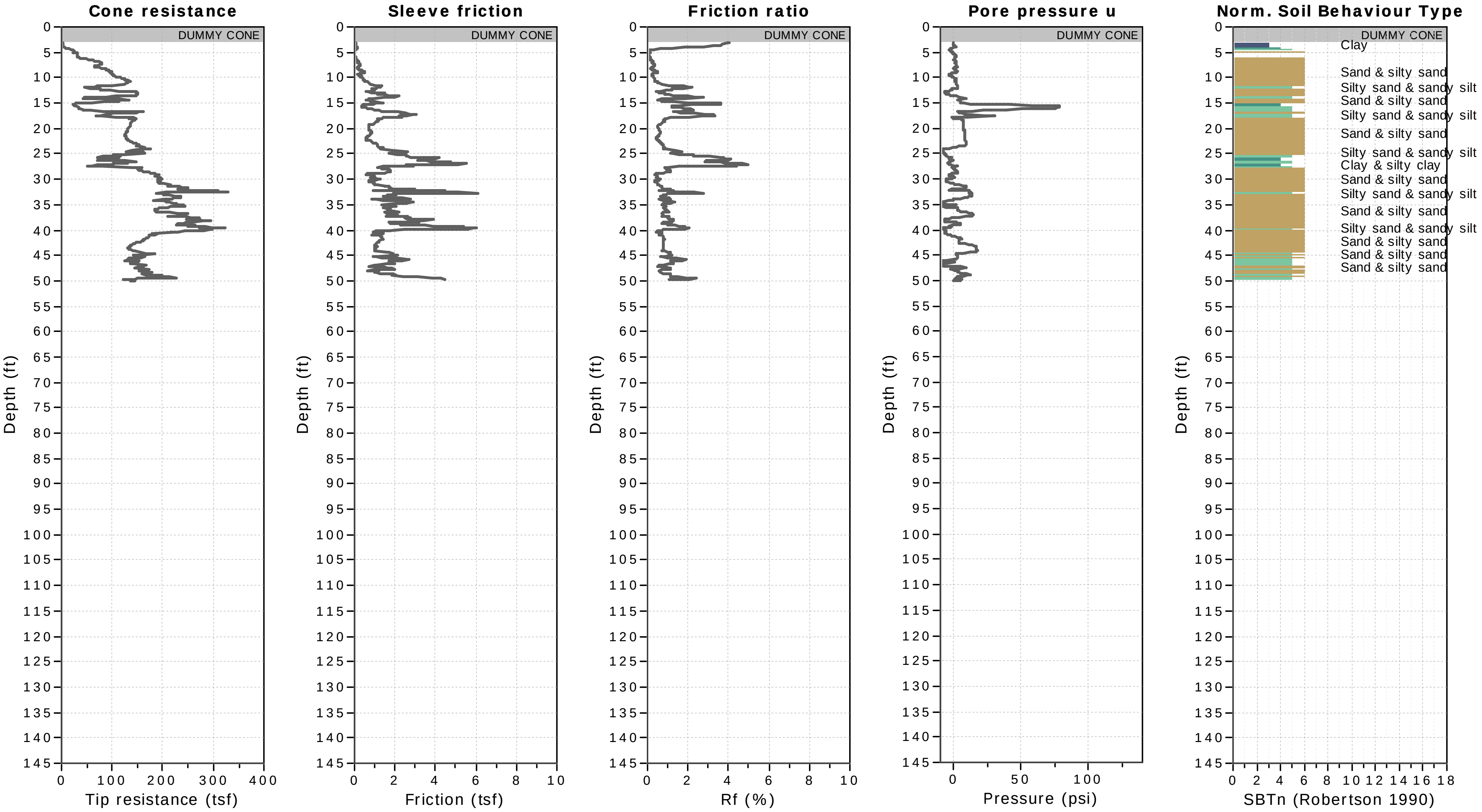
Project: **SWLRT**
Location: **Hopkins, MN**
Project Number: BL-13-00213



Braun Intertec Corporation
11001 Hampshire Ave S
Minneapolis, MN 55438
952-995-2000

Project: **SWLRT**
Location: **Hopkins, MN**
Project Number: BL-13-00213

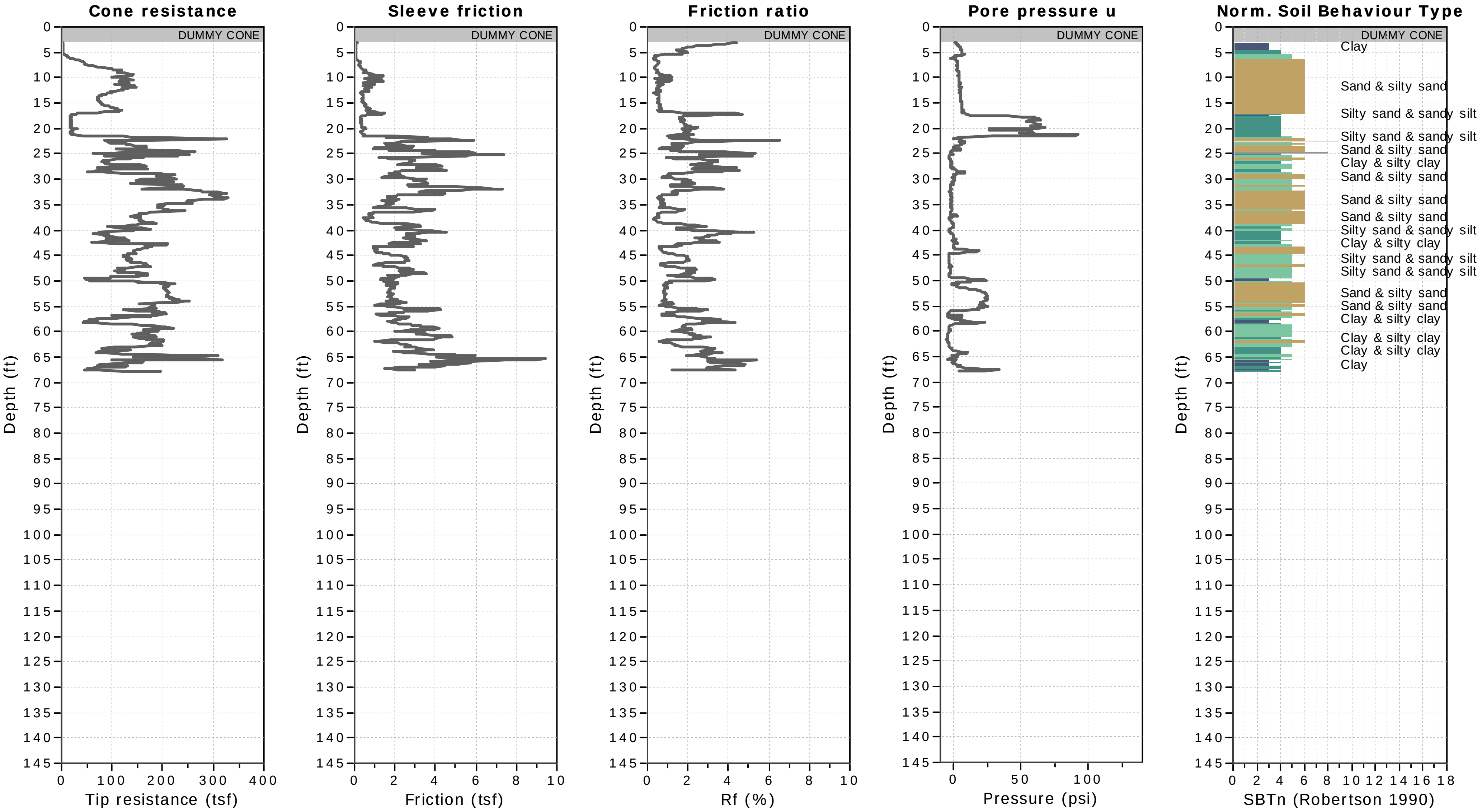
CPT: 2087CB
Total depth: 50.03 ft, Date: 3/26/2014
Surface Elevation: 896.30 ft
Coords: X:489888.80, Y:143713.40
Cone Type: SCPTu
Cone Operator: Reich/Lee



Braun Intertec Corporation
11001 Hampshire Ave S
Minneapolis, MN 55438
952-995-2000

Project: SWLRT
Location: Hopkins, MN
Project Number: BL-13-00213

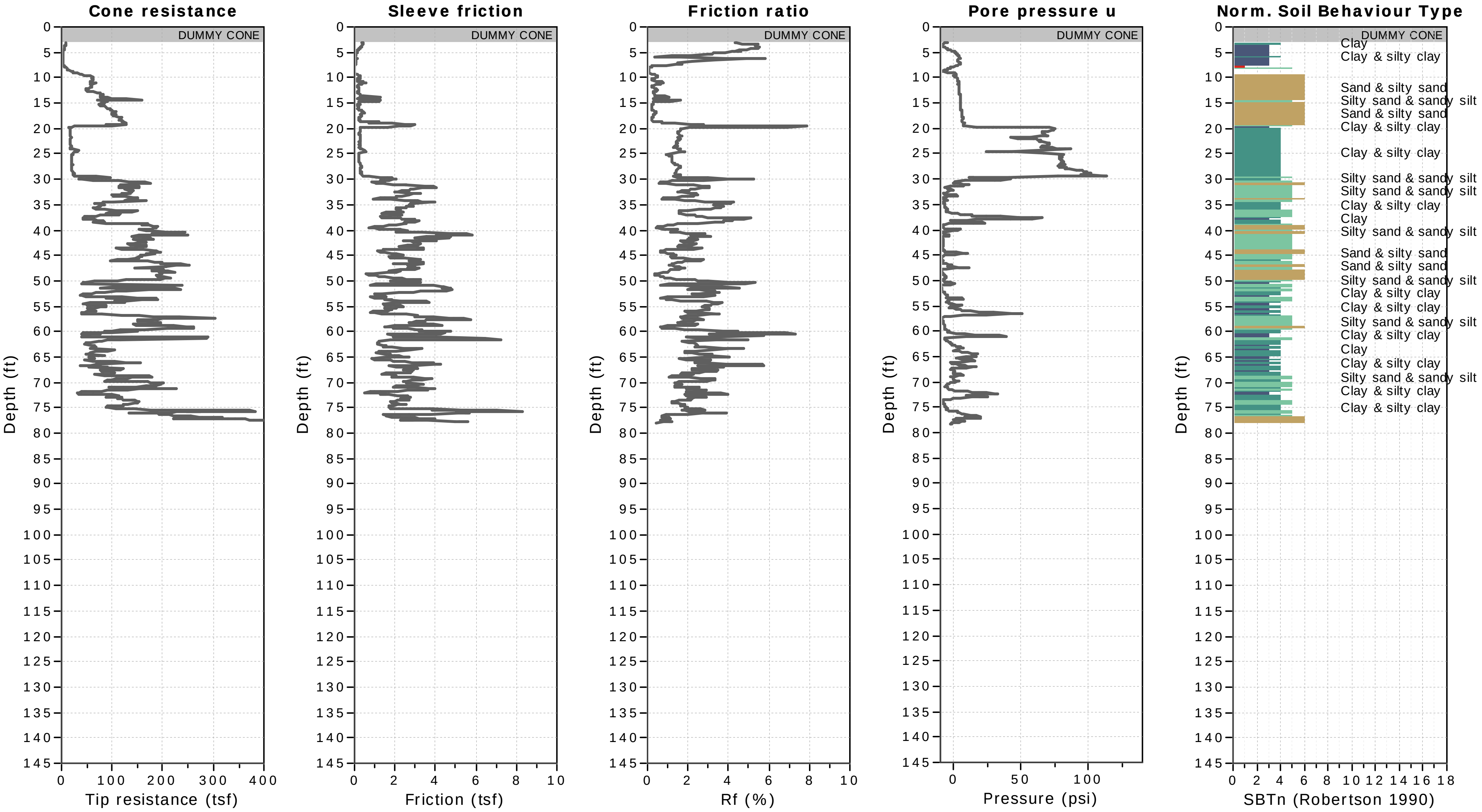
CPT: 2088CB
Total depth: 67.91 ft, Date: 3/26/2014
Surface Elevation: 897.10 ft
Coords: X:489903.10, Y:143979.80
Cone Type: SCPTu
Cone Operator: Reich/Lee



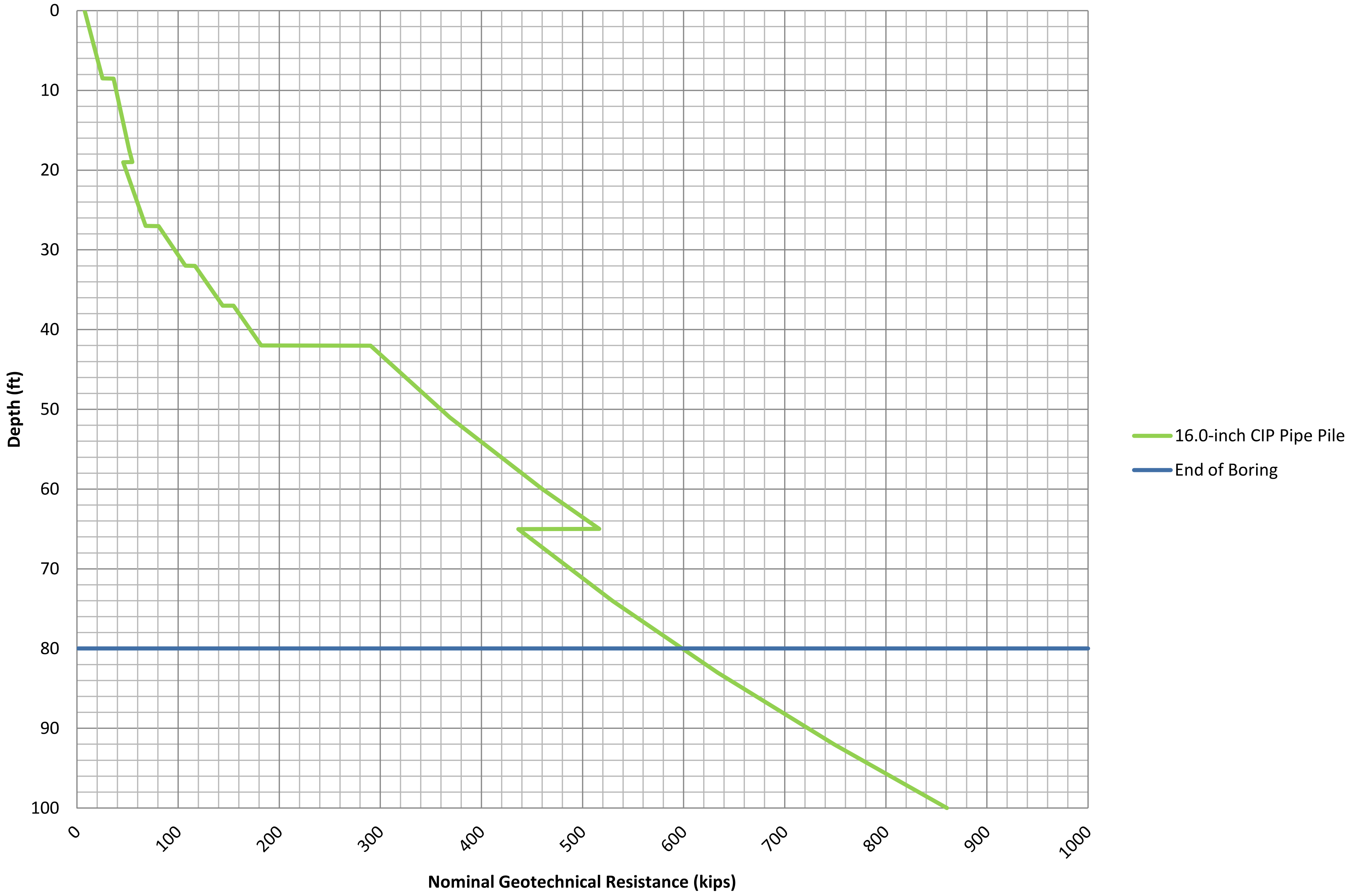
Braun Intertec Corporation
11001 Hampshire Ave S
Minneapolis, MN 55438
952-995-2000

Project: **SWLRT**
Location: **Hopkins, MN**
Project Number: BL-13-00213

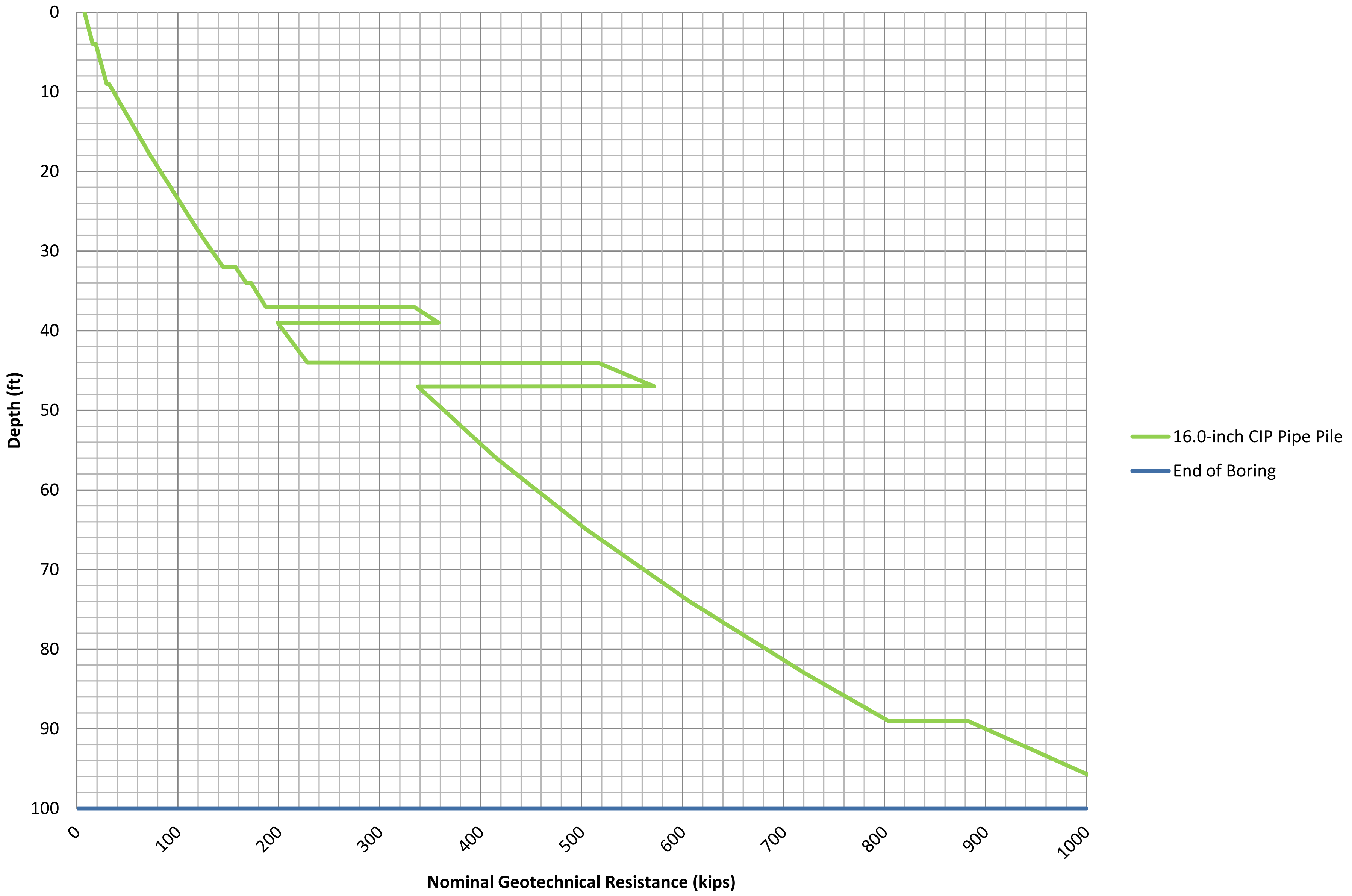
CPT: 2089CB
Total depth: 78.23 ft, Date: 3/26/2014
Surface Elevation: 897.70 ft
Coords: X:489909.10, Y:144100.50
Cone Type: SCPTu
Cone Operator: Reich/Lee



Minnetonka/Hopkins Crossing
Boring: 2007SB
16.0-inch Closed Ended Pipe Pile



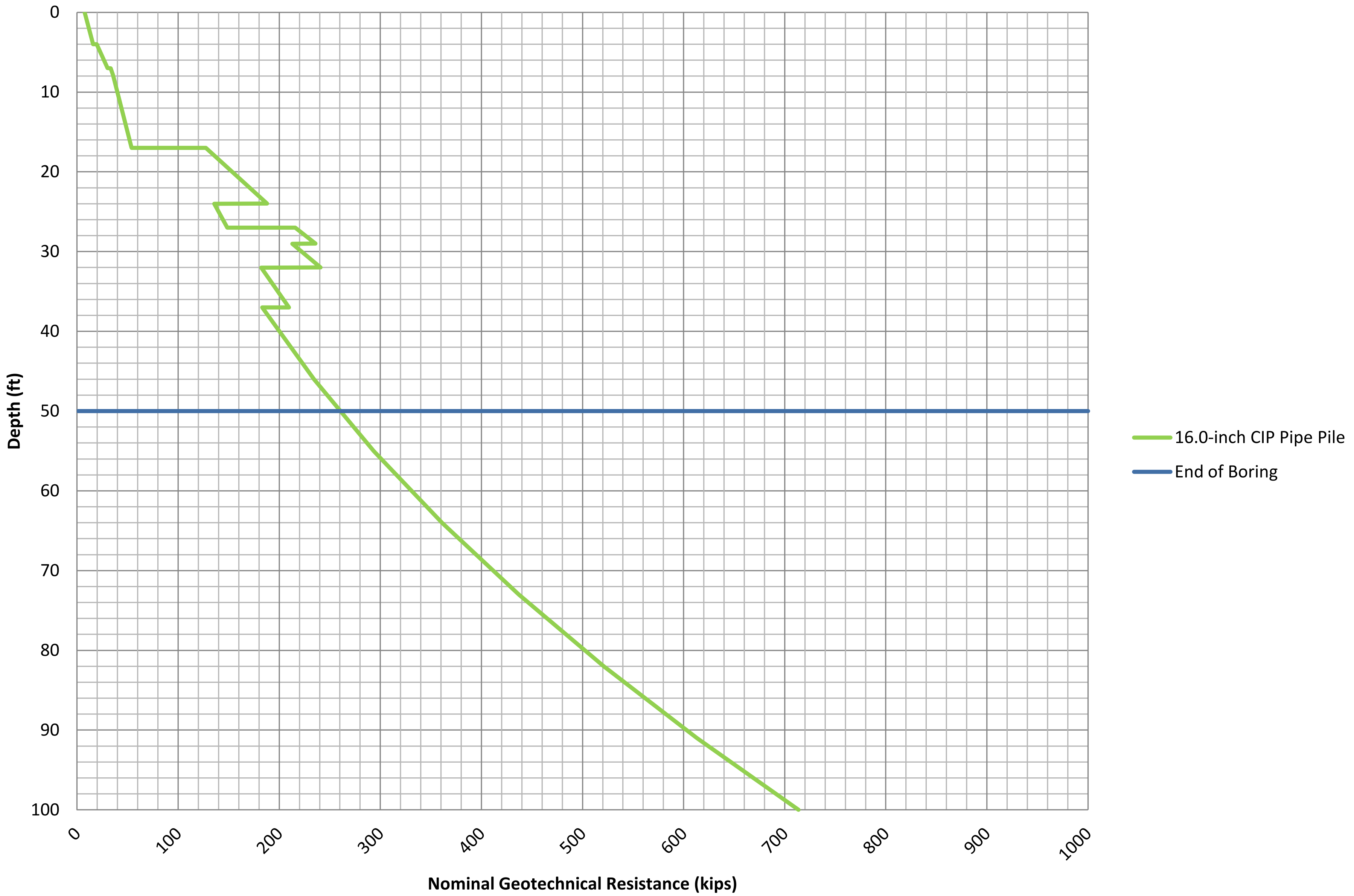
Minnetonka/Hopkins Crossing
Boring: 2008SB
16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

BRAUN
INTERTEC

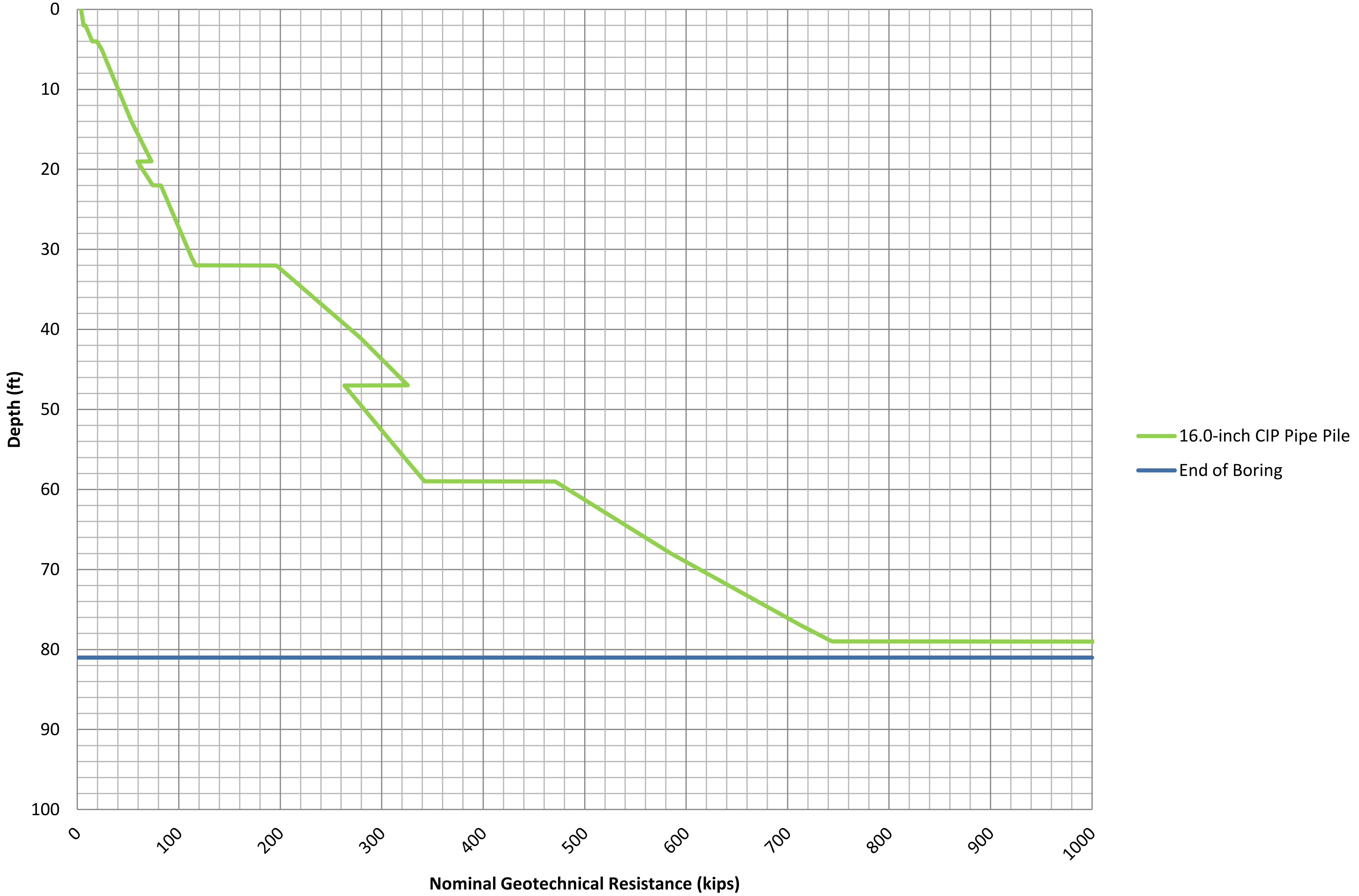
Minnetonka/Hopkins Crossing
Boring: 2009SB
16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

BRAUN INTERTEC

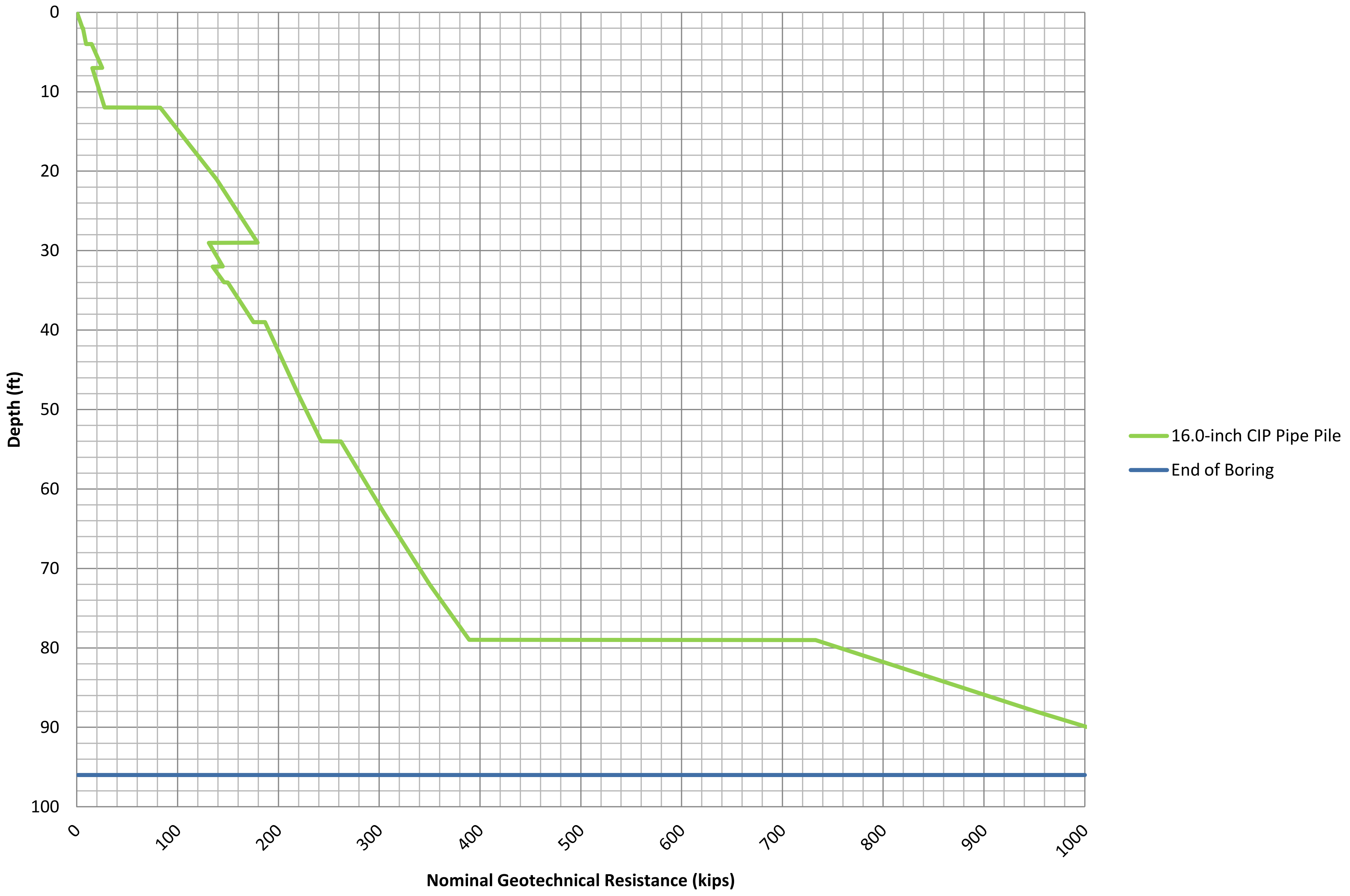
Minnetonka/Hopkins Crossing
Boring: 2010SB
16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

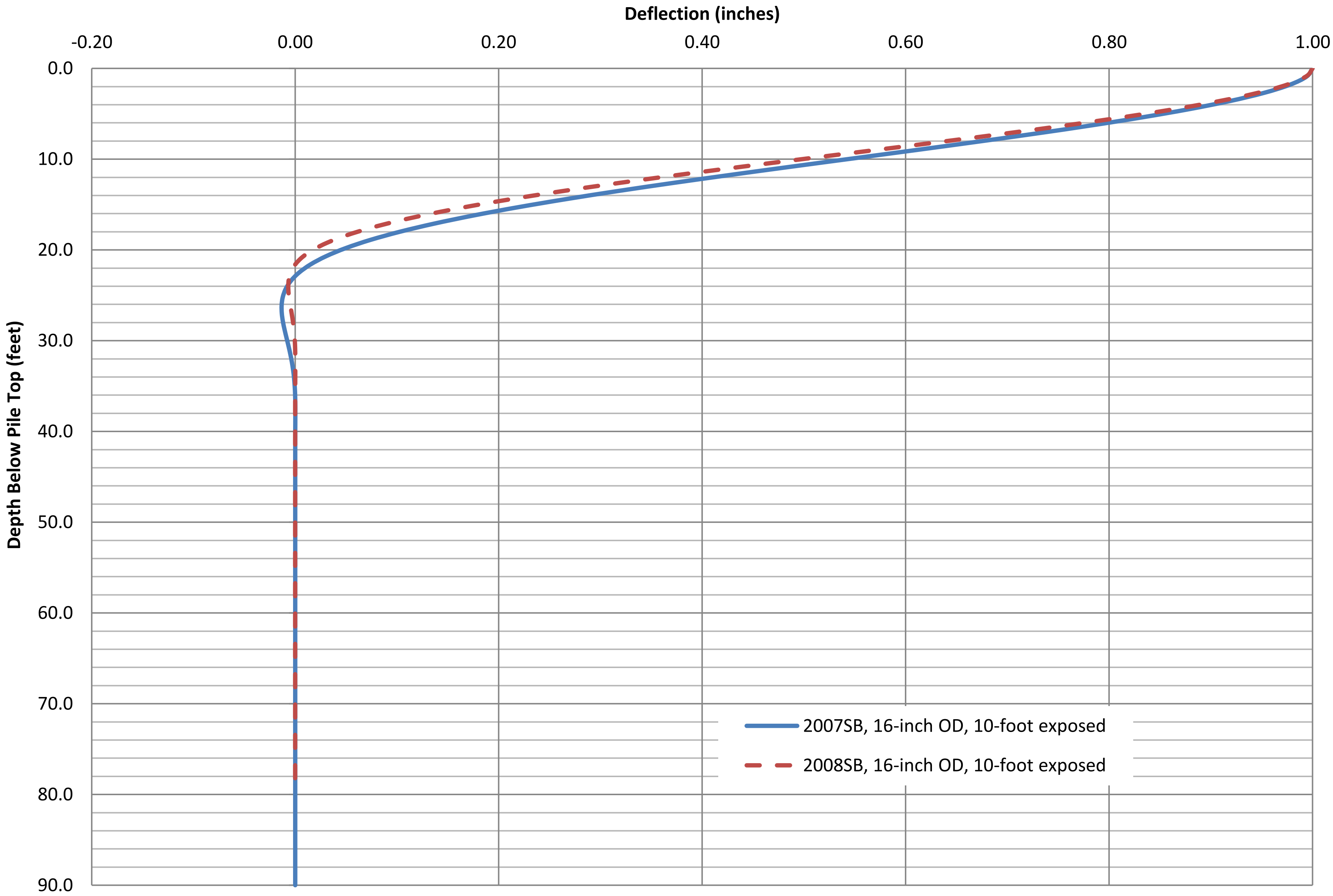
BRAUN INTERTEC

Minnetonka/Hopkins Crossing
Boring: 2011SB
16.0-inch Closed Ended Pipe Pile

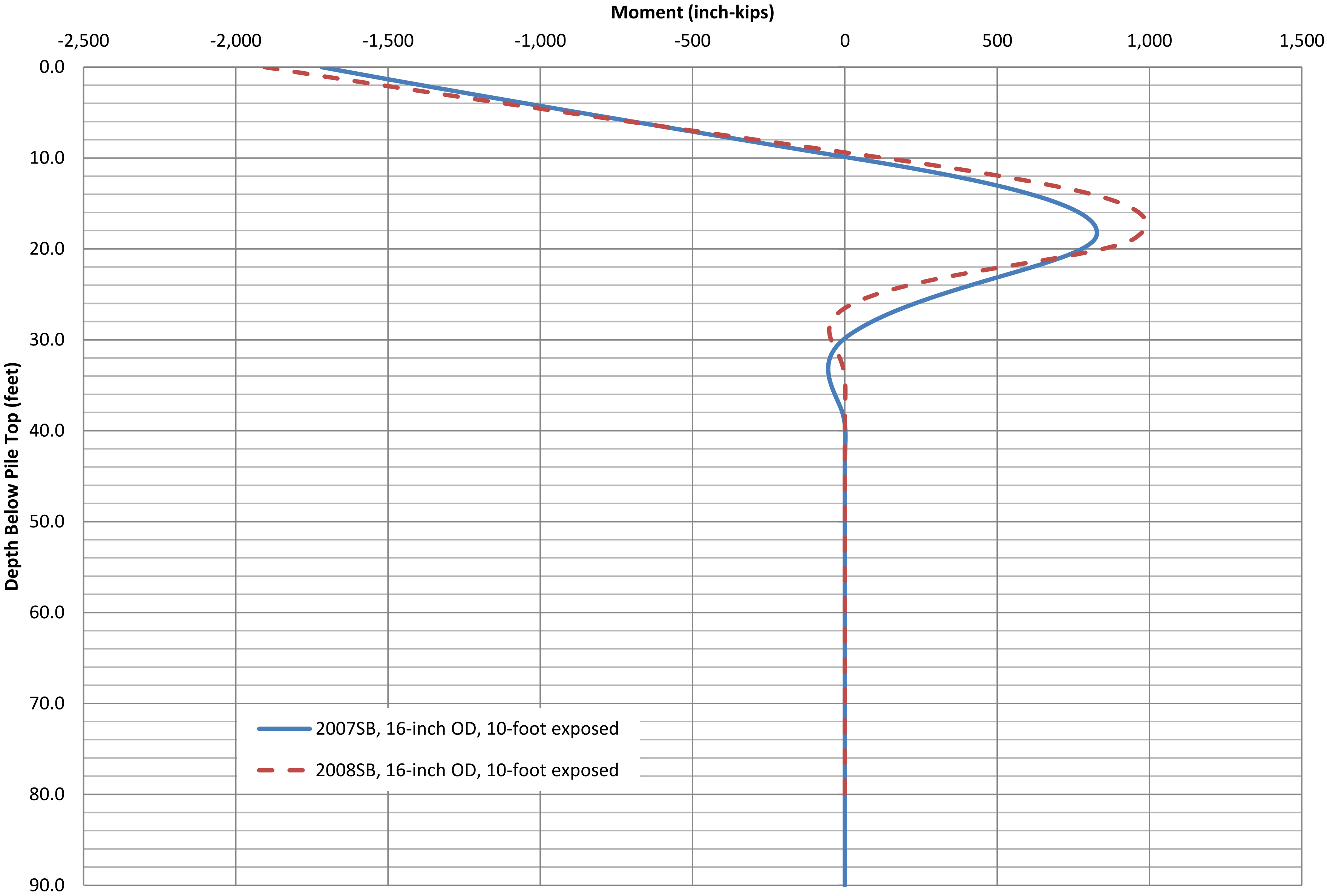


Braun Project No. BL-13-00213

Lateral Analysis Results - Deflection



Lateral Analysis Results - Moment

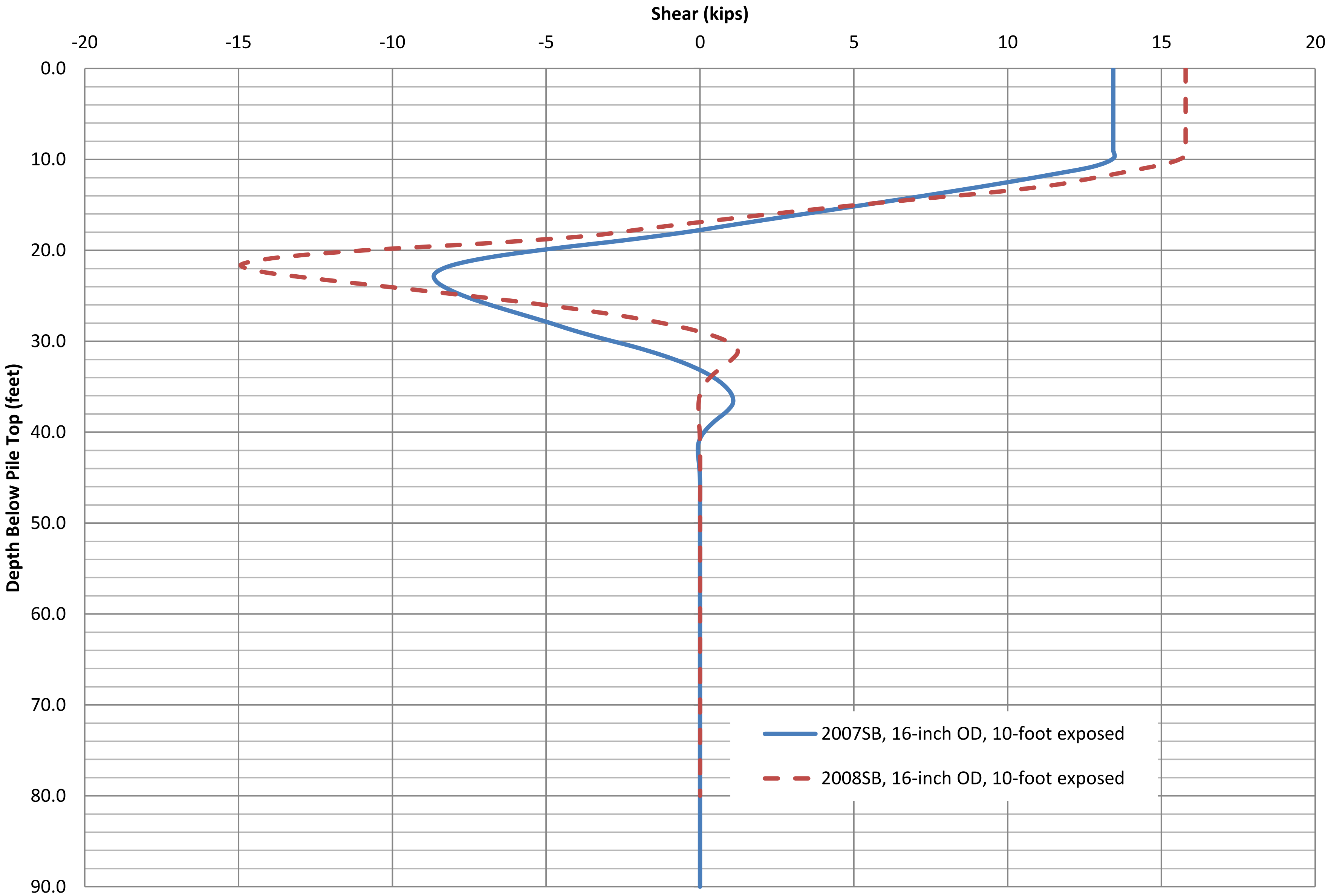


BL-13-00213
5/29/2014

Southwest LRT
Minnetonka Hopkins Bridges

BRAUN
INTERTEC

Lateral Analysis Results - Shear

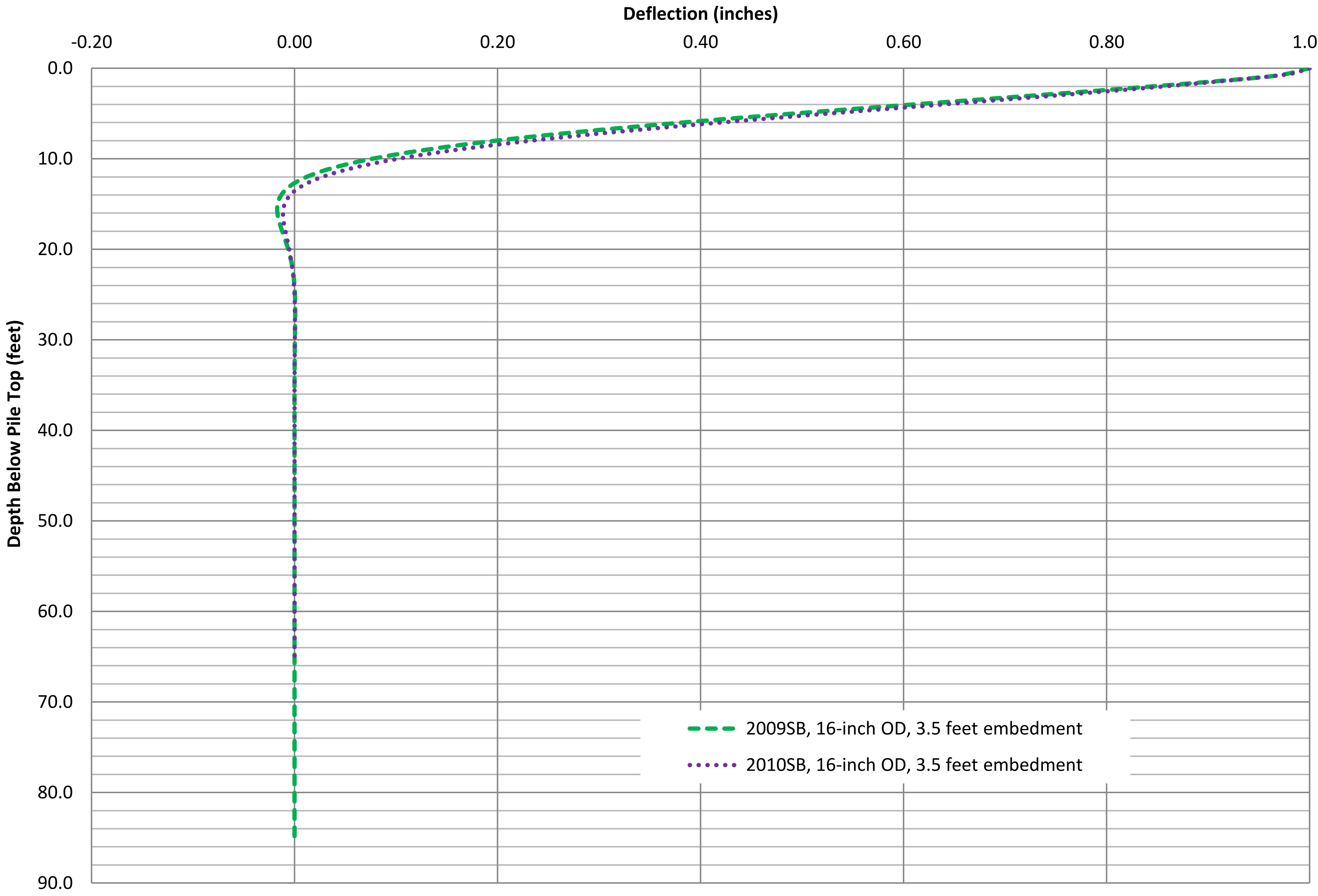


BL-13-00213
5/29/2014

Southwest LRT
Minnetonka Hopkins Bridges

BRAUN
INTERTEC

Lateral Analysis Results - Deflection

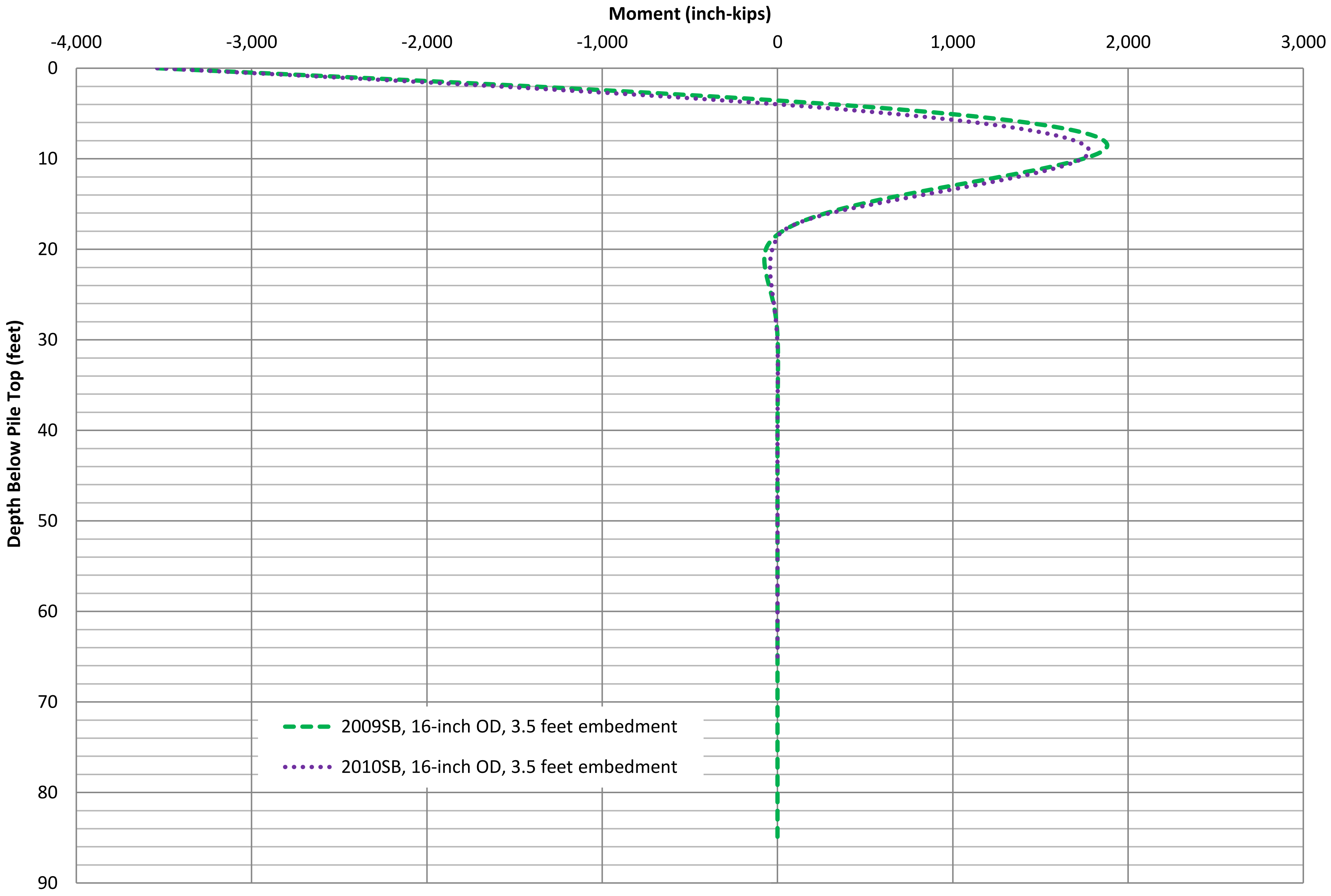


BL-13-00213
5/29/2014

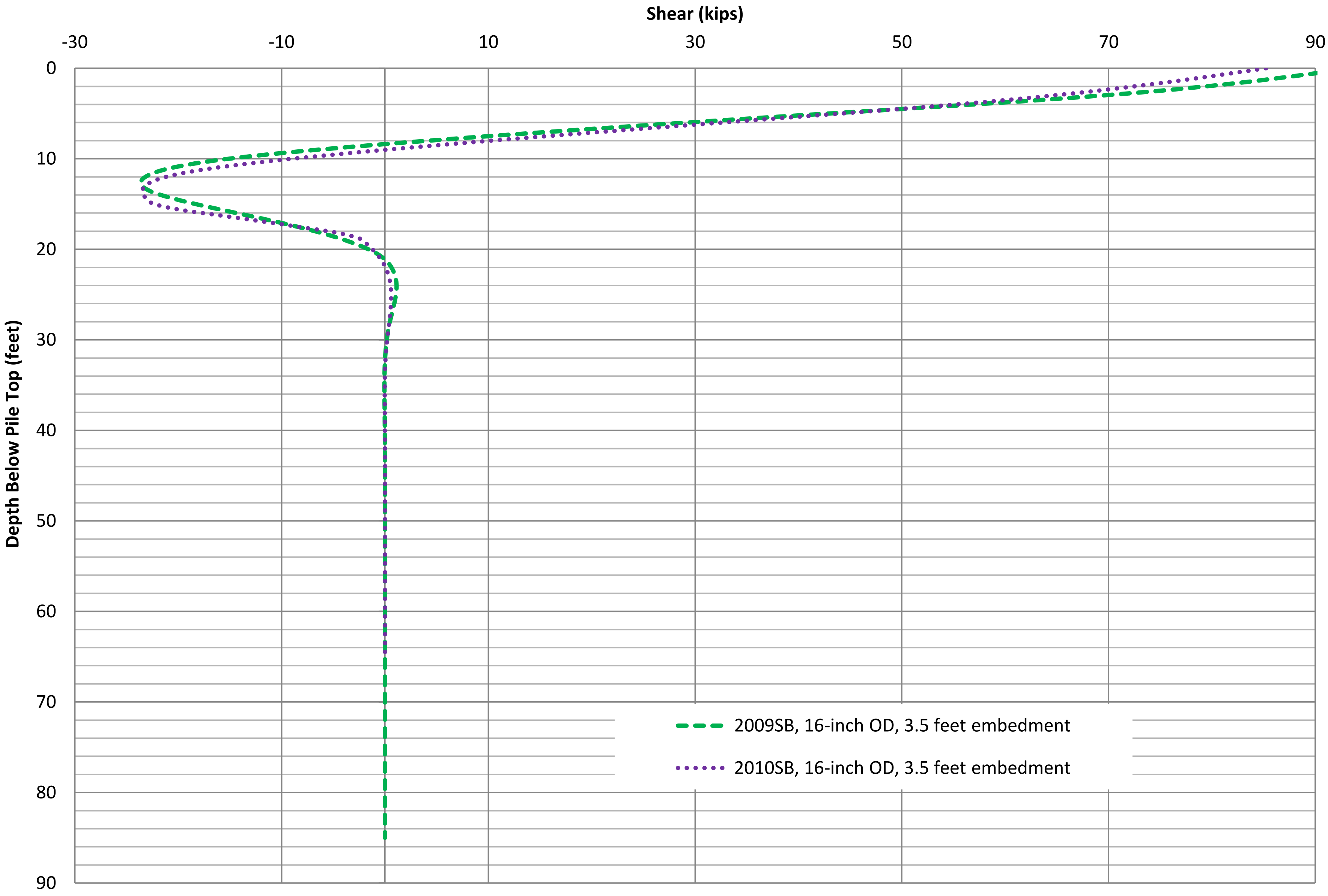
Southwest LRT
Minnetonka Hopkins Bridges

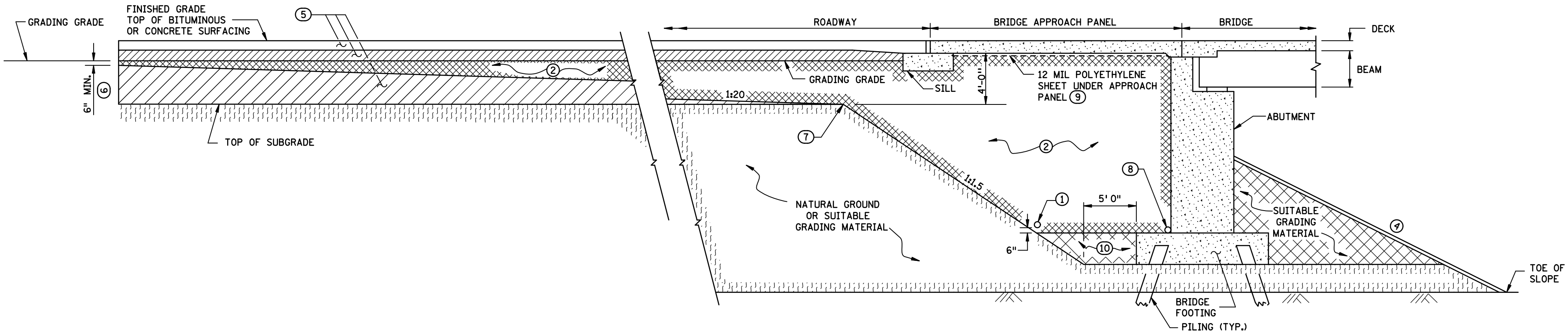
BRAUN
INTERTEC

Lateral Analysis Results - Moment



Lateral Analysis Results - Shear

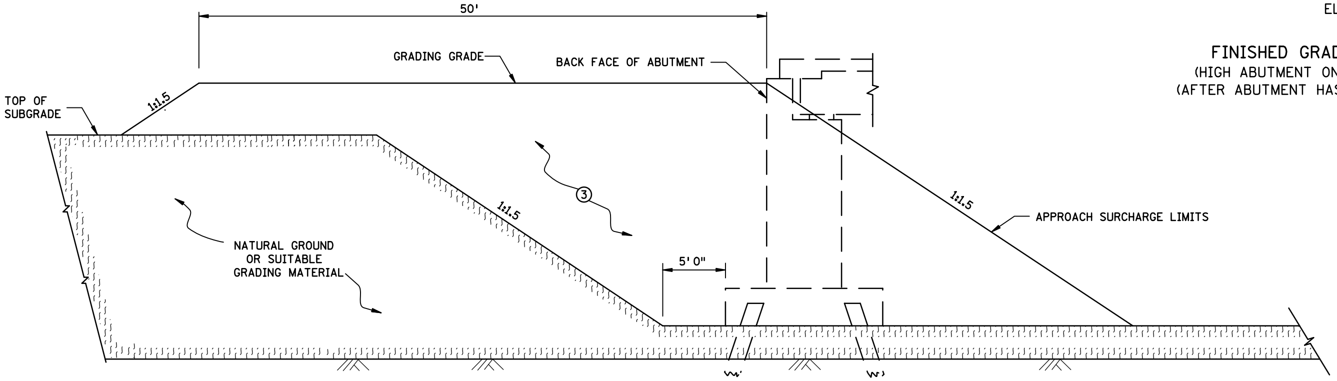




ELEVATION

FINISHED GRADING SECTION

(HIGH ABUTMENT ON PILING SHOWN)
(AFTER ABUTMENT HAS BEEN CONSTRUCTED)



ELEVATION

ROUGH GRADING SECTION

(PRIOR TO ABUTMENT CONSTRUCTION)

NOTES:

① SUBSURFACE PIPE DRAIN. SEE GRADING PLAN FOR DETAILS. FURNISH AND INSTALL IF SHOWN IN GRADING PLAN.

② QUANTITY OF SELECT GRANULAR MATERIAL MODIFIED 10% IS BASED ON DIMENSIONS SHOWN, AND PAYMENT IS BASED ON THIS QUANTITY. SELECT GRANULAR MATERIAL MODIFIED 10% SHALL COMPLY WITH SPEC. 3149.2B2, MODIFIED TO 10% OR LESS PASSING THE NUMBER 200 SIEVE. SEE GRADING PLAN FOR QUANTITY. IF THE CONTRACTOR CHOOSES TO INCREASE DIMENSIONS IN ORDER TO FACILITATE CONSTRUCTION OPERATIONS, ANY QUANTITY INCREASES SHALL BE CONSIDERED INCIDENTAL.

③ PLACE ABUTMENT APPROACH SURCHARGE MATERIAL PRIOR TO ABUTMENT CONSTRUCTION. AFTER COMPLETION OF SURCHARGE WAITING PERIOD, REMOVE SURCHARGE AND EXISTING NATURAL GROUND OR SUITABLE GRADING MATERIAL TO THE LIMITS SHOWN IN "ROUGH GRADING SECTION" ABOVE, PRIOR TO ABUTMENT CONSTRUCTION. SEE BRIDGE PLANS AND SPECIAL PROVISIONS FOR ABUTMENT APPROACH SURCHARGE REQUIREMENT AND PAYMENTS.

④ SEE BRIDGE PLANS FOR SLOPE AND SLOPE PROTECTION.

⑤ SEE GRADING PLANS FOR TYPE OF MATERIAL.

⑥ GRADING TO BE SQUARED OFF ON SKEWED BRIDGES.

⑦ TOP OF 1:1.5 SLOPE (FORMS A LINE PARALLEL TO END OF BRIDGE).

⑧ SUBSURFACE PIPE DRAIN. FURNISH AND INSTALL AT TOP OF BRIDGE FOOTING IF BRIDGE DETAIL B910 IS INCLUDED ON BRIDGE PLAN.

⑨ IF THE APPROACH PANEL IS TIED TO THE ABUTMENT WITH REINFORCEMENT BARS, PLACE 12 MIL POLYETHYLENE SHEETING (OR TWO LAYERS OF OF 6 MIL) UNDER THE LIMITS OF THE APPROACH PANEL TO ALLOW THE PANEL TO MOVE LONGITUDINALLY ON THE GRADE. SHEETING IS INCIDENTAL.

⑩ SUITABLE GRADING MATERIAL SHALL HAVE SUITABLE MOISTURE CONTENT DURING PLACEMENT AND SHALL BE COMPACTED PER SPEC. 2105. SELECT GRANULAR MATERIAL MODIFIED 10% MAY BE USED IN LIEU OF SUITABLE GRADING MATERIAL.

STANDARD SHEET NO.
5-297.233 (1 OF 2)
STANDARD APPROVED:
AUGUST 1, 2011

TITLE:
BRIDGE ABUTMENT APPROACH TREATMENT
FOR ABUTMENT ON FOOTING

STATE PROJ. NO. (TH) SHEET NO. OF SHEETS

BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	**Group Name** [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	**GW**	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	**GP**	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	**GM**	Silty gravel [d f g]
			Fines classify as CL or CH	**GC**	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	**SW**	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	**SP**	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	**SM**	Silty sand [f g h]
			Fines classify as CL or CH	**SC**	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above “A” line [j]	**CL**	Lean clay [k l m]
			$PI < 4$ or plots below “A” line [j]	**ML**	Silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OL**	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above “A” line	**CH**	Fat clay [k l m]
			PI plots below “A” line	**MH**	Elastic silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OH**	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			**PT**	Peat

a. Based on the material passing the 3-in (75mm) sieve.

b. If field sample contained cobbles or boulders, or both, add “with cobbles or boulders or both” to group name.

c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

d. If soil contains ≥15% sand, add “with sand” to group name.

e. Gravels with 5 to 12% fines require dual symbols:

GW-GM	well-graded gravel with silt
GW-GC	well-graded gravel with clay
GP-GM	poorly graded gravel with silt
GP-GC	poorly graded gravel with clay

f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

g. If fines are organic, add “with organic fines” to group name.

h. If soil contains ≥ 15% gravel, add “with gravel” to group name.

i. Sands with 5 to 12% fines require dual symbols:

SW-SM	well-graded sand with silt
SW-SC	well-graded sand with clay
SP-SM	poorly graded sand with silt
SP-SC	poorly graded sand with clay

j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

k. If soil contains 10 to 29% plus No. 200, add “with sand” or “with gravel” whichever is predominant.

l. If soil contains ≥ 30% plus No. 200, predominantly sand, add “sandy” to group name.

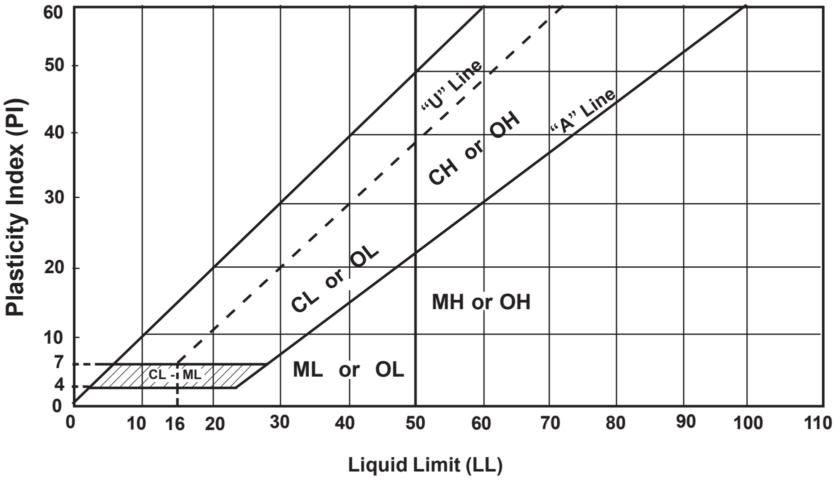
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add “gravelly” to group name.

n. PI ≥ 4 and plots on or above “A” line.

o. PI < 4 or plots below “A” line.

p. PI plots on or above “A” line.

q. PI plots below “A” line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12”
Cobbles	3” to 12”
Gravel	
Coarse	3/4” to 3”
Fine	No. 4 to 3/4”
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below “A” line
Clay	< No. 200, PI ≥ 4 and on or above “A” line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4” or 6 1/4” ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix “ST” (Split Tube). All samples were taken with the standard 2” OD split-tube sampler, except where noted.

Power auger borings were advanced by 4” or 6” diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix “B.”

Hand auger borings were advanced manually with a 1 1/2” or 3 1/4” diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix “H.”

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as “N” value. The sampler was set 6” into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6” increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6” increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Rev. 7/07

BRAUN
INTERTEC

Descriptive Terminology
Cone Penetration Test

This document accompanies Cone Penetration Test Data. Please refer to the Boring Log Descriptive Terminology Sheet for information relevant to conventional v. Cone Penetration Test (CPT) boring logs.

Cone Penetration Test (CPT) sounding was performed in general accordance with ASTM D 5778 and consistent with the ordinary degree of care and skill used by reputable practitioners of the same discipline currently practicing under similar circumstances and in the same locality. No warranty, express or implied, is made.

Since subsurface conditions outside each CPT sounding are unknown, and soil, rock and pore water conditions cannot be relied upon to be consistent or uniform, no warranty is made that conditions adjacent to each sounding will necessarily be the same as or similar to those shown on this log. Braun Intertec is not responsible for any interpretations, assumptions, projections or interpolations of the data made by others.

Pore water pressure measurements and subsequently interpreted water levels shown on CPT logs should be used with discretion as they represent dynamic conditions. Dynamic pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils. In cohesive soils, pore water pressures often take an extended time to reach equilibrium and thus reflect their true field level. Groundwater levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that groundwater is not present to the depth explored, or that a contractor will not encounter groundwater during excavation or construction.

CPT Terminology

CPT............Cone Penetration Test
CPTU.........Cone Penetration Test with Pore Pressure measurements
SCPTU.......Cone Penetration Test with Pore Pressure and Seismic measurements
Piezocone...Common name for CPTU test
Q_T ....normalized cone resistance
B_q.........................pore pressure ratio
F_r..........................normalized friction ratio
σ_{vo}........................overburden pressure
σ'_{vo}.......................effective overburden pressure

q_T TIP RESISTANCE

The resistance at the cone corrected for water pressure. Data is from cone with a 60 degree apex angle and a 15 cm^2 end area.

f_s SLEEVE FRICTION RESISTANCE

The resistance along the sleeve of the penetrometer.

F_r Friction Ratio

Ratio of sleeve friction over corrected tip resistance. $F_r = f_s/q_t$

V_s Shear Wave Velocity

A measure of the speed at which a seismic wave travels through soil/rock.

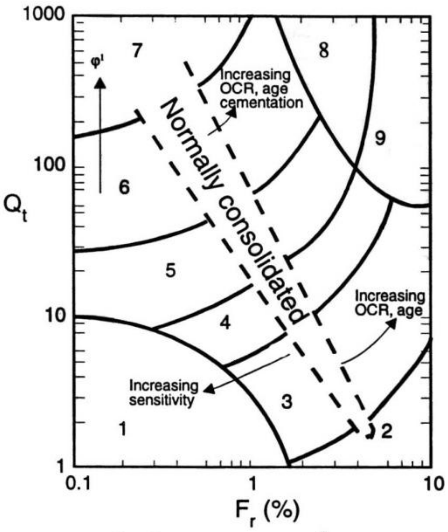
SBT SOIL BEHAVIOR TYPE

Soil Identification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these identification charts are provided as a guide to Soil Behavior Type and should not be used to infer a soil classification based on grain size distribution.

Engineering judgment and comparison with augered borings is especially important in the proper interpretation of CPT data in certain geo-materials.

The following charts provide a Soil Behavior Type for the CPT Data. The numbers corresponding to different regions on the charts represent the following soil behavior types:

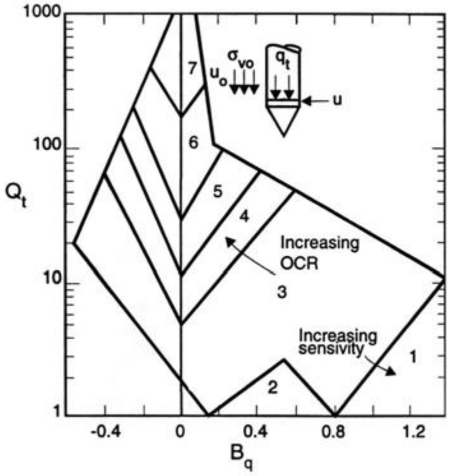
Soil Behavior Type based on friction ratio



$$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad F_r = \frac{f_s}{q_t - \sigma_{vo}} \times 100\%$$

Robertson CPT 1990

Soil Behavior Type based on pore pressure



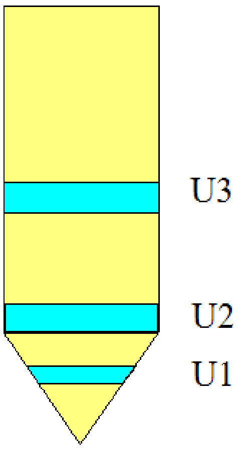
$$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad B_q = \frac{u_2 - u_o}{q_t - \sigma_{vo}}$$

Robertson CPT 1990

1 Sensitive, Fine Grained
2 Organic Soils - Peat
3 Clays - Clay to Silty Clay
4 Silt Mixtures - Clayey Silt to Silty Clay
5 Sand Mixtures - Silty Sand to Sandy Silt
6 Sands - Clean Sand to Silty Sand
7 Gravelly Sand to Sand
8 Very Stiff Sand to Clayey Sand
9 Very Stiff, Fine Grained

U2 PORE WATER MEASUREMENTS

Pore water measurements reported on CPT logs are representative of pore water pressures measured at the U2 location, just behind the cone tip, prior to the sleeve, as shown in the figure below. These measurements are considered to represent dynamic pore water pressures due to the local disturbance caused by the cone tip. Dynamic pore water pressure decay and static pore water pressure measurements are reported on a Pore Water Pressure Dissipation Graph.



Appendix D

Shady Oak Station

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014

Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Geotechnical Evaluation
Proposed Shady Oak Platform Station – 100% Design
STA 2430+00 to STA 2432+75
Southwest LRT, West Segment 3
Eden Prairie, Minnesota

Dear Mr. Demers:

We are pleased to present this Geotechnical Evaluation Report for the Shady Oak Platform Station, located between STA 2430+00 and STA 2432+75 in Hopkins, Minnesota. Details of our results and recommendations are provided in the following report.

This report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for pole foundations for the Overhead Contact System (OCS) will be addressed in a separate report.

A. Project Information

SWLRT is proposing to construct a light rail transit line through the cities of Hopkins, Minnetonka, and Eden Prairie, Minnesota. This Geotechnical Evaluation Report addresses the proposed Shady Oak Platform Station, from approximate track STA 2430+00 to STA 2432+75 in Hopkins, Minnesota. The site is located approximately 500 feet north of the intersection of K-Tel Drive (5th Street South) and 16th Avenue South in Hopkins, Minnesota. The site is relatively flat on the edges with an apparent holding pond located in the center of the proposed station. The site appears to be covered with gravel with some minimal grass covered areas.

AA/EOE

B. Results

B.1. Exploration Logs

B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, penetration resistance testing performed for the project, laboratory test results, and available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

B.2.a. Summary of Borings Taken

The Southwest Light Rail Transit Project Office (SPO) requested subsurface soil and groundwater information in the area of the proposed Shady Oak Platform Station. Two (2) standard penetration soil borings were performed in this area. The boring number, approximate track stationing, surface elevation, and function of the soil boring can be seen in Table 1 below.

Table 1. Soil Boring Information for Shady Oak Station Area

Boring	Approximate Track Station	Surface Elevation	Soil Boring Function
2040SS	2430+00	910.9	Platform Station
2090SS	2043+00	911.0	Platform Station

B.2.b. Geologic Materials

The borings encountered approximately 1 foot of pavement materials overlying existing fill to depths ranging from 7 to 12 feet below the ground surface. The fill appeared to be non-organic and consisted of poorly graded sand with silt (SP-SM), silty sand (SM), and lean clay (CL). Boring 2040SS encountered concrete debris within the existing fill at a depth of about 5 feet below the ground surface.

Beneath the fill, the borings encountered glacially deposited sands over clays to a termination depth of 25 feet below existing grades. The glacial deposits encountered consisted of poorly graded sand (SP), poorly graded sand with silt (SP-SM), silty sand (SM), and lean clay (CL). Penetration resistance values recorded in the glacial sands ranged from 8 to 33 blows per foot (BPF), indicating the sands were in a loose to dense condition. The clays penetration resistance values were at 9 BPF, indicating they were rather stiff.

B.2.c. Groundwater

Groundwater was observed in the borings at depths ranging from 12 1/2 to 17 1/2 feet below the ground surface. These depths correspond to elevations of 893 and 898.

Seasonal and annual fluctuations of groundwater, however, should be anticipated.

C. Basis for Recommendations

C.1. Design Details

C.1.a. Proposed Construction

The Shady Oak Platform Station is approximately 275 feet in length and is located between track STA 2430+00 and STA 2432+75. We have assumed the station will be lightly loaded with ramps on each end leading to an elevated slab-on-grade supported on cast-in-place footings and foundation walls. Pedestrian access to the station such as ramps and/or walks, along with an associated canopy structure will also be constructed as part of the station construction project.

C.1.b. Anticipated Grade Changes

Based on the plan and profile drawing prepared by AECOM, Inc., the top of rail elevation will be at 913 with a finished station grade of 914. Borings 2040SS and 2090SS were completed in the area of the proposed station at elevations 910.9 and 911.

C.1.c. Precautions Regarding Changed Information

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Design and Construction Considerations

Based on the soil borings, the site is generally well suited for station construction of the station using shallow spread footings and ground supported slabs. Potential issues affecting the station construction are as follows:

- Maximum frost depth for the Southwest Light Rail Transit is assumed to be 60 inches (5 feet), therefore, a frost-free section of 5 feet should be provided below the station. To provide this frost-free section at the station location and the adjacent track segments, a subcut of 4 1/2 feet below the top of rail is anticipated. We referenced the above information from the SWLRT Guideway design criteria.

- A stormwater pond is present between the borings within the proposed station construction area. Boring 2040SS also encountered concrete debris within the fill soils at a depth of about 5 feet below the ground surface. The subgrade soils, which we assume will be clayey soils, encountered at the proposed station should be observed by a geotechnical engineer to evaluate the suitability of the soils prior to placement of fill. Soils containing organics or construction debris should be removed from the station subgrade area.

- Clayey soils are considered moisture sensitive and are also susceptible to construction relative disturbances. Therefore, site grading and movement on the site will be somewhat limited during wet weather conditions. Stabilization of the subgrade with gravel (haul roads) may be required.

D. Recommendations

Our recommendations below are for final design of the platform station based on the information provided to us within the preliminary engineering plans. We have also referenced the design guidelines used for the recently completed Central Corridor Light Rail Transit (CCLRT) construction. Recommendations for general Guideway construction will be addressed in a separate report.

D.1. Station Subgrade Preparation

D.1.a. Excavations

We recommend removing vegetation, topsoil, and topsoil fill from below the proposed station area. A 5 foot zone of non-frost susceptible soil should be provided beneath the top of slab elevation (4 1/2 feet below top of rail). We recommend removing the fill soils in Boring 2040SS down to the poorly graded sand (classified as possible fill) at a depth of 7 feet, or elevation 904. At Boring 2090SS we recommend removing the soil down to the proposed bottom of Guideway subcut elevation of 909 and evaluating the fill soils. While fill soils are present to a depth of 899, the penetration resistances appear to indicate some compactive effort was used within the fill. The fill soils should be evaluated in the field by a geotechnical engineer. If the fill soils are found to be unsuitable, they should be removed down to the native soils.

As mentioned above, an existing stormwater pond is present within the footprint of the proposed platform station, with an approximate pond bottom elevation of 896. While soil borings could not be performed within the pond, we anticipate one to three feet of unsuitable soils may require removal to encounter a suitable excavation bottom, however, the depth of unsuitable soils may be greater and should be confirmed during construction by a geotechnical engineer.

Table 2. Excavation Depths and Bottom Elevations to Anticipated Suitable Subgrade

Location	Ground Surface Elevation	Anticipated Excavation Depth (ft)	Corresponding Bottom Elevation
2040SS	910.9	7	904
2090SS	911	1 1/2 - 10*	901 - 908 1/2*
Pond Bottom	896	1 - 3**	893 - 895**

*The condition of the fill should be evaluated upon excavation.

**Excavation depth should be considered approximate and confirmed in the field during construction.

Excavation depths will vary between the borings. Portions of the excavations may also be deeper than indicated by the borings. Contractors should also be prepared to extend excavations in wet or fine-grained soils to remove disturbed bottom soils.
To provide lateral support to replacement backfill, additional required fill and the structural loads they will support, we recommend oversizing (widening) the excavations 1 foot horizontally beyond the outer edges of the platform station for each foot the excavations extend below bottom-of-footing.

D.1.b. Surface Compaction

We recommend soils exposed in the excavation bottoms be surface compacted prior to placement of backfill and fill or structures. Surface compaction should involve at least six passes of a vibratory sheepsfoot compactor (3-foot minimum in diameter). Deflections under the compaction process should be observed for the purpose of evaluating where unstable soils may still exist within the subgrade. Instability would likely be caused by wet, clayey zones or inclusions within the fill. If unstable zones are detected, they should be subcut and replaced with more favorable granular soils.

D.1.c. Selecting Excavation Backfill and Additional Required Fill

D.1.c.1. Subgrade Fill

On-site soils free of organic soil and debris can be considered for reuse as subgrade backfill and fill. The clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces.

Imported material needed to replace excavation spoils or balance cut and fill quantities, may consist of sand, silty sand, clayey sand, sandy lean clay or lean clay. We recommend, however, that the plastic index of these materials not exceed 20.

D.1.c.2. Guideway and Platform Station Fill

Based on the proposed design sections, the Guideway will be composed of 40-inch thick layer of granular material, over a minimum of 12-inches of subballast material. We recommend specifying Guideway fill to meet the requirements of the Minnesota Department of Transportation (MnDOT) 3149.2B2 (Select Granular Borrow) for the granular material, and 3138 (Aggregate Base) for the subballast.

D.1.d. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 6 to 12 inches. We recommend compacting backfill and fill in accordance with the criteria presented below in Table 3.

The relative compaction of utility backfill should be evaluated based on the structure below which it is installed, and vertical proximity to that structure.

Table 3. Material and Compaction Specification for Backfill and Fill

Material	Material Specification	Compaction Specification
Guideway Subgrade Fill	Onsite Material Free of Debris and Organic Material	100% of standard Proctor Density (ASTM D698)
Guideway Select Granular Layer	MnDOT 3149.2B2*	100% of standard Proctor Density (ASTM D698)
Guideway Subballast	MnDOT 3138	MnDOT 2211.3C

*-Select Granular Borrow Modified 10%

D.1.e. Subgrade Drainage

We recommend crowning the subgrade, so excess water entering the Guideway fill can be collected and routed away to a storm sewer. We recommend installing perforated drainpipes at the bottom of the Select Granular drainage layer, outside of the track footprint at points to which the subgrade is directed. We recommend perforated drain pipe used be placed within a Coarse Filter Aggregate material (MnDOT Specification 3149.2H) with a geotextile separation fabric separating it from the Select Granular Material.

D.2. Spread Footings

D.2.a. Embedment Depth

We recommend embedding footings and other footings associated with canopies, stoops or sidewalks 60 inches below the lowest exterior grade.

D.2.b. Subgrade Improvement

Prior to placing fill, forms or reinforcement, we recommend surface compacting the exposed subgrade. If unstable soils are encountered, they should be subcut and replaced with more favorable granular soils.

D.2.c. Net Allowable Bearing Pressure

We recommend sizing spread footings to exert a net allowable bearing pressure of 2,500 pounds per square foot (psf). This value includes a safety factor of at least 3.0 with regard to bearing capacity failure.

D.2.d. Settlement

We estimate that total and differential settlements among the footings will amount to less than one-inch and ½-inch, respectively, under the assumed loads.

D.3. Slab-On-Grade Construction

We anticipate the slab-on-grade for the platform station will be supported by the Guideway fill. We recommend using a modulus of subgrade reaction, k, of 200 pounds per square inch per inch of deflection (pci) to design the slab. Also, we recommend a minimum of 6 inches of aggregate base be provided below the platform slab. We recommend following the compaction criteria provided in Section D.1.d.

D.4. Exterior Slabs

Though not necessarily designed to accommodate dead and live load surcharges or vehicles, exterior slabs can be subjected to both. Settlement of exterior slabs on poorly compacted foundation backfill, utility backfill and other compressible naturally deposits soils or fills can also contribute to unfavorable surface drainage conditions and frost-related damage to the slabs and adjacent structures and pavements. Subgrades supporting exterior slabs should therefore consist of non-organic compacted fill or native soils. To accommodate the potential for exterior slabs bearing unanticipated traffic loads, we recommend using the compaction criteria provided in Section D.1.d. We anticipate that a majority of exterior slabs associated with station construction will be placed on the Guideway fill section. For exterior slabs not supported by the Guideway fill, we recommend a transition zone of at least 5:1 (H:V) to reduce the effects of differential frost heave away from the station.

D.5. Construction Quality Control

D.5.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade preparation and spread footing and slab-on-grade construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations, and the adequacy of required excavation oversizing.

D.5.b. Materials Testing

We recommend density tests be taken in excavation backfill and additional required fill placed below spread footings, slab-on-grade construction, beside foundation walls, and below pavements.

We also recommend slump, air content and strength tests of portland cement concrete.

D.5.c. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed on frozen subgrades. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with a flotation tired-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2-foot intervals to termination depth. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout. Sealing records for those boreholes will be forwarded to the Minnesota Department of Health Well Management Section. Copies of the sealing records follow the Log of Boring sheets in the Appendix.

E.2. Material Classification and Testing

E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars and returned to our facility for review and storage.

E.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM or AASHTO procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled as noted on the boring logs.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

F.3. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these recommendations, please call Josh Kirk at 952.995.2222 jkirk@braunintertec.com or Ray Huber at 952.995.2260 rhuber@braunintertec.com at your convenience.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate-Project Engineer
License Number: 45005

JOSHUA L. KIRK
45005

Reviewed by:

FoR:

Ray A. Huber, PE
Vice President-Principal Engineer

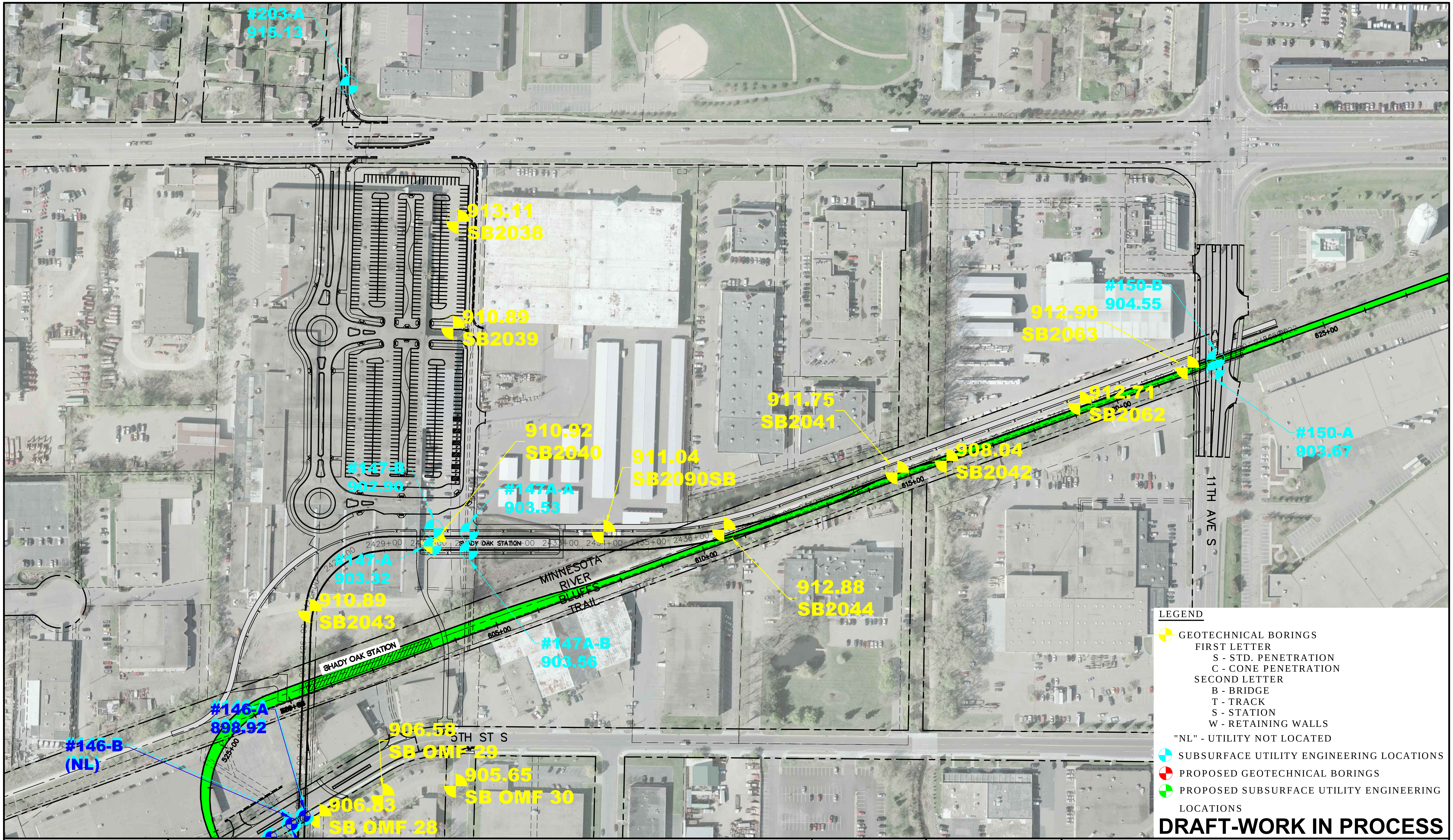
Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Engineering Plan and Profile Page W3-TRL-PPFL-007
Standard Penetration Borings 2040SS and 2090SS
SPT Descriptive Terminology

APPENDIX

Aug. 28, 2014 11:35 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



LEGEND

● GEOTECHNICAL BORINGS
FIRST LETTER
S - STD. PENETRATION
C - CONE PENETRATION
SECOND LETTER
B - BRIDGE
T - TRACK
S - STATION
W - RETAINING WALLS
"NL" - UTILITY NOT LOCATED

● SUBSURFACE UTILITY ENGINEERING LOCATIONS

● PROPOSED GEOTECHNICAL BORINGS

● PROPOSED SUBSURFACE UTILITY ENGINEERING LOCATIONS

DRAFT-WORK IN PROCESS

SOUTHWEST
Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 12 OF 12

IRT: N/A

REV: 0

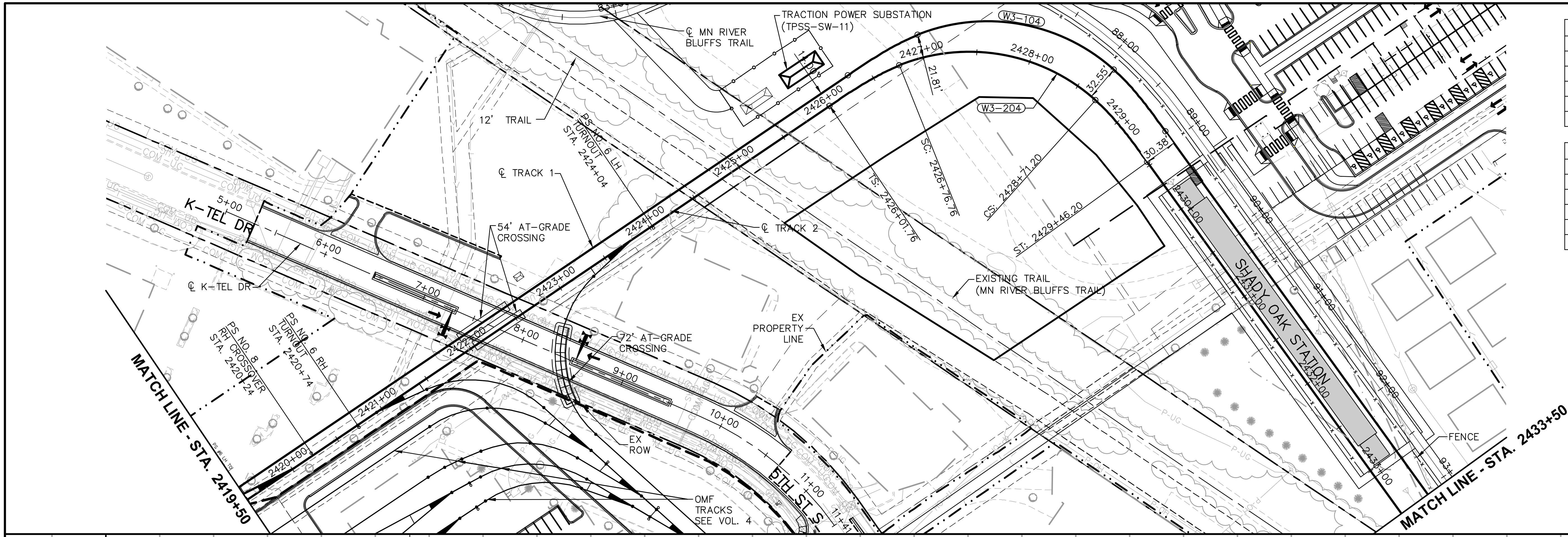
DATE: 06/30/2014

NORTH
0 50 100 200

METROPOLITAN COUNCIL

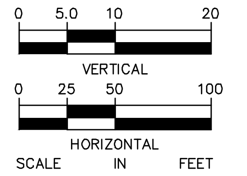
AECOM

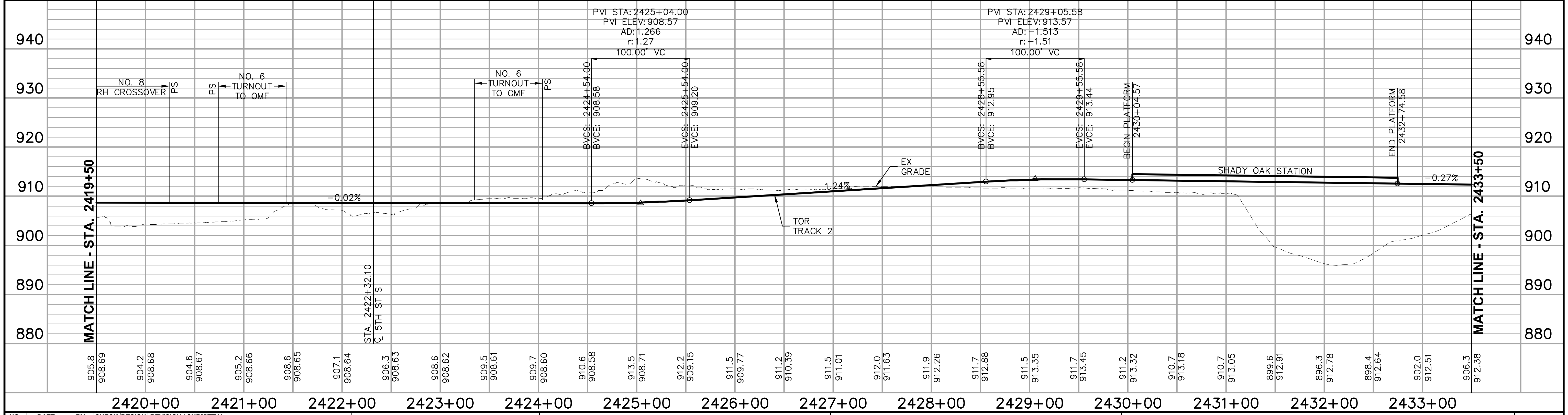
SRF Consulting Group, Inc.



CURVE NO. W3-204
R = 175.00'
Lc = 194.44'
Ls = 75.00'
Ea = 2.25"
Eu = 2.84"
V = 15 MPH

CURVE NO. W3-104
R = 175.00'
Lc = 194.44'
Ls = 75.00'
Ea = 2.25"
Eu = 2.84"
V = 15 MPH





Jun, 13 2014 12:55 pm V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\TRACK\W3-TRK-PLN.dwg By: Konenji

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 3
TRACK
PLAN AND PROFILE
STA. 2419+50 TO STA. 2433+50

DISCIPLINE: TRACK

SHEET NAME: W3-TRK-PPFL-007

SHEET 33 OF 54

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2040SS**

LOCATION: N: 146401.1; E: 490232.5; See attached sketch.

DRILLER: M. Belch

METHOD: 3 1/4" HSA, Autohammer

DATE: **10/3/13**

SCALE: **1" = 4'**

Elev. feet 910.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
910.1	0.8	PAV	4 inches of bituminous over 6 inches of aggregate base.				
903.9	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, with Lean Clay lenses, brown and dark brown, moist. With concrete debris at 5 feet.	6 19			
898.9	12.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, moist. (Possible Fill)	19 19		7	P200=12%
886.9	24.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense to dense. (Glacial Outwash)	33 20 32 28	▽		
884.9	26.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, grayish brown, waterbearing, medium dense. (Glacial Outwash)	12			* Water not observed to cave-in depth of 11 feet immediately after withdrawal of auger.
			END OF BORING. Water observed at 12 1/2 feet with 12 1/2 feet of hollow-stem auger in the ground. Water observed at 16 feet with 24 1/2 feet of hollow-stem auger in the ground. *				Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 6/6/14 16:24

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2090SS**

LOCATION: N: 146424.6; E: 490617.2;
See attached sketch.

DRILLER: B. Kammermeier	METHOD: 3 1/4" HSA, Autohammer	DATE: **4/24/14**	SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 911.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
910.3	0.8	PAV	3 inches of bituminous over 5 inches of aggregate base.				
904.0	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, dark brown to brown, moist.	23 21		9	
901.0	10.0	FILL	FILL: Lean Clay with Sand, with Gravel, dark brown, wet.	6		24	
899.0	12.0	SM	SILTY SAND, fine- to medium-grained, dark brown, moist. (Possible Fill)	6		11	
894.0	17.0	SP	POORLY GRADED SAND, fine- to medium-grained, light brown to brown, moist, medium dense. (Glacial Outwash) Gravel at 15 feet.	26 19		5	P200=5%
886.0	25.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	8 14	∇		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
885.0	26.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff. (Glacial Till)	9			
			END OF BORING. Water observed at 17 1/2 feet while drilling. Water observed at 19 feet with 24 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth at 15 feet immediately after withdrawal of auger.*				*Boring immediately backfilled with bentonite grout.

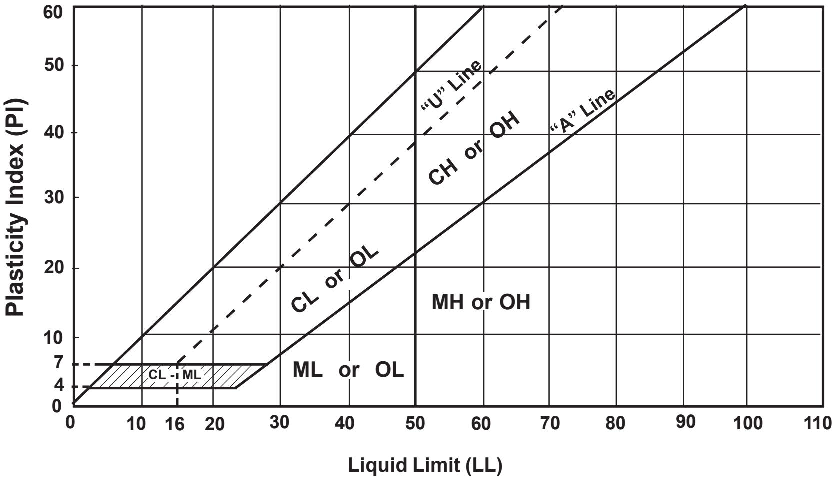
BRAUN
INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	**GW**	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	**GP**	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	**GM**	Silty gravel [d,f,g]
			Fines classify as CL or CH	**GC**	Clayey gravel [d,f,g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	**SW**	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	**SP**	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	**SM**	Silty sand [f,g,h]
			Fines classify as CL or CH	**SC**	Clayey sand [f,g,h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	**CL**	Lean clay [k,l,m]
			PI < 4 or plots below "A" line [j]	**ML**	Silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OL** **OL**	Organic clay [k,l,m,n] Organic silt [k,l,m,o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	**CH**	Fat clay [k,l,m]
			PI plots below "A" line	**MH**	Elastic silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OH** **OH**	Organic clay [k,l,m,p] Organic silt [k,l,m,q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			**PT**	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   - GW-GM well-graded gravel with silt
   - GW-GC well-graded gravel with clay
   - GP-GM poorly graded gravel with silt
   - GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   - SW-SM well-graded sand with silt
   - SW-SC well-graded sand with clay
   - SP-SM poorly graded sand with silt
   - SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Rev. 7/07

Appendix E

Track STA 2413+65 to STA 2450+22

BRAUN
INTERTEC

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Preliminary Geotechnical Evaluation
General Track, RTW-W313, RTW-W314, and Traction Power Substation – 50% Design
STA 2413+65 to STA 2450+22
Southwest LRT, West Segment 3
Minnetonka and Hopkins, Minnesota

Dear Mr. Demers:

Braun Intertec has completed the preliminary geotechnical evaluation for the proposed track, retaining walls, and traction power substation (TPSS-SW-11) construction between STA 2413+65 and STA 2450+22. The following sections provide preliminary information regarding our opinions, methods, and preliminary recommendations for general track, RTW-W313, RTW-W314, and TPSS-SW-11 construction in this area.

This preliminary report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for the Shady Oak Platform Station and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project Description

The west segment of the SWLRT project is proposing to construct a light rail transit line through Hopkins, Minnetonka, and Eden Prairie, Minnesota. This Geotechnical Evaluation Report addresses the proposed light rail transit line track, retaining wall, and traction power substation construction between STA 2413+65 and STA 2450+22 in Hopkins.

B. Subsurface Investigation Summary

B.1. Geologic Profile

Braun Intertec performed 16 soil borings within the boundaries noted above (OMF-13, OMF-15, OMF-3, OMF-19, OMF-21, 2011SB, OMF-24, OMF-28, 2043SB, 2040SS, 2090SS, 2044ST, 2041SB, 2042SB, 2062ST, 2063ST). Table 1 below provides the approximate track stationing and surface elevations at each of the performed soil boring locations.

Table 1. Boring Location and Elevation

Boring	Approximate Track Station	Boring Surface Elevation (ft)
OMF-13	2414+00	899.4
OMF-15	2415+25	899.5
OMF-3	2416+25	900.1
OMF-19	2417+75	901.0
OMF-21	2418+50	901.2
2011SB	2418+60	902.6
OMF-24	2415+50	902.1
OMF-28	2422+00	906.8
2043ST	2426+75	910.9
2040SS	2430+00	910.9
2090SS	2434+00	911.0
2044ST	2436+75	912.9
2041SB	2441+00	911.8
2042SB	2442+00	908.0
2062ST	2445+25	912.7
2063ST	2448+00	913.0

Logs of the borings are included in the Appendix, along with a boring location sketch showing their locations.

A description of the soils encountered is described below, starting at the surface.

B.1.a. Pavements

Borings OMF-3, OMF-15, OMF-13, OMF-19, OMF-21, OMF-24, OMF-28, 2040SS, 2090SS, 2062ST, and 2063ST encountered various amounts of bituminous pavement and/or aggregate base. A summary of the encountered pavement section is provided in Table 2 below.

Table 2. Encountered Pavement Section

Boring	Approximate Track Station	Approximate Bituminous Thickness (inches)	Approximate Aggregate Base Thickness (inches)
OMF-13	2414+00	3	5 1/2
OMF-15	2415+25	4	3
OMF-3	2416+25	4	--
OMF-19	2417+75	8	10
OMF-21	2418+50	7	8
OMF-24	2415+50	6	5
OMF-28	2422+00	5 1/4	8 3/4
2040SS	2430+00	4	6
2090SS	2434+00	3	5
2062ST	2445+25	--	6
2063ST	2448+00	--	6

The majority of these borings are not along the proposed alignment, and the above noted pavement sections will not be encountered at the track locations.

B.1.b. Topsoil Fill

Borings 2011SB and 2043ST encountered 6 to 24 inches of topsoil fill at the surface, consisting of silty sand (SM).

B.1.c. Fill

Fill was encountered beneath the pavement materials and topsoil fill at Borings OMF-13, OMF-15, OMF-3, OMF-19, OMF-21, 2011SB, OMF-28, 2043ST, 2040SS, 2099SS, 2062ST, 2063ST, and at the surface of Borings 2044ST, 2041SB, and 2042SB. The fill consisted of poorly graded sand with silt (SP-SM), silty sand, clayey sand (SC), lean clay with sand (CL), and sandy lean clay (CL). Table 3 below illustrates the depth and elevations of fill materials encountered.

Table 3. Fill Depths at Boring Locations

Boring	Boring Elevation (ft)	Approximate Depth of Fill (ft)	Elevation at Bottom of Fill (ft)
OMF-13	899.4	6	893
OMF-15	899.5	4	895 1/2
OMF-3	900.1	2	898
OMF-19	901.0	2	899
OMF-21	901.2	4	897
2011SB	902.6	9	893 1/2
OMF-24	902.1	1	901
OMF-28	906.8	7	900
2043ST	910.9	7	904
2040SS	910.9	12	899
2090SS	911.0	12	899
2044ST	912.9	14	899
2041SB	911.8	17	895
2042SB	908.0	17	891
2062ST	912.7	17	896
2063ST	913.0	14	899

B.1.d. Swamp Deposits

Swamp deposits were encountered directly below the fill in Borings OMF-13, OMF-15, OMF-3, OMF-19, OMF-21, 2044ST, 2041SB, 2042SB, 2062ST, and 2063ST and consisted primarily of peat (PT) with occasional layers of silty sand, silt (ML), lean clay (CL), organic clay (OL), and organic silt (OH). The swamp deposited layers extended to variable depths ranging from 2 to 34 feet below existing grade, corresponding to elevations ranging from 899 to 874.

B.1.e. Glacial Deposits

Glacially deposited soils were encountered beneath the topsoil fill, fill, and swamp deposits at all of the boring locations, extending to the termination depth of the borings. The glacial soils consisted of outwash and tills with classifications including poorly graded sand (SP), poorly graded sand with silt, silty sand, clayey sand, and sandy lean clay. The till soils contained traces of gravel, while the outwash sands generally contained gravel. Glacial soils have the potential to contain cobbles and boulders.

B.1.f. Penetration Resistance Testing

The results of our penetration resistance testing from the borings are summarized in Table 4 below. Comments are provided to qualify the significance of the results.

Table 4. Penetration Resistance Data

Geologic Material	Classification	Range of Penetration Resistances*	Comments
Fill	SP-SM, SM, SC, CL	4 to 29 BPF	Variable Compaction
Swamp Deposits	PT, OL, OH, SP-SM, SM, ML, CL	2 to 14 BPF	Slightly to moderately consolidated
Glacial Deposits	SP, SP-SM, SM	3 to 100 BPF	Locally very loose to very dense, generally loose to medium dense
	SC, CL	6 to 37 BPF	Locally medium to hard, generally medium to very stiff

*BPF – blows per foot

B.2. Summary of Water Level Measurements

Groundwater was observed in all of the borings during the time of drilling operations. Groundwater elevations noted on the boring logs at the time of drilling range between elevations 888 and 898 1/2 feet above Mean Sea Level (MSL). Seasonal and annual fluctuations of groundwater, however, should be anticipated.

B.3. Interpretation of Water Level

The water level observations in the borings indicated groundwater was observed between 890 1/2 and 899 1/2 feet MSL, however, the boreholes were only open for a short period of time and it is unlikely that sufficient time was available for groundwater to rise to its hydrostatic level. Groundwater was measured or estimated at the time of drilling operations to be located at the depths shown below in Table 5.

Table 5. Groundwater Summary

Location	Surface Elevation (ft)	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
OMF-13	899.4	6 1/2	893 1/2
OMF-15	899.5	3 1/2	896
OMF-3	900.1	4	896
OMF-19	901	6	895
OMF-21	901.2	6 1/2	894 1/2
2011SB	902.6	12	890 1/2

Location	Surface Elevation (ft)	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
OMF-24	902.1	4	898
OMF-28	906.8	7 1/2	899 1/2
2043ST	910.9	12	899
2040SS	910.9	12 1/2	898 1/2
2090SS	911	17 1/2	893 1/2
2044ST	912.9	22 1/2	890 1/2
2041SB	911.8	22 1/2	889 1/2
2042SB	908	20	888
2062ST	912.7	17	896
2063ST	913	22	891

-Seasonal and Annual Fluctuations in groundwater level should be anticipated.

C. Basis for Recommendations

C.1. Design Details

C.1.a. Anticipated Grade Changes

The existing ground surface elevation varies throughout the alignment requiring both cuts and fill to reach proposed top of rail elevations. In most areas, cut and fills will be less than 8 feet, however deeper fills are proposed at the north abutment of the Hopkins-Minnetonka Bridge (16 feet) and to fill in a pond near the Shady Oak Station (16 feet).

C.1.b. Retaining Wall (RTW-W313 and RTW-W314) Construction

Wall RTW-W313 is located along the west side and RTW-W314 is located along the east side of the proposed SWLRT alignment, extending from STA 2413+7 to STA 2417+50, for wall lengths of 377 feet. The two walls are proposed to retain the track embankment and act as wing walls to the north abutment of the Hopkins-Minnetonka Bridge, with exposed wall heights of 8 to 22 feet and total wall heights of 11 to 26 feet.

C.1.c. Traction Power Substation (TPSS-SW-11) Construction

According to the plan and profile drawings, a traction power substation (TPSS) is proposed adjacent to the track alignment on the west side of the track near STA 2426+00.

C.1.d. Precautions Regarding Changed Information

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Design and Construction Considerations

Based on information from the design team, we have assumed a service limit state for settlement of the track and retaining walls to be no more than one-inch.

Swamp deposit soils were encountered beneath the proposed track embankment in two areas addressed in this report. To properly support the track and to control settlement, these soils will need to be removed and replaced. Based on the construction limits, shallow groundwater levels, and proximity of open water (ponds), an extensive dewatering program and sheeting will be required to facilitate a soil correction. The extent of the dewatering program should be further evaluated so a condtion is not created where the drawdown necessary to facilitate construction will result in consolidation and settlement of soils away from construction, that may affect neighboring structures.

Similarly, retaining walls RTW-W313 and RTW-W314 are located in areas where swamp deposits are present. To properly support the walls, the soils beneath the foundations will need to be removed and replaced, or an intermediate or deep foundation system could be used to support the walls.

As an alternative to performing a soil correction between STA 2413+65 and STA 2417+50, the north abutment of the Hopkins-Minnetonka Bridge could be extended past the area of organic soils and the limits of the pond to near STA 2420+00, where it appears organic soils are not present and embankment fill heights are reduced.

Organic soils were also noted near STA 2440+00, extending to the end of the West segment. While the majority of the proposed construction will take place on the existing rail embankment with minimal raises in grade (generally less than 2 feet, no more than 4 feet), we anticipate the limits of the new construction will extend laterally beyond the existing embankment. Placing fill outside of the existing embankment will cause settlement of the underlying organic soils that have not been consolidated by the existing embankment, resulting in differential settlement. The use of lightweight fill material may be needed in these areas to reduce the effects of differential settlement.

D. Recommendations

In accordance with our findings, we prepared the following preliminary recommendations for the design and construction of the proposed track, retaining walls, and TPSS-SW-11. We recommend performing additional borings prior to final design.

D.1. Guideway Subgrade Preparation

Throughout the track profile, a five-foot section below the proposed top of rail is anticipated for construction of the Guideway. The following subsections provide preliminary recommendations to prepare the ground supported track subgrades. We recommend additional borings be performed prior to final design, especially between the north abutment of the Hopkins-Minnetonka Bridge and STA 2420+00 and from STA 2440+00 to the end of the West segment to better define the limits of buried swamp deposits.

D.1.a. Excavations (Track Construction)

D.1.a.1. STA 2413+65 to STA 2420+00

Borings OMF-13, OMF-15, OMF-3, OMF-19, and OMF-21, performed between STA 2413+65 and STA 2418+50, encountered fill over swamp deposits to depths of 6 to 22 feet below the surface. Based on the depth of the swamp deposits, groundwater levels, and construction site limitations, it is our opinion that an excavate/backfill program will be required to meet the service limit state for settlement. A soil correction will be extremely difficult in this area, and will require extensive dewatering and retention systems to retain both soils and water from the pond near STA 2415+00.

We recommend the design team consider extending the Hopkins-Minnetonka Bridge to near STA 2420+00. Adding length to the bridge will improve the long term performance of the track and would eliminate settlement issues of the north approach embankment for the Hopkins-Minnetonka Bridge by moving the abutment and wing walls to more suitable soils and reducing the embankment heights. The exact additional length of bridge will require additional drilling. Based on our current boring program, we recommend assuming the new abutment would be near STA 2420+00.

D.1.a.2. STA 2420+00 to STA 2430+05 and STA 2432+75 to STA 2436+50

We recommend excavating the soils down to the proposed bottom of subgrade elevation. We expect a combination of native soils and previously placed fill will be encountered at the anticipated track subgrade. If fill is encountered at the track subgrade, we recommend evaluating the condition of the fill during construction. If soft or otherwise unsuitable soils are encountered, additional subcuts may be necessary and should be determined in the field at the time of construction.

Areas of the track where borings have not been performed may contain pockets of organic soils or debris-laden fill. We recommend removing all vegetation, topsoil, and any soft or wet soils encountered at the surface. We also recommend removing any large debris encountered within the fill. If soft or otherwise unsuitable soils are encountered at subgrade elevations, additional excavations may be necessary. Table 6 below provides our recommended excavation depths the boring locations.

Table 6. Recommended Guideway Subgrade Correction Depths

Boring	Boring Elevation (ft)	Guideway Subgrade Elevation (ft)	Recommended Excavation Depth Below Subgrade (ft)	Excavation Bottom Elevation (ft)
2011SB	902.6	902	2*	900 1/2
OMF-24	902.1	902	1	901
OMF-28	906.8	903	--	902
2043ST	910.9	904	2	904
2040SS	910.9	906	2*	904
2090SS	911.0	906	--	906

*-organic soils and/or construction debris noted on the logs in the existing fill soils

Excavation depths will vary away from the boring locations and could be deeper than indicated in the table above. We recommend a geotechnical engineer or experienced technician working under the supervision of a geotechnical engineer observe the subgrade soils prior to the placement of fill. If pockets of unsuitable fill or soft native soils are encountered, the excavations may extend beyond the depths noted in the table above.

We recommend performing a final boring program for the track alignment to evaluate excavation depths along the alignment and to further evaluate potential fill areas or areas containing possible organics.

D.1.a.3. STA 2436+50 to STA 2450+22

Based on conversations with the design team, we anticipate the proposed track alignments will largely fall within an existing rail embankment, now known as the Minnesota River Bluffs Regional Trail that will result in minimal to no soil correction. We recommend excavating down to the proposed bottom of Guideway subgrade elevation and evaluating the soils exposed in the bottom of the excavation. However, we anticipate the embankments will need to be widened laterally in areas along the proposed alignment. The soils beneath the existing embankment have undergone consolidation and settlement for over 20 years, however, new fill loads placed outside of the embankment will likely result in consolidation of underlying swamps deposits not previously stressed by the existing embankment, resulting in differential settlement between the existing embankment and any new fill. The magnitude of the settlement will be based on the amount of fill placed and the slope extending away from the embankment. To minimize the differential settlement between the existing and new embankments, we recommend using materials for the embankment to produce a zero-net stress increase on the underlying soils. This can be accomplished by subcutting the existing soils to a prescribed depth and replacing them with lightweight fill. Lightweight fill could also be used for new embankment construction.

The lightweight fill should be “keyed” or “benched” into the existing embankment to to reduce the risk of fill instability. The extent of the lightweight fill should be determined by additional soil borings. Expanded Polystyrene (EPS) foam blocks are the most likely source of lightweight fill be to be used. However, these block cannot be placed beneath the groundwater level and can be prone to chemical deterioration should any environmental contamination be present. Additional fill options or foundation types may be explored upon final design and will be addressed in our final report.

D.1.b. Excavation Dewatering

We recommend removing groundwater from the excavations. Sumps and pumps can be considered for excavations in low-permeability silt- and clay-rich soils, or where groundwater can be drawn down 2 feet below the bottoms of excavations in more permeable sands. In large excavations, or where groundwater must be drawn down more than 2 feet, a well contractor should review our logs to determine if wells are required, how many will be required, and to what depths they will need to be installed. Care should be taken when developing a dewatering program to minimize the potential for drawdown of the water table away from the construction area, which could results in consolidation and settlement of soils and potential damage to structures.

Seasonal and annual precipitation will influence the amount and extent of groundwater that will be encountered.

D.1.c. Selecting Excavation Backfill and Additional Required Fill

D.1.c.1. General Subgrade Fill

We recommend fill for the new embankment placed at or below the water level of the pond consist of sand having less than 70 percent of the particles by weight passing a #40 sieve and less than 10 percent of the particles by weight pass a #200 sieve to a height two feet above groundwater elevations. Sand meeting this gradation will need to be imported to the site.

On-site soils free of organic soil and debris can be considered for reuse as subgrade backfill and fill. The clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces.

Imported material needed to replace excavation spoils or balance cut and fill quantities, may consist of sand, silty sand, clayey sand, sandy lean clay or lean clay. We recommend, however, that the plastic index of these materials not exceed 20.

D.1.c.2. Guideway Fill

Based on the proposed design sections, the Guideway will be composed of 40-inch thick layer of granular material, over a minimum of 12-inches of subballast material. We recommend specifying Guideway fill to meet the requirements of the Minnesota Department of Transportation (MnDOT) 3149.2B2 (Select Granular Borrow) for the granular material, and 3138 (Aggregate Base) for the subballast.

D.1.d. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 6 to 12 inches. We recommend compacting backfill and fill in accordance with the criteria presented below in Table 7. The relative compaction of utility backfill should be evaluated based on the structure below which it is installed, and vertical proximity to that structure.

Table 7. Material and Compaction Specification for Backfill and Fill

Material	Material Specification	Compaction Specification
Subgrade Fill	Onsite Material Free of Debris and Organic Material or Imported Soil	100% of standard Proctor Density (ASTM D698)
Retaining Wall Backfill	MnDOT 3149.2D2	MnDOT 2105.3F
Guideway Select Granular Layer	MnDOT 3149.2B2	100% of standard Proctor Density (ASTM D698)
Guideway Subballast	MnDOT 3138	MnDOT 2211.3C

D.2. Retaining Walls RTW-W313 and RTW-W314

As mentioned previously, RTW-W313 and RTW-W314 are proposed to support the track embankment starting at the north abutment of the Hopkins-Minnetonka Bridge and extending to STA 2417+50. Emankment heights associated with the proposed walls will extend up to 22 feet above existing grade.

Based on the proposed wall heights and the raises in grade, the service limit for settlement will be exceeded, requiring soil corrections beneath the walls, and a construction delay for the embankment.

Given the limits of construction, the shallow groundwater level, and the proximity to the pond west of the alignment, a soil correction will be difficult to achieve and will require the use of temporary shoring and dewatering. As an alternative, we recommend extending the length of the Hopkins-Minnetonka Bridge to approximately STA 2420+00, where the embankment height and the depth of soil corrections are minimal. We recommend additional borings be performed in this area to better define the limits of the swamp deposit soils. Piezometers could also be installed to evaluate the ground water level in the area.

Should the retaining walls be the preferred choice of the design team, we recommend removing all fill and swamp deposit soils beneath the retaining walls and embankment. The expected bottom of excavation will range from elevations 888 to 893, however, soil boring OMF-21 encountered unsuitable soils down to near elevation 879. Groundwater elevations are expected to be near elevations 895 to 896.

Should temporary shoring be required, we recommend using the values provided below in Table 8. Saturated unit weights are recommended to account for the potential build up of hydrostatic pressure behind undrained support structures. We recommend that saturated unit weights be reduced by 62.4 pounds per cubic foot for strata or portions of a stratum extending below the groundwater levels at the structure location or as noted on the borings

Table 8. Parameters for Shoring Design

Geologic Material	Saturated Unit Weight (pcf)	Friction Angle (deg)	K_A	K_O	K_P
Select Granular Borrow	120	35	.27	.43	3.69
Sand Fill (SP, SP-SM)	120	30	.33	.50	3.00
Sand Fill (SM, SC)	125	28	.36	.53	2.76
Clay Fill (CL)	125	26	.39	.56	2.56
Swamp Deposit Soils (PT)	75	14	.61	.76	1.63
Swamp Deposit Soils (OL, ML)	90	22	.46	.62	2.20
Glacial Sands (SP, SP-SM)	120	32	.31	.47	3.25
Glacial Lean Clay (CL)	130	28	.36	.53	2.76

Fill and backfill for retaining walls should follow the material specifications and compaction recommendations noted in Table 7 above.

Alternatives to subcutting and replacing the fill beneath the retaining walls and embankments include the use of driven pile foundations or rammed aggregate piers. We anticipate rammed aggregate piers will extend through the fill and swamp deposits, into the underlying glacial soils. Installation of these piers may be difficult due to grandular conditions. We recommend consulting a specialty contractor to evaluate the number and depth of piers that may be required.

If driven piles are considered, we anticipate driving depths on the order of 60 to 80 feet to support the walls. Should the bridge be extended, additional analysis will be necessary to determine anticipated pile lengths.

D.3. Traction Power Substation (TPSS-SW-11) Construction

A traction power substation (TPSS) is proposed on the west side of the track near STA 2426+00. We anticipate soils similar to those encountered in Boring 2043ST. We recommend budgeting for a soil correction of up to 7 feet. However, we recommend further investigation of this area to determine a suitable foundation system. TPSS stations are generally small, lightly loaded structures, so a limited soil correction or the use of spread footings should be considered. Further investigation should be given to the settlement tolerances of these stations as electrical conduits are running in and out of the station. If the settlement tolerances are such that damage to the conduits is probable, we recommend the use of intermediate to deep foundation systems, which may include helical anchors or driven piles if a soil correction is not performed.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with core and auger drill equipped with hollow-stem auger mounted on an off-road carrier. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout.

E.2. Material Classification and Testing

E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

E.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or allowed to remain open for an extended period of observation as noted on the boring logs.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.3. Use of Report

This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these recommendations, please call Josh Kirk at 952.995.2222 jkirk@braunintertec.com or Ray Huber at 952.995.2260 rhuber@braunintertec.com at your convenience.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal-Project Engineer
License Number: 45005

Reviewed by:

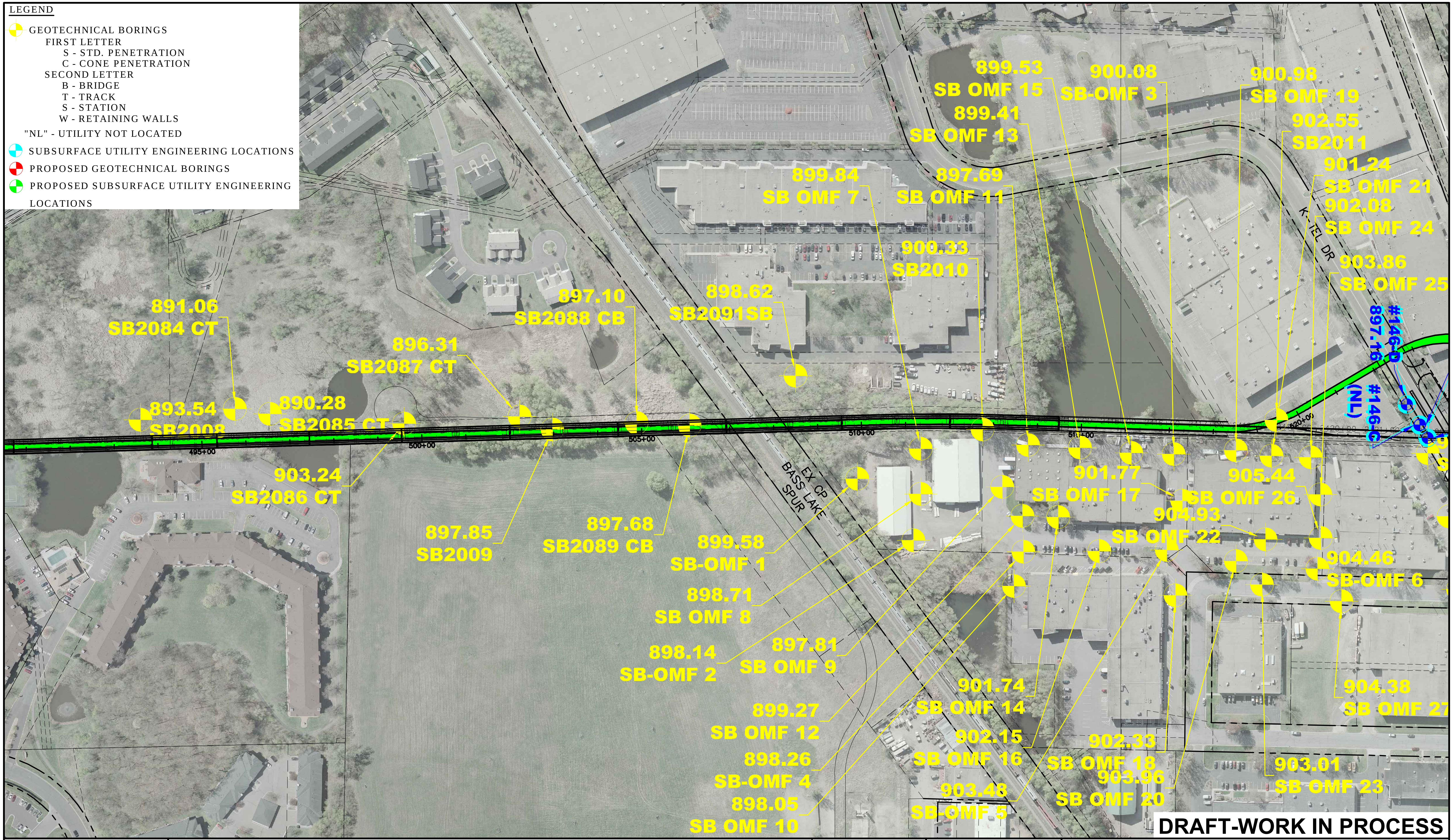
Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Soil Boring Location Sketch
Preliminary Engineering Plan and Profile Sheets – W3-TRK-PPFL-006 through 009
Soil Boring Logs OMF-13, OMF-15, OMF-3, OMF-19, OMF-21, 2011SB, OMF-24, OMF-28, 2043ST, 2044ST, 2041SB, 2042SB, 2062ST, 2063ST
Descriptive Terminology of Soil

APPENDIX



DRAFT-WORK IN PROCESS

SOUTHWEST
Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 11 OF 12

IRT: N/A
REV: 0
DATE: 06/30/2014

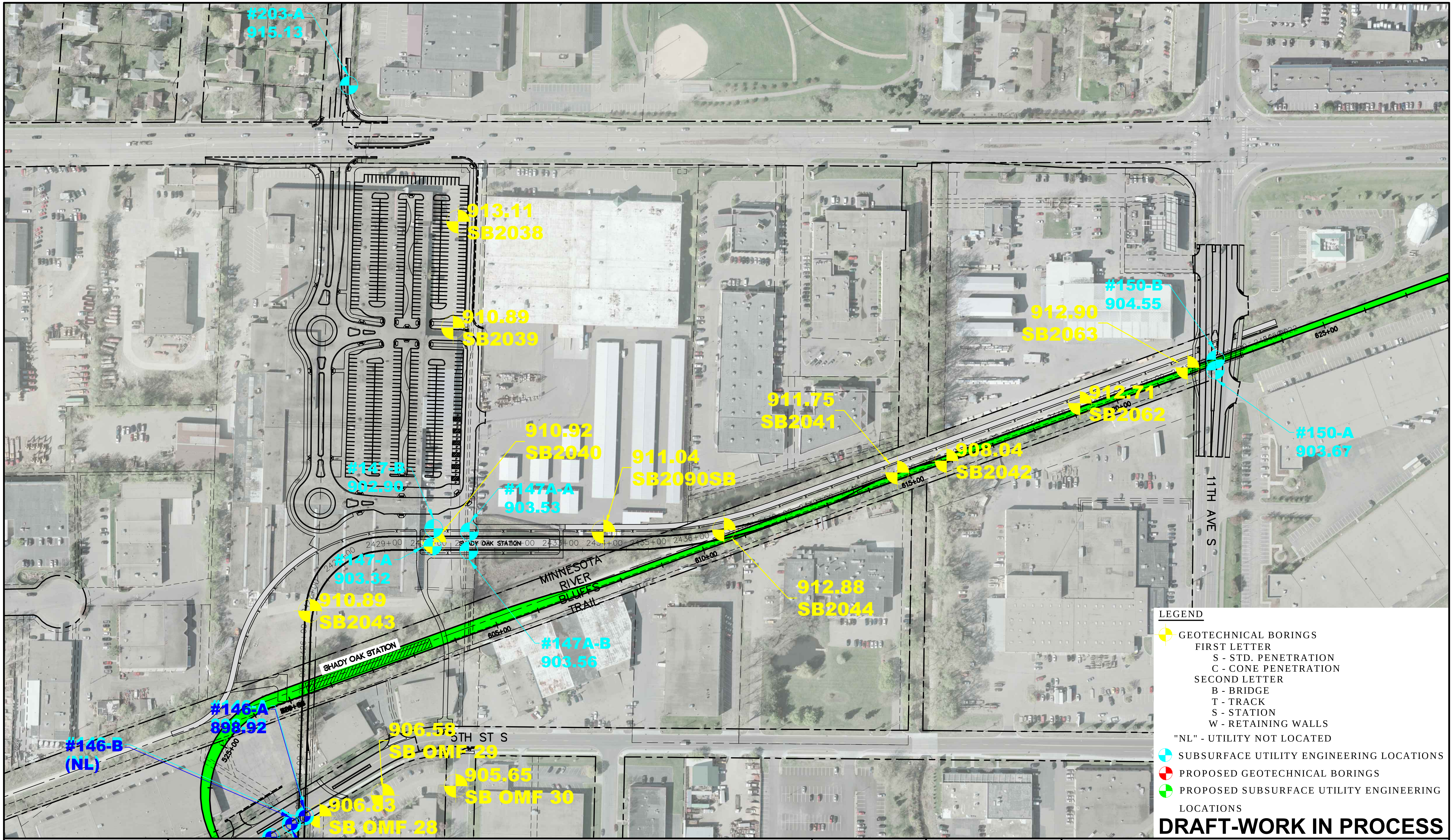
NORTH
0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.

Aug, 28 2014 11:34 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



LEGEND

GEOTECHNICAL BORINGS
FIRST LETTER
S - STD. PENETRATION
C - CONE PENETRATION
SECOND LETTER
B - BRIDGE
T - TRACK
S - STATION
W - RETAINING WALLS

"NL" - UTILITY NOT LOCATED

SUBSURFACE UTILITY ENGINEERING LOCATIONS

PROPOSED GEOTECHNICAL BORINGS

PROPOSED SUBSURFACE UTILITY ENGINEERING LOCATIONS

DRAFT-WORK IN PROCESS

SOUTHWEST
Green Line LRT Extension

SOUTHWEST LIGHT RAIL
SOIL BORINGS
SHEET 12 OF 12

IRT: N/A
REV: 0
DATE: 06/30/2014

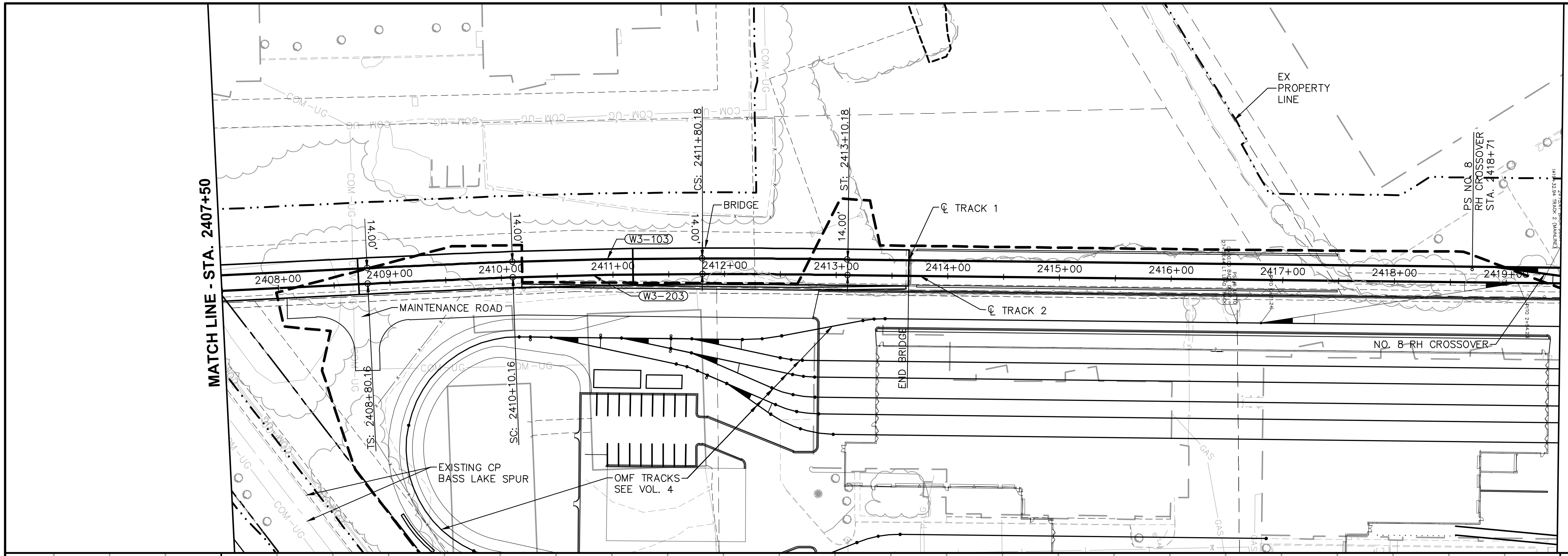
NORTH
0 50 100 200

METROPOLITAN COUNCIL

AECOM

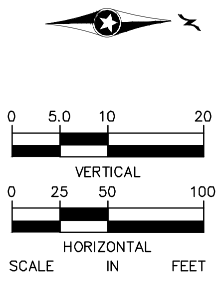
SRF Consulting Group, Inc.

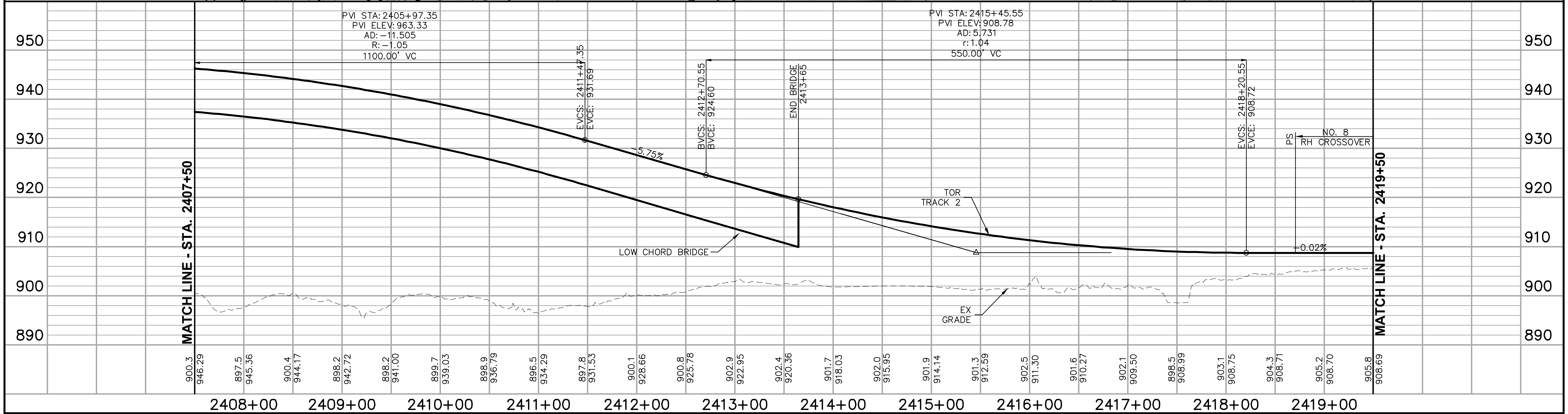
Aug, 28 2014 11:35 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



CURVE NO. W3-203
R = 5,000.00'
Lc = 170.02'
Ls = 130.00'
Ea = 1.00"
Eu = 1.40"
V = 55 MPH

CURVE NO. W3-103
R = 5,000.00'
Lc = 170.02'
Ls = 130.00'
Ea = 1.00"
Eu = 1.40"
V = 55 MPH





Jun, 13 2014 12:55 pm V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\TRACK\W3-TRK-PLN.dwg By: Konenji

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

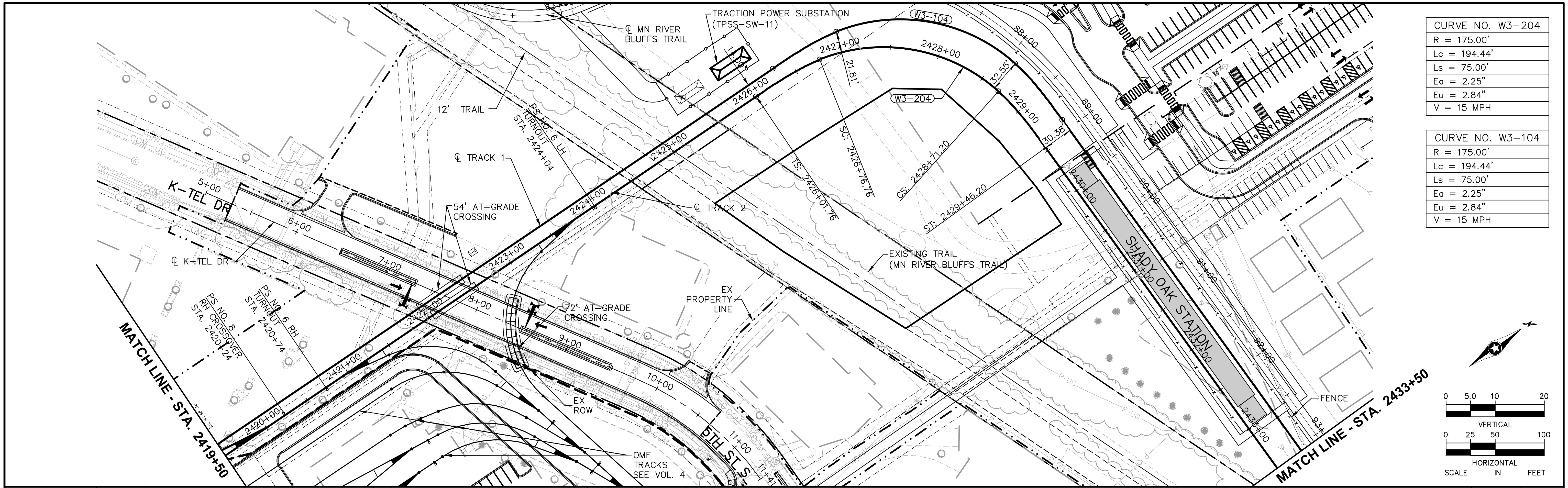
SOUTHWEST
Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 3
TRACK
PLAN AND PROFILE
STA. 2407+50 TO STA. 2419+50

DISCIPLINE: **TRACK**

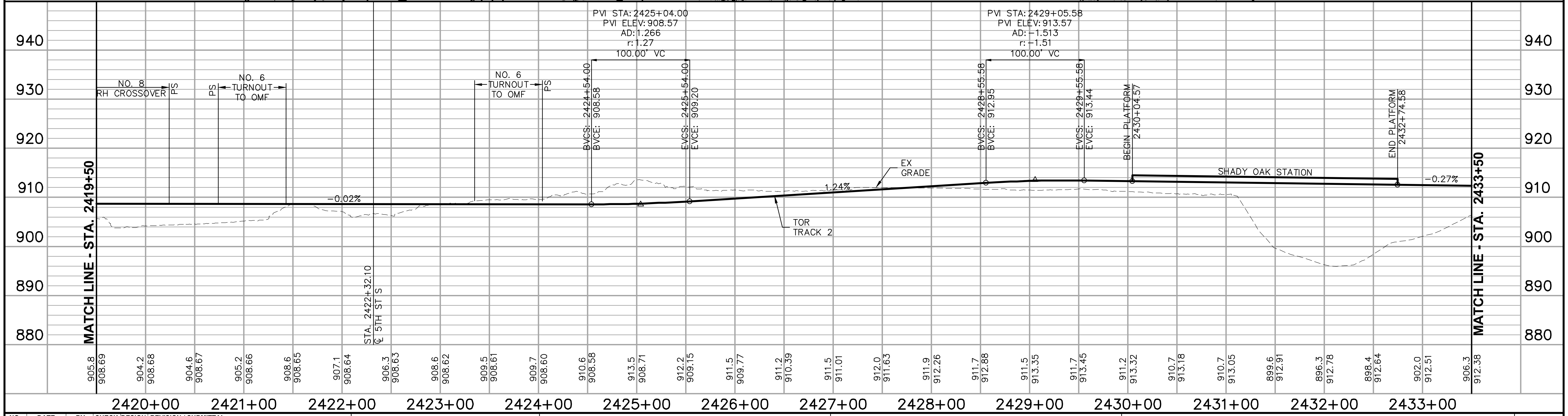
SHEET NAME: **W3-TRK-PPFL-006**

SHEET
32
OF
54



CURVE NO. W3-204
R = 175.00'
Lc = 194.44'
Ls = 75.00'
Ea = 2.25"
Eu = 2.84"
V = 15 MPH

CURVE NO. W3-104
R = 175.00'
Lc = 194.44'
Ls = 75.00'
Ea = 2.25"
Eu = 2.84"
V = 15 MPH



Jun, 13 2014 12:55 pm V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\TRACK\W3-TRK-PLN.dwg By: Konenji

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

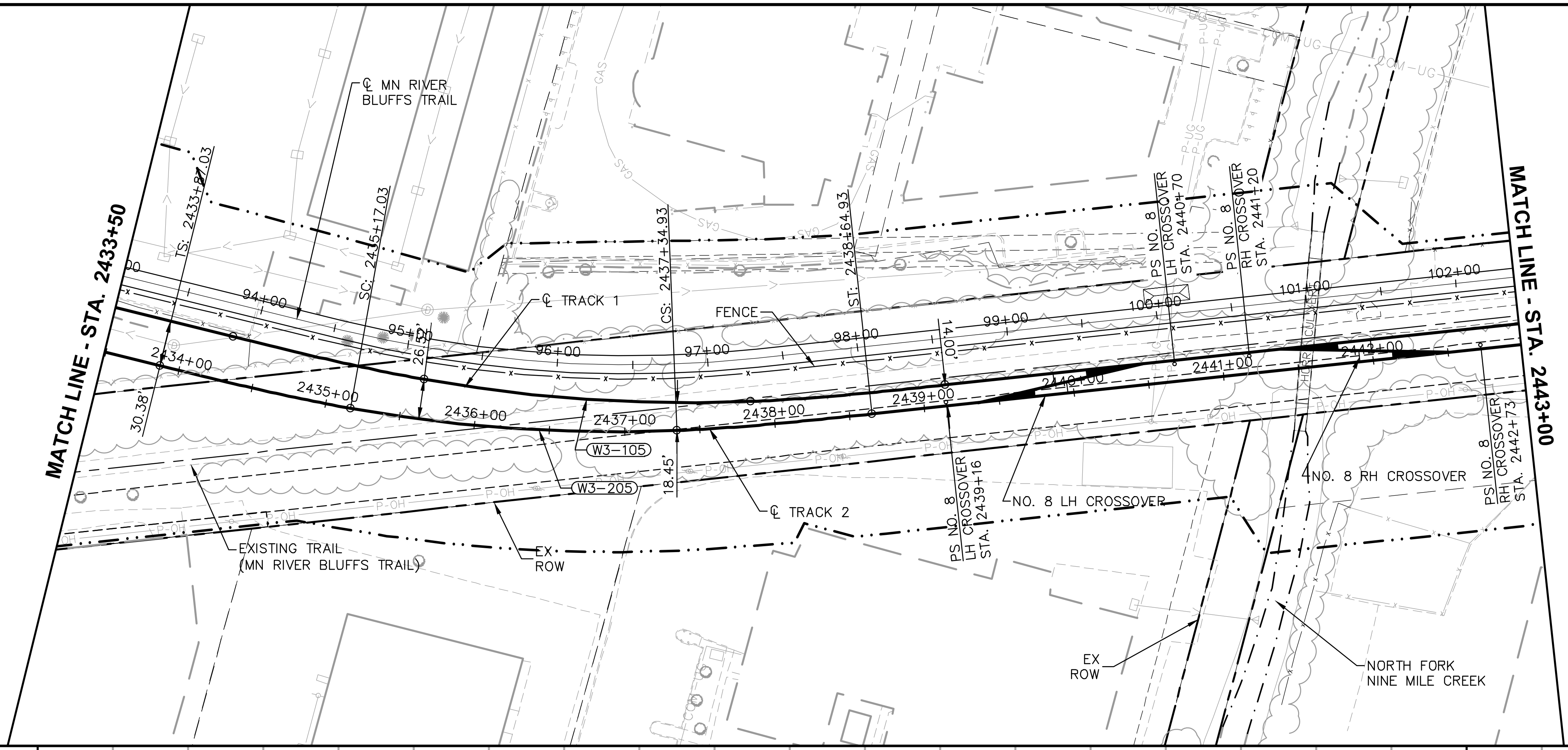
SOUTHWEST Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 3
TRACK
PLAN AND PROFILE
STA. 2419+50 TO STA. 2433+50

DISCIPLINE: **TRACK**

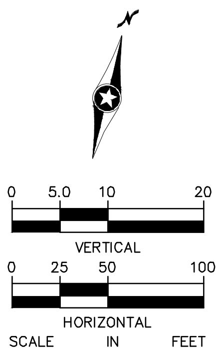
SHEET NAME: **W3-TRK-PPFL-007**

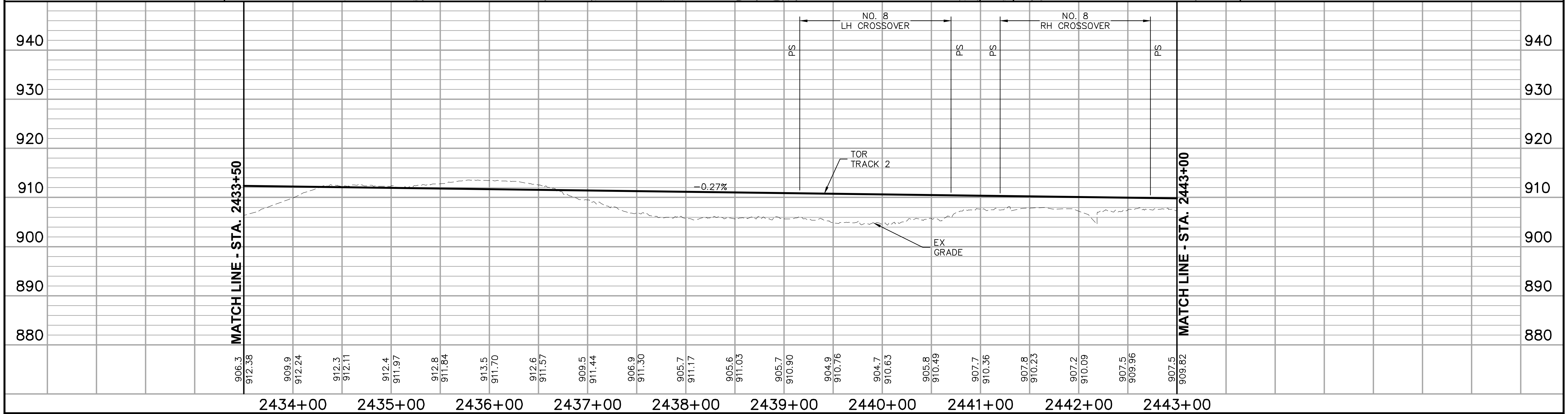
SHEET 33 OF 54



CURVE NO. W3-205
R = 1,000.00'
Lc = 217.90'
Ls = 130.00'
Ea = 2.75"
Eu = 2.10"
V = 35 MPH

CURVE NO. W3-105
R = 1,000.00'
Lc = 217.90'
Ls = 130.00'
Ea = 2.75"
Eu = 2.10"
V = 35 MPH





NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extension

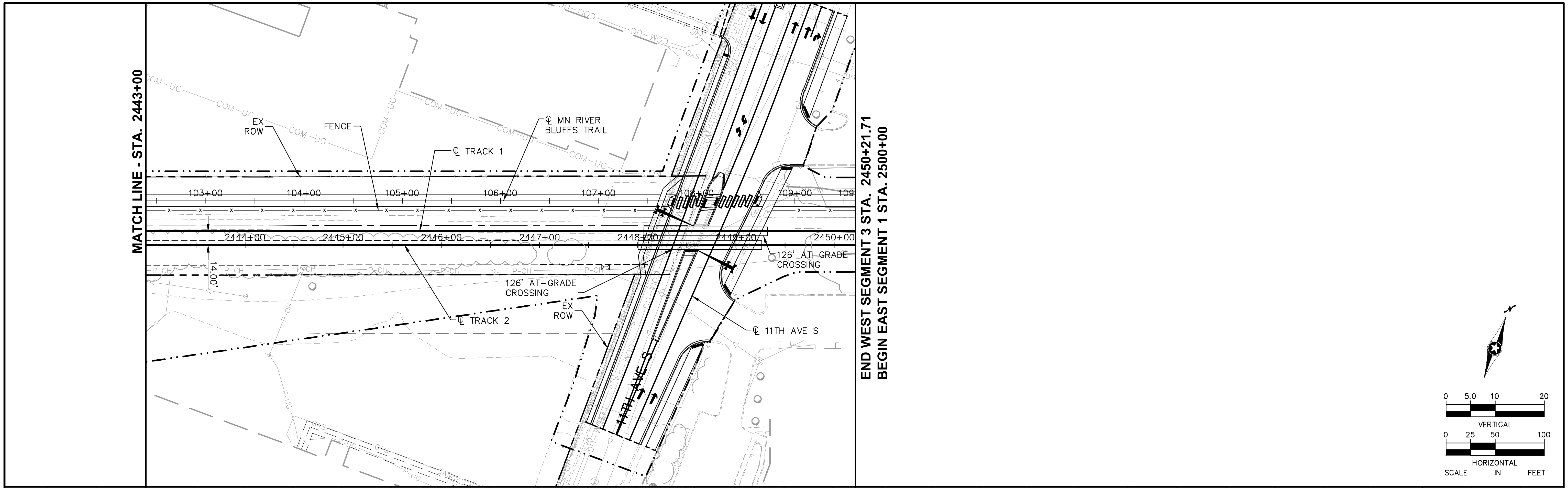
WEST - VOLUME 1 (CIVIL) - SEGMENT 3
TRACK
PLAN AND PROFILE
STA. 2433+50 TO STA. 2443+00

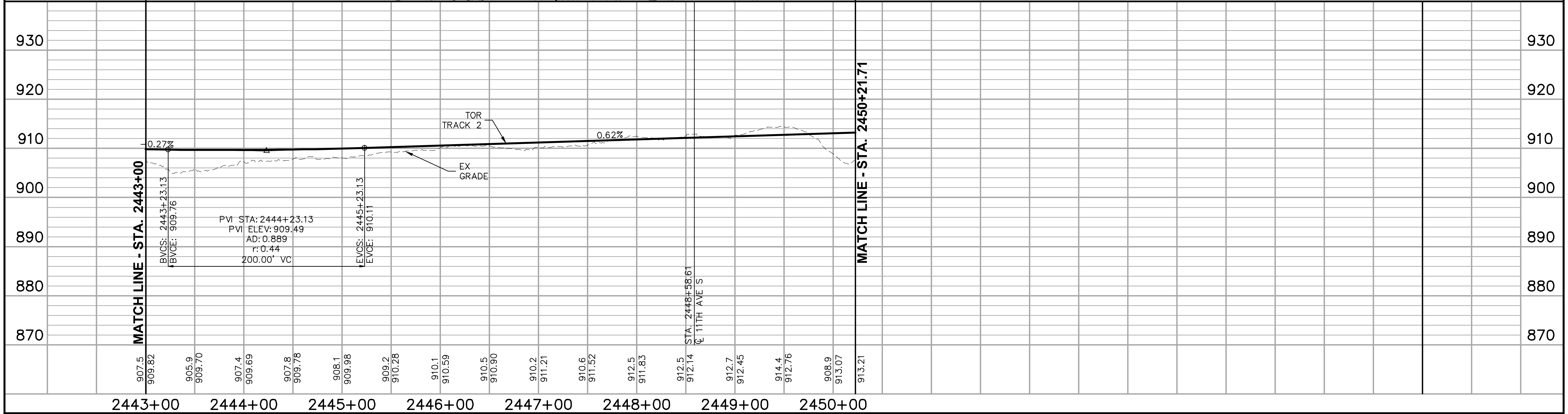
DISCIPLINE: TRACK

SHEET NAME: W3-TRK-PPFL-008

SHEET 34 OF 54

Jun, 13 2014 12:29 pm V:\3200_PEC-W\CAD\SEGMENT-W3\SHEET\TRACK\W3-TRK-PLN.dwg By: Boscha





NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 3
TRACK
PLAN AND PROFILE
STA. 2443+00 TO STA. 2450+21.71

DISCIPLINE: TRACK

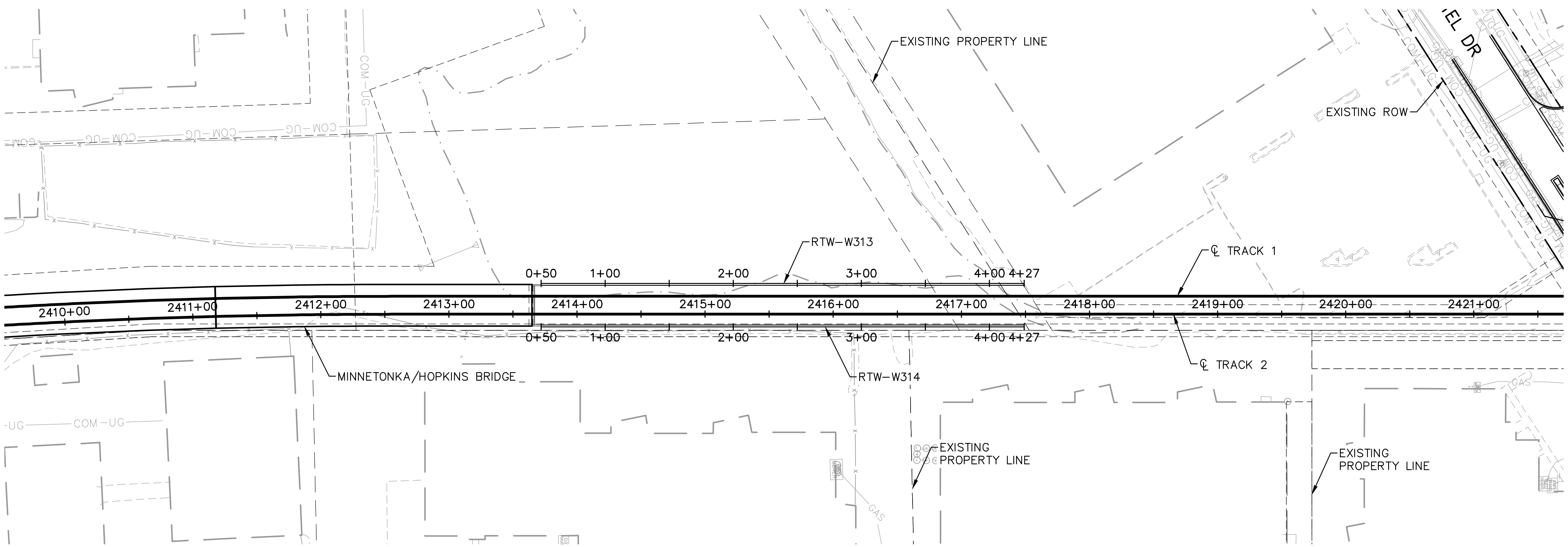
SHEET NAME: W3-TRK-PPFL-009

SHEET 35 OF 54

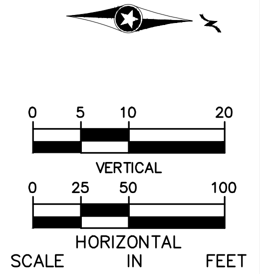
NOTE:
RTW-W313 AND RTW-W314 ARE ANTICIPATED TO BE CAST-IN-PLACE RETAINING WALLS ON SPREAD FOOTINGS.

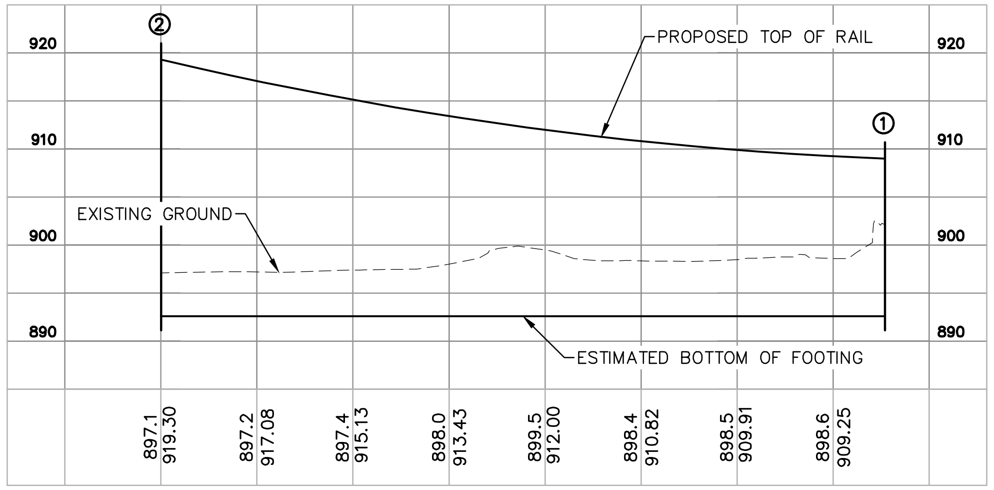
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

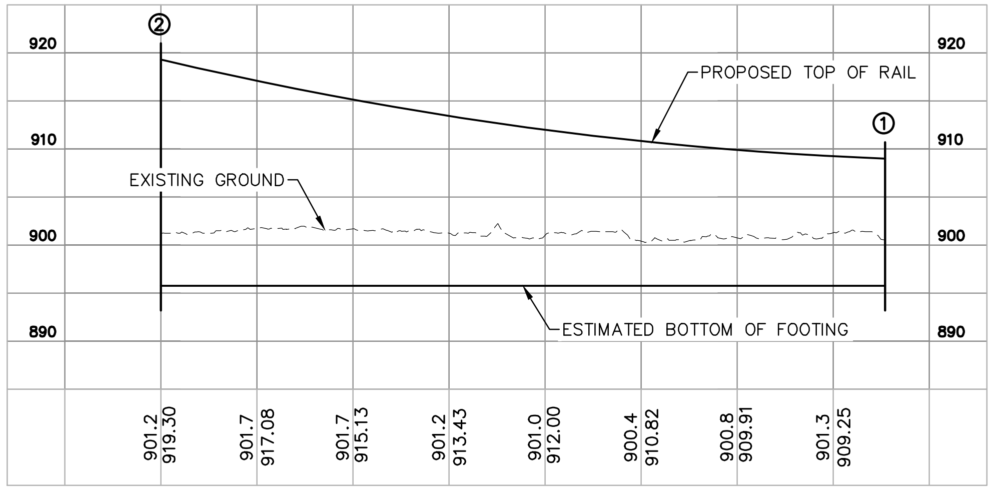


RTW-W313 & RTW-W314 PLAN

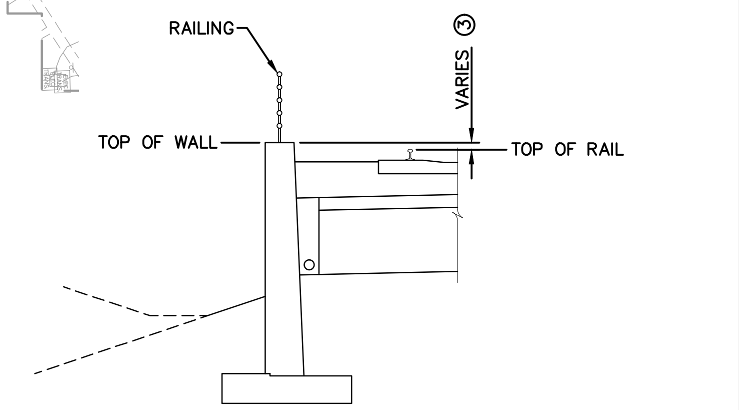




RTW-W313 PROFILE

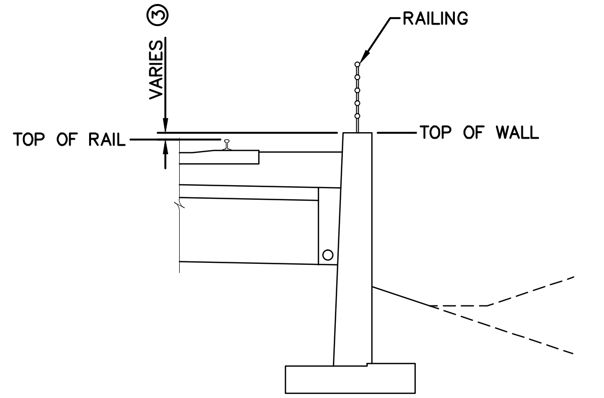


RTW-W314 PROFILE



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES & SPIRALS

RTW-W313 TYPICAL SECTION



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES & SPIRALS

RTW-W314 TYPICAL SECTION

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

Aug. 14 2014 03:48 pm V:\3200_pec-w\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-RETW.dwg By: mnutzmann

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST
Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 3
RTW-W313 & RTW-W314
PLAN AND PROFILE

DISCIPLINE: **STRUCTURES**

SHEET NAME: **W3-STU-RTW-PPFL-007**

SHEET
202
OF
204

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-13**

LOCATION: N: 144987.7; E: 489959.4.
See attached sketch.

DRILLER: M. Barber
METHOD: 3 1/4" HSA, Autohammer
DATE: **6/13/14**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 899.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.7	0.8	PAV	3 inches of Bituminous over 5 1/2 inches of Aggregate Base.				
895.4	4.0	FILL	FILL: Clayey Sand, trace Gravel, gray, moist.	6			
893.4	6.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, brown, wet.	5		12	P200=11%
890.4	9.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with Peat lenses, gray with layers of black, waterbearing. (Swamp Deposit)	4	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
887.4	12.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, loose. (Glacial Outwash)	5			
873.4	26.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, very loose to loose. (Glacial Outwash)	8 5 9 4 6 8		17	P200=4%
			END OF BORING. Water observed at 6 1/2 feet while drilling. Boring immediately backfilled with bentonite grout.				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:25

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-15**

LOCATION: N: 145104.2; E: 489971.4.
See attached sketch.

DRILLER: M. Beck

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/13/14**

SCALE: **1" = 4'**

Elev. feet 899.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.9	0.6	PAV	4 inches of Bituminous over 3 inches of Aggregate Base.				
895.5	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, gray, wet.	5	▽	12	P200=19% An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
893.5	6.0	PT	PEAT, black, wet. (Swamp Deposit)	4			
890.5	9.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel and roots, gray, waterbearing, very loose. (Alluvium)	3			
880.5	19.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, waterbearing, very loose to loose. (Glacial Outwash)	4 4 3 5		19	
873.5	26.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brownish gray, waterbearing, very loose to loose. (Glacial Outwash)	5 4 6			
			END OF BORING. Water observed at 3 1/2 feet while drilling. Water observed at 6 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-3**

LOCATION: N: 145200.6; E: 489973.9.
See attached sketch.

DRILLER: S. McLean
METHOD: 3 1/4" HSA, Autohammer
DATE: **7/1/13**
SCALE: **1" = 4'**

Elev. feet 900.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.8	0.4	PAV	4 inches of Bituminous.				
898.1	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist.				
		PT	PEAT, with Organic Clay layer at 2 feet, dark brown to black, wet. (Swamp Deposit)	4	∇	209	OC=35%
				3			
			with fibers at 6 feet.	2			
888.1	12.0		with gray Silt layer at 10 to 12 feet.	3			
886.1	14.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, gray, waterbearing, loose. (Alluvium)	7		19	P200=16%
881.1	19.0	SP	POORLY GRADED SAND, medium- to coarse-grained, with Gravel, gray, waterbearing, loose. (Glacial Outwash)	6			
		SP	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, with occasional lenses of brown Silt, grayish brown, waterbearing, loose. (Glacial Outwash)	9		24	P200=4%
871.1	29.0			8			*Water observed at 4 feet with 4 feet of hollow-stem auger in the ground. Water observed at 4 feet with 29 1/2 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.
869.1	31.0	CL	SANDY LEAN CLAY, trace Gravel, with frequent Sand lenses, brown, wet, rather stiff. (Glacial Till)	11			
			END OF BORING.*				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:26

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-19**

LOCATION: N: 145342; E: 489965.6.
See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: **6/10/14**	SCALE: **1" = 4'**

Elev. feet 901.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
899.5	1.5	PAV	8 inches of Bituminous over 10 inches of Aggregate Base.			
899.0	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.			
893.0	8.0	PT	PEAT, well decomposed, black, wet. (Swamp Deposit)	5 3	▽	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
884.0	17.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash) Gravel layer at 15 feet.	19 10 12 10		
882.0	19.0	CL	SANDY LEAN CLAY, trace Gravel, with waterbearing Poorly Graded Sand seam at 18 feet, brown, wet, rather stiff. (Glacial Till)	11		
875.0	26.0	SC	CLAYEY SAND, trace Gravel, brown and gray, wet, stiff to very stiff. (Glacial Till)	15 29 21		
			END OF BORING. Water observed at 6 feet while drilling. Water observed at 6 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:27

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-21**

LOCATION: N: 145422.8; E: 489977.7.
See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: **6/9/14**	SCALE: **1" = 4'**

Elev. feet 901.2	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.9	1.3	PAV	7 inches of Bituminous over 8 inches of Aggregate Base.				
897.2	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, brown, moist.	4		46	
889.2	12.0	PT	PEAT, with fibers, dark brown to black, wet. (Swamp Deposit)	4			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
					▽		
				4		344	OC=74%
				4			
885.2	16.0	ML	SILT, with Gravel, dark brown, wet, rather soft to medium. (Alluvium)	4			
				7			
879.2	22.0	CL	LEAN CLAY, with Peat lenses, with frequent waterbearing Sand and Gravel layers, gray and brown, wet. (Swamp Deposit/Alluvium)	8			
				10			
875.2	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense. (Glacial Outwash)	32			
				38			

END OF BORING.

Water observed at 6 1/2 feet while drilling.

water observed at 6 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:26

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2011SB**

LOCATION: N: 145434.3; E: 489896.4
See attached sketch.

DRILLER: S. McLean | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/14/13** | SCALE: **1" = 4'**

Elev. feet 902.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
900.6	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown and black, moist. (Topsoil Fill)				
898.6	4.0	FILL	FILL: Sandy Lean Clay, trace Gravel, dark brown, wet.	5			
895.6	7.0	FILL	FILL: Clayey Sand, slightly organic, trace Gravel, with Sand lenses, dark brown, wet.	4		17	OC=2%
893.6	9.0	FILL	FILL: Sandy Lean Clay, trace Gravel and roots, dark brown to gray, wet.	6			
890.6	12.0	CL	SANDY LEAN CLAY, with occasional Silt lenses and seams, trace Gravel and roots, gray, wet, medium. (Alluvium)	6		19	OC=1%
					▽		
873.6	29.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash)	10			
				23		11	P200=1%
			Cobbles layer encountered between 17 to 29 feet.	19			
				20			
				16			
				15		11	P200=2%
				19			
870.6	32.0	SC	CLAYEY SAND, trace Gravel, brown, wet, very stiff. (Glacial Till)	28			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:28

LOG OF BORING

BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2011SB (cont.)**

LOCATION: N: 145434.3; E: 489896.4
See attached sketch.

DRILLER: S. McLean | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/14/13** | SCALE: **1" = 4'**

Elev. feet 870.6	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff. (Glacial Till)	15			
868.6	34.0						
		SC	CLAYEY SAND, trace Gravel, brown, wet, medium to very stiff. (Glacial Till)	14			
			With waterbearing Sand lenses at 37 feet.	6		12	See attached Grain Size Accumulation Curve.
				19*			*No sample recovery.
				27			
858.6	44.0						
		CL	SANDY LEAN CLAY, trace Gravel, brown, wet, very stiff. (Glacial Till)	24			
			With Sand seams at 47 feet.	25			
				22			
848.6	54.0						
		SC	CLAYEY SAND, with waterbearing Sand lenses, brown, wet, hard. (Glacial Till)	32			
				31		11	See attached Grain Size Accumulation Curve.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:28

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2011SB (cont.)**

LOCATION: N: 145434.3; E: 489896.4
See attached sketch.

DRILLER: S. McLean | METHOD: 3 1/4" HSA, Autohammer | DATE: **5/14/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 838.6	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			CLAYEY SAND, with waterbearing Sand lenses, brown, wet, hard. (Glacial Till) *(continued)*	32 36			
			With Poorly Graded Sand lenses and seams at 75 feet.	37			
823.6	79.0						
		SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, dense to very dense. (Glacial Till)	67 41			**END OF BORING AT 96 FEET.
813.6	89.0						Water observed at 12 feet with 12 feet of hollow-stem auger in the ground.
		SC	CLAYEY SAND, with Gravel, brown, wet, hard. (Glacial Till)	34			Switched to mud rotary drilling at 15 feet. Boring immediately backfilled with bentonite grout.
808.6	94.0						
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, greenish brown, waterbearing, very dense.** (Glacial Outwash)	100			
806.6	96.0						

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:28

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-24**

LOCATION: N: 145512.2; E: 489981.5.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/11/14**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 902.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.2	0.9	PAV	6 inches of Bituminous over 5 inches of Aggregate Base.				
885.1	17.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, moist to 4 feet then waterbearing, medium dense. (Glacial Outwash)	15			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
					▽		
				12		14	P200=7%
				17			
				13			
				20			
				17			
880.1	22.0	CL	SANDY LEAN CLAY, trace Gravel, brown and gray, wet, rather stiff. (Glacial Till)	9			
			Gravel layer at 20 feet.	12			
876.1	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	8			
				15			
			END OF BORING. Water observed at 4 feet while drilling. Water observed at 4 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:28

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-28**

LOCATION: N: 145778.3; E: 489971.8.
See attached sketch.

DRILLER: J. Chermak

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/16/14**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 906.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
905.6	1.2	PAV	5 1/4 inches of Bituminous over 8 3/4 inches of Aggregate Base.				
902.8	4.0	FILL	FILL: Poorly Graded Sand, fine- to medium-grained, trace Gravel, light brown, moist.	12			
899.8	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, dark brown and brown, moist.	19		6	P200=14%
892.8	14.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, light brown and brown, waterbearing, loose to medium dense. (Glacial Outwash)	8	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				12		18	P200=4%
				7			
884.8	22.0	CL	SANDY LEAN CLAY, trace Gravel, brown, wet, medium. (Glacial Till)	6			
				8*			*No sample recovery.
				8			
880.8	26.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with frequent lenses of Lean Clay, brown, waterbearing, loose. (Glacial Till)	9			
				9			
			END OF BORING. Water observed at 7 1/2 feet while drilling. Water observed at 19 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:28

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2043ST**

LOCATION: N: 146244.6; E: 489950;
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/2/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 910.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
910.6	0.3	FILL	FILL: Silty Sand, with roots, dark brown. (Topsoil Fill)				
903.9	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist. With bricks and black Lean Clay at 5 feet.	12 15			
898.9	12.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, brown, moist, medium dense. (Glacial Outwash)	16 27	▽	4	P200=7%
881.9	29.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown and gray, waterbearing, loose to medium dense. (Glacial Outwash)	16 27 10 16 8			* Water observed at 12 feet with 12 feet of hollow-stem auger in the ground. Water observed at 17 feet with 29 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 10 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.
879.9	31.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with Sandy Lean Clay layer at 29 feet, brown, waterbearing, medium dense. (Glacial Till)	19			
			END OF BORING. *				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:29

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2044ST**

LOCATION: N: 146429.5; E: 490891;
See attached sketch.

DRILLER: M. Belch
METHOD: 3 1/4" HSA, Autohammer
DATE: **10/2/13**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 912.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, brown, moist.				
				13			Little recovery from 2-12 feet.
				18		9	
				23		6	
				9*			No sample recovery.
900.9	12.0						
		FILL	FILL: Sandy Lean Clay, with Gravel, brown, wet.	8		13	
898.9	14.0						
		PT	PEAT, with fibers and shells, black and dark brown, wet. (Swamp Deposit)	8			
				TW			
				5			
890.9	22.0						
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to dense. (Glacial Outwash)	11	▽		
				9			
				9			

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:29

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **2044ST (cont.)** LOCATION: N: 146429.5; E: 490891; See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **10/2/13**	SCALE: **1" = 4'**

Elev. feet 880.9	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to dense. (Glacial Outwash) *(continued)*	44			
876.9	36.0		END OF BORING. Water observed at 22 1/2 feet with 22 1/2 feet of hollow-stem auger in the ground. Water observed at 23 feet with 34 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 12 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:29

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2041SB**

LOCATION: N: 146559.1; E: 491285.1;
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **10/2/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 911.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		FILL	FILL: Clayey Sand, trace Gravel, brown and dark brown, moist.	9			
				9		9	
			With Lean Clay lenses.				
				8		11	
			With black Lean Clay layer at 10 feet.	11			
899.8	12.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, with occasional Lean Clay lenses, brown, moist.	20			
				19			
894.8	17.0	PT	PEAT, fibrous, black and dark brown, wet. (Swamp Deposit)	13			
				TW			
889.8	22.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, gray, waterbearing, medium dense. (Glacial Till)	15	▽	18	P200=18%
887.8	24.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	24			
				11			
				6*			*No sample recovery.

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:30

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2041SB (cont.)**

LOCATION: N: 146559.1; E: 491285.1;
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **10/2/13**	SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 879.8	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
877.8	34.0						
872.8	39.0	SC	CLAYEY SAND, trace Gravel, brownish gray, wet, very stiff. (Glacial Till)	26		10	P200=29%
870.8	41.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, gray, waterbearing, loose. (Glacial Till)	8			
			END OF BORING. Water observed at 22 1/2 feet with 22 1/2 feet of hollow-stem auger in the ground. Water observed at 28 feet with 39 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 14 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.				

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2042SB**

LOCATION: N: 146585.7; E: 491397.4;
See attached sketch.

DRILLER: M. Belch
METHOD: 3 1/4" HSA, Autohammer
DATE: **10/1/13**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 908.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown and black, moist.	15			
				16		8	P200=14%
				29			
			With Lean Clay lenses at 10 feet.	13			
				11			
894.0	14.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Fat Clay lenses, brown, moist.	15			
891.0	17.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, with Lean Clay and Organic Clay lenses, dark gray, wet to 20 feet then waterbearing. (Fill/Swamp Deposit)	5			
				9	▽		
886.0	22.0	PT	PEAT, fibrous, black and dark brown, wet. (Swamp Deposit)	10			
				TW			
881.0	27.0	OL	ORGANIC CLAY, with fibers and shells, gray and brown, moist. (Swamp Deposit)	6			
				4		66	OC=9%

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:30

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **2042SB (cont.)** LOCATION: N: 146585.7; E: 491397.4; See attached sketch.

DRILLER:	METHOD:	DATE:	SCALE:
M. Belch	3 1/4" HSA, Autohammer	**10/1/13**	**1" = 4'**

Elev. feet 876.0	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
874.0	34.0		ORGANIC CLAY, with fibers and shells, gray and brown, moist. (Swamp Deposit) *(continued)*				Attempted thinwall, no recovery.
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	25		14	P200=3%
				10*			*No sample recovery.
				12			
857.0	51.0		Fine-grained at 50 feet.	30			
			END OF BORING. Water observed at 20 feet with 20 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:30

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN℠ INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2062ST**

LOCATION: N: 146716.6; E: 491700.3;
See attached sketch.

DRILLER: K. Keck

METHOD: 3 1/4" HSA, Autohammer

DATE: **1/31/14**

SCALE: **1" = 4'**

Elev. feet 912.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
912.2	0.5	AGG	6 inches of Aggregate Base.				Frozen to 4 feet.
910.7	2.0	FILL	FILL: Silty Sand, fine- to coarse-grained, with Gravel, brown, moist.				
908.7	4.0	FILL	FILL: Silty Sand, fine- to coarse-grained, with cinders and ash, black, moist.	84			
905.7	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, brown, moist.	23		5	P200=14%
900.7	12.0	FILL	FILL: Silty Sand, slightly organic, fine- to medium-grained, with Gravel, dark brown, moist.	7 6		10 15	 OC=2.2%
895.7	17.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Lean Clay and Silt lenses, brown and gray, moist.	12 15			
893.7	19.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with black Silt lenses, gray, waterbearing, very loose. (Fill/Swamp Deposit)	7	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
888.7	24.0	PT	PEAT, well decomposed, trace roots, black, wet. (Swamp Deposit)	4			
883.7	29.0	OH	ORGANIC SILT, gray, wet. (Swamp Deposit)	12		40	OC=5%
		SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, with Peat lenses at 29 1/2 feet, brown, waterbearing, medium dense. (Glacial Outwash)	19			

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:30

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2062ST (cont.)**

LOCATION: N: 146716.6; E: 491700.3;
See attached sketch.

DRILLER: K. Keck
METHOD: 3 1/4" HSA, Autohammer
DATE: **1/31/14**
SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 880.7	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, with Peat lenses at 29 1/2 feet, brown, waterbearing, medium dense. (Glacial Outwash) *(continued)*	19 14			
871.7	41.0		END OF BORING. Water observed at 17 feet with 17 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 20 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.				

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2063ST**

LOCATION: N: 146797.5; E: 491944.9;
See attached sketch.

DRILLER: K. Keck

METHOD: 3 1/4" HSA, Autohammer

DATE: **1/31/14**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 913.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
912.5	0.5	AGG	6 inches of Aggregate Base.				
911.0	2.0	FILL	FILL: Sandy Lean Clay, with Gravel, black, moist.				Frozen to 3 feet.
909.0	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, with Lean Clay lenses, brown, moist.	59		7	P200=13%
		FILL	FILL: Sandy Lean Clay, trace Gravel, with frozen Silty Sand lenses, dark brown, wet.	23		11	
				10*			*No sample recovery.
				6			
899.0	14.0			6		15	
896.0	17.0	PT	PEAT, well decomposed, black, wet. (Swamp Deposit)	14			
		SM	SILTY SAND, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, gray, moist to 22 feet then waterbearing, medium dense. (Glacial Outwash)	17			
				30			
889.0	24.0				▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	18			*Water observed at 22 feet with 24 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 22 feet immediately after withdrawal of auger.
882.0	31.0			13			Boring immediately backfilled with bentonite grout.
			END OF BORING.*				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:31

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2090SS**

LOCATION: N: 146424.6; E: 490617.2;
See attached sketch.

DRILLER: B. Kammermeier | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/24/14** | SCALE: **1" = 4'**

Elev. feet 911.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
910.3	0.8	PAV	3 inches of bituminous over 5 inches of aggregate base.				
904.0	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, dark brown to brown, moist.	23 21		9	
901.0	10.0	FILL	FILL: Lean Clay with Sand, with Gravel, dark brown, wet.	6		24	
899.0	12.0	SM	SILTY SAND, fine- to medium-grained, dark brown, moist. (Possible Fill)	6		11	
894.0	17.0	SP	POORLY GRADED SAND, fine- to medium-grained, light brown to brown, moist, medium dense. (Glacial Outwash) Gravel at 15 feet.	26 19		5	P200=5%
886.0	25.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	8 14	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
885.0	26.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff. (Glacial Till)	9			
			END OF BORING. Water observed at 17 1/2 feet while drilling. Water observed at 19 feet with 24 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth at 15 feet immediately after withdrawal of auger.*				*Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/14/14 17:29

BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	**Group Name** [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	**GW**	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	**GP**	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	**GM**	Silty gravel [d,f,g]
			Fines classify as CL or CH	**GC**	Clayey gravel [d,f,g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	**SW**	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	**SP**	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	**SM**	Silty sand [f,g,h]
			Fines classify as CL or CH	**SC**	Clayey sand [f,g,h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above "A" line [j]	**CL**	Lean clay [k,l,m]
			$PI < 4$ or plots below "A" line [j]	**ML**	Silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OL**	Organic clay [k,l,m,n]
				OL	Organic silt [k,l,m,o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	**CH**	Fat clay [k,l,m]
			PI plots below "A" line	**MH**	Elastic silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OH**	Organic clay [k,l,m,p]
				OH	Organic silt [k,l,m,q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			**PT**	Peat

a. Based on the material passing the 3-in (75mm) sieve.

b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.

c. $C_u = D_{60} / D_{10}$ $\quad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

d. If soil contains $\geq$15% sand, add "with sand" to group name.

e. Gravels with 5 to 12% fines require dual symbols:

GW-GM	well-graded gravel with silt
GW-GC	well-graded gravel with clay
GP-GM	poorly graded gravel with silt
GP-GC	poorly graded gravel with clay

f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

g. If fines are organic, add "with organic fines" to group name.

h. If soil contains $\geq$ 15% gravel, add "with gravel" to group name.

i. Sands with 5 to 12% fines require dual symbols:

SW-SM	well-graded sand with silt
SW-SC	well-graded sand with clay
SP-SM	poorly graded sand with silt
SP-SC	poorly graded sand with clay

j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.

l. If soil contains $\geq$30% plus No. 200, predominantly sand, add "sandy" to group name.

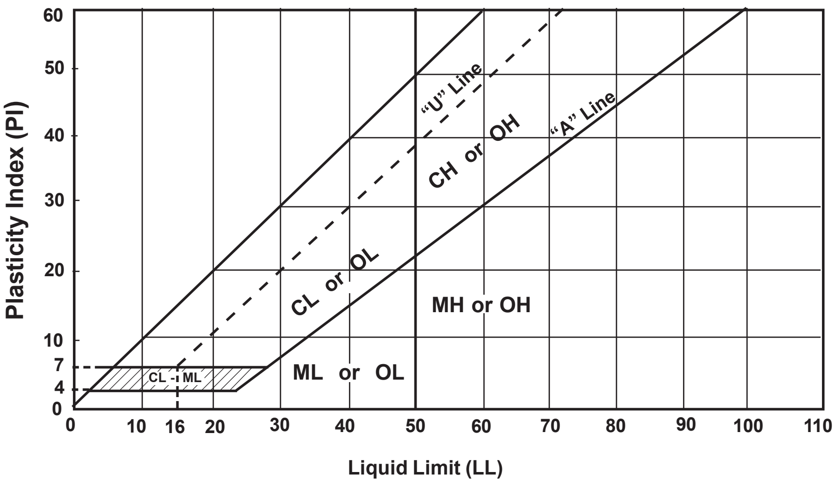
m. If soil contains $\geq$ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.

n. PI $\geq$ 4 and plots on or above "A" line.

o. PI $<$ 4 or plots below "A" line.

p. PI plots on or above "A" line.

q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI $\geq$ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix F

OMF

BRAUN
INTERTEC

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Preliminary Geotechnical Evaluation
Proposed Operations and Maintenance Facility – Site 9A – 75% Design
544-620 16th Avenue South
STA 2409+00 to STA 2424+00
Southwest LRT, West Segment 3
Hopkins, Minnesota

Dear Mr. Demers:

The purpose of this letter is to provide you and your design team with the results of our soil borings and preliminary recommendations regarding the proposed Operations and Maintenance Facility (OMF), Site 9A in Hopkins, Minnesota. Thirty (30) soil borings were performed to assist in determining the subsurface soils and groundwater conditions with regard to design and construction of the proposed facility.

This preliminary report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project.

Project Description

The west segment of the SWLRT project is proposing to construct a light rail transit line through the cities of Hopkins, Minnetonka, and Eden Prairie, Minnesota. This portion of the project considers the preliminary design and construction of the proposed OMF facility in Hopkins.

Subsurface Investigation Summary

2.1. Geologic Profile

Braun Intertec performed 30 soil borings (OMF-1 through OMF-30) within the proposed OMF facility area. Logs of the borings are included in the Appendix along with a boring location sketch showing their locations. A description of the soils encountered is described below, starting at the surface.

2.1.a. Pavements

Approximately 75 percent of the borings were located within existing parking lot/drive areas. The borings generally encountered approximately 1½ to 8 inches of bituminous over 3 to 13 inches of aggregate base. However, no aggregate base was apparent below the bituminous at Borings OMF-3, OMF-6, and OMF-7. Boring OMF-8 encountered 8 inches of aggregate base at the surface.

2.1.b. Topsoil and Topsoil Fill

Borings OMF-12, OMF-14, and OMF-27 encountered a surficial layer of topsoil or topsoil fill. The topsoil fill ranged in thickness from a few inches to 2 feet and consisted of silty sand (SM), clayey sand (SC), and sandy lean clay (CL).

B.1.c. Fill

Fill was encountered beneath the topsoil and pavement materials at a majority of the borings and at the surface of Borings OMF-1, OMF-2, OMF-5, and OMF-22. The fill consisted of poorly graded sand (SP), poorly graded sand with silt (SP-SM), silty sand, clayey sand, lean clay (CL), sandy lean clay, and peat (PT). Table 1 below illustrates the depth and elevations of fill materials encountered.

Table 1. Fill Depths and Elevations at Boring Locations

Boring	Boring Elevation (ft)	Approximate Depth of Fill (ft)	Elevation at Bottom of Fill (ft)	Fill Composition
OMF-1	899.6	10	889 ½	SM, SP-SM
OMF-2	898.1	7	891	SM, SP-SM
OMF-3	900.1	2	898	SM
OMF-4	898.3	9	889	SM, SP
OMF-5	903.5	9	894 ½	SC, SM, CL
OMF-6	904.5	9	895 ½	SM, SP
OMF-7	899.8	8	892	SP-SM, PT, CL
OMF-8	898.7	4	894 ½	SM
OMF-9	897.8	4	894	SM, SP
OMF-10	898.0	3	895	SC
OMF-11	897.7	9	889	SM, CL
OMF-12	899.3	9	890	SC, SM
OMF-13	899.4	6	893 ½	SC, SP-SM
OMF-14	901.7	9	893	SM
OMF-15	899.5	4	895 ½	SM
OMF-16	902.2	7	895	SM, CL

Boring	Boring Elevation (ft)	Approximate Depth of Fill (ft)	Elevation at Bottom of Fill (ft)	Fill Composition
OMF-17	901.8	4	897 ½	CL
OMF-18	902.3	1	901	SP-SM
OMF-19	901.0	2	899	SM
OMF-20	904.0	4	900	SM
OMF-21	901.2	4	897	SM
OMF-22	905.0	12	893	SC, SM, SP-SM
OMF-23	903.0	12	891	SP
OMF-24	902.1	1	901	SP-SM
OMF-25	903.9	4	900	CL, SM
OMF-26	905.4	4	901 ½	SP-SM
OMF-27	904.4	½	904	SC
OMF-28	906.8	7	900	SP, SM
OMF-29	906.6	6	900 ½	SP, SM
OMF-30	905.7	7	899	CL

A faint petroleum odor was noted in Boring OMF-2 at the 2½-foot sample. We have notified the project team of the odor, and understand an environmental program will take place to further investigate the site.

B.1.d. Swamp Deposits

Swamp deposits were encountered directly below the topsoil or fill at Borings OMF-2, OMF-3, OMF-7, OMF-8, OMF-9, OMF-10, OMF-13, OMF-14, OMF-15, OMF-19, OMF-21, and OMF-27. The swamp deposits consisted of silty sand, silt (ML), clayey sand, lean clay, and peat. The swamp deposits extended to varying depths ranging from ½-foot to 12 feet below existing grade, corresponding to elevations 899 to 879.

2.1.e. Alluvium Soils

Varying layers of alluvial soils were encountered directly below the fill and swamp deposits in Borings OMF-3, OMF-5, OMF-10 and OMF-14. The alluvial deposits consisted of silty sand and silt varying in depths ranging from 9 to 16 feet below the existing grade, corresponding to elevations 895 to 886.

B.1.f. Glacial Soils

Glacial soils were encountered in all of the borings below the fill, swamp deposits and alluvial soils to boring termination depths. The glacial soils consisted of till and outwash with classifications including poorly graded sand, poorly graded sand with silt, silty sand, clayey sand, lean clay and sandy lean clay. Glacial soils have the potential to contain cobbles and boulders.

B.1.g. Penetration Resistance Testing

The results of our penetration resistance testing from the borings are summarized below in Table 2. Comments are provided to qualify the significance of the results.

Table 2. Penetration Resistance Data

Geologic Material	Classification	Range of Penetration Resistances*	Comments
Fill	SP, SP-SM, SM, SC, CL, PT	2 to 25 BPF	Variable compaction
Swamp Deposits	SM, ML, SC, CL, PT	2 to 8 BPF	Slightly to moderately consolidated
Native Soils	SP, SP-SM, SM, ML	1 to 38 BPF	Locally very loose to dense, generally loose to medium dense
	SC, CL	4 to 32 BPF	Locally rather soft to hard, generally medium to very stiff

*BPF-Blows per Foot

2.2. Summary of Water Level Measurements

Groundwater was measured or estimated to be located at the depths shown below in Table 3. Corresponding groundwater elevations were determined from comparisons of the observed depths to groundwater and surface elevations, and were rounded to the highest ½-foot.

Table 3. Groundwater Summary

Location	Surface Elevation	Observed Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
OMF-1	899.6	7	892 ½
OMF-2	898.1	5	893
OMF-3	900.1	4	896
OMF-4	898.3	4	894

Location	Surface Elevation	Observed Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
OMF-5	903.5	9	894 ½
OMF-6	904.5	7	897 ½
OMF-7	899.8	8	892
OMF-8	898.7	5	893 ½
OMF-9	897.8	2 ½	895
OMF-10	898.0	9	889
OMF-11	897.7	2 ½	895
OMF-12	899.3	5	893
OMF-13	899.4	6 ½	893
OMF-14	901.7	14	888
OMF-15	899.5	3 ½	896
OMF-16	902.2	7 ½	895
OMF-17	901.8	4	898
OMF-18	902.3	7 ½	895
OMF-19	901.0	6	895
OMF-20	904.0	10	894
OMF-21	901.2	6 ½	894 ½
OMF-22	905.0	7	898
OMF-23	903.0	5	898
OMF-24	902.1	4	898
OMF-25	903.9	5	899
OMF-26	905.4	7	898 ½
OMF-27	904.4	12	892 ½
OMF-28	906.8	7 ½	899 ½
OMF-29	906.6	7 ½	899
OMF-30	905.7	7	898 ½

Groundwater was encountered at all of the boring locations at depths ranging from 2 ½ to 14 feet beneath the surface, or elevations ranging from 899 ½ to 888 feet Above Mean Sea Level (MSL). The majority of the borings encountered groundwater between elevations 895 and 899. Seasonal and annual fluctuations of groundwater, however, should be anticipated.

Basis for Recommendations

3.1. Proposed Construction

The proposed OMF facility is in preliminary planning stages. At this time, we were provided with the following information from the design team:

- The proposed facility will consist mainly of a one-story structure; however, portions of the building will contain a second and third story.
- The eastern portion of the facility will have a below-grade area for maintenance bays.
- Several tracks will enter and exit the facility to allow for vehicle access.

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

3.2. Design and Construction Considerations

Historically, this area is known to contain areas of organic deposits. Based on the borings, it appears that some of the organic deposits were removed during construction of the existing buildings; however, there are areas of fill and swamp deposits that were left in place and are not considered suitable for support of the proposed OMF facility or any proposed embankments. The groundwater elevation appears to be shallow in this area and will affect excavations and may affect areas such as maintenance pits or below grade levels.

We will discuss several options for support of the facility in the following sections, including an excavate/backfill approach, helical piers, and rammed aggregate piers.

It should be noted that our recommendations may be altered by the results of any environmental testing. We understand a testing program will be implemented across the site.

Groundwater was encountered at depths ranging from 2 ½ to 14 feet beneath the surface during or immediately after drilling operations. Groundwater shall be removed from excavations; however, consideration should also be given to the effects of dewatering on neighboring structures. Additional analyses will be required to determine the extent of dewatering that can occur.

Recommendations

The following sections provide preliminary recommendations for several options to support the proposed facility. The final approach to construction will be dependant on the final building loads, groundwater levels, and environmental considerations.

4.1. Excavate/Backfill Approach

An excavate/backfill approach is a common approach to supporting structures. However, the cost of dewatering and environmental considerations should contaminated soils or groundwater exist be taken into consideration prior to proceeding with this approach.

We recommend removing vegetation, topsoil, topsoil fill, pavements, existing fill, swamp deposits and portions of the alluvial soils within the building pad areas and oversized areas. This requirement is to be applied to any building structure on the proposed site. To properly support the proposed structure, we recommend removing the unsuitable soils and replacing them with engineered fill. Table 4 below provides the recommended excavation depths at the borings locations.

Table 4. Recommended Excavation Depths at Boring Locations

Boring	Ground Surface Elevation (feet)	Anticipated Depth of Excavation (feet)	Anticipated Bottom of Excavation (feet)	Observed Groundwater Elevation (feet)*
OMF-1	899.6	10	899 ½	892 ½
OMF-2	898.1	12	886	893
OMF-3	900.1	12	888	896
OMF-4	898.3	9	890	894
OMF-5	903.5	14	889 ½	894
OMF-6	904.5	9	895 ½	897 ½
OMF-7	899.8	12	888	892

Boring	Ground Surface Elevation (feet)	Anticipated Depth of Excavation (feet)	Anticipated Bottom of Excavation (feet)	Observed Groundwater Elevation (feet)*
OMF-8	898.7	5	894	893 ½
OMF-9	897.8	7	891	895
OMF-10	898	12	886	889
OMF-11	897.7	9	889	895
OMF-12	899.3	9	890	893
OMF-13	899.4	9	890 ½	893
OMF-14	901.7	16	886	888
OMF-15	899.5	9	890 ½	896
OMF-16	902.2	7	895	895
OMF-17	901.8	4	898	898
OMF-18	902.3	1	901	895
OMF-19	901	8	893	895
OMF-20	904	4	900	894
OMF-21	901.2	22	879	894 ½
OMF-22	905	12	893	898
OMF-23	903	12	891	898
OMF-24	902.1	1	901	898
OMF-25	903.9	4	900	899
OMF-26	905.4	4	901 ½	898 ½
OMF-27	904.4	12	892 ½	892 ½
OMF-28	906.8	7	900	899 ½
OMF-29	906.6	6	900 ½	899
OMF-30	905.7	7	899	898 ½

*-Groundwater observations were made during a relatively short period of time on the dates we were onsite. Observations in other seasons or if long term monitoring is performed, these elevations may be higher.

Excavation depths will vary between the borings. Portions of the excavations may also be deeper than indicated by the borings. Contractors should also be prepared to extend excavations in wet and fine-grained soils to remove disturbed bottom soils.

To provide lateral support to the structural loads they will support, we recommend oversizing (widening) the excavations 1 foot horizontally beyond the edge of the footings for each foot the excavations extend below bottom-of-footing subgrades.

Upon removal of the unsuitable soils as noted above, we anticipate the excavations bottoms will consist predominately of sandy soils, with clays noted in Borings OMF-5 and OMF-11. Based on Table 4, it is anticipated that the excavation bottom elevations will be near or below the observed groundwater elevations. If waterbearing sands are encountered, the excavations should be performed with care as the water coupled with vibration and disturbance from construction activities could result in temporary "quick" conditions in the soils. These soils would then not stabilize without temporary dewatering and compaction, and subcutting would likely be needed.

4.1.a. Excavation Dewatering

Groundwater was encountered at depths ranging from 2 ½ to 14 feet beneath the surface during, during drilling operations. The depth of groundwater will affect the removal of the swamp deposit soils in some areas and may affect utility installations.

Sumps and pumps can be considered for excavations in low-permeability silt- and clay-rich soils, or where groundwater can be drawn down 2 feet below the bottom of excavations in more permeable sands. In large excavations, or where groundwater must be drawn down more than 2 feet, a well contractor should review our logs to determine if wells or well points are required, how many will be required and to what depths they will need to be installed.

In sands, we do not recommend attempting to dewater within an excavation. Upward seepage will loosen and disturb the excavation bottom. Rather, groundwater should be drawn down at least 2 feet below the anticipated excavation bottom prior to excavation.

Consideration should also be given to the effects of dewatering on neighboring structures. Excessive drawdown of the water may result in consolidation of organic or sandy soils outside of the construction area, resulting in potential impacts on neighboring streets or structures. Additional analyses will be necessary to determine the extent of dewatering that can occur.

4.1.b. Excavation Support

The fill, swamp deposits and alluvial soils are considered Type C soils under OSHA guidelines. Unsupported excavations or areas that are dewatered should therefore be maintained at a gradient no steeper than 1 ½ to 1 (horizontal: vertical). Beneath the groundwater level, the slopes of unsupported soils may be as shallow as 6:1.

Slopes constructed in this manner may still exhibit surface sloughing. If site constraints do not allow the construction of temporary slopes with these dimensions, then temporary shoring may be required and we should be consulted for additional recommendations. OSHA requires that slope and excavations over 20 feet in depth need to be evaluated by an engineer.

An OSHA approved competent person should review this soil classification in the field. Excavations must comply with the requirements of OSHA 29 CFR, Part 2926, Subpart P, “Excavations and Trenches”. This document states that excavation safety is the responsibility of the contractor. Reference to these OSHA requirements should be included in the project specifications.

4.1.c. Placement Compaction of Backfill and Fill

We recommend backfilling over wet or submerged excavation bottoms at least two feet above the water with coarse sand having less than 70 percent of the particles by weight passing a #40 sieve and less than 10 percent of the particles by weight passing the #200 sieve. We anticipate that this material will need to be imported.

Once above the groundwater, we anticipate the onsite sandy soils free of organic material or debris can be reused to establish building, track and pavement subgrades elevations. Should additional fill be required to balance the site, we recommend imported fill meet the requirements of MnDOT Specification 3149.2 (Granular Borrow) to maintain soil consistency across the site.

We recommend spreading backfill and fill in loose lifts no thicker than 12 inches. Smaller equipment may require thinner lifts to meet specified density. We recommend compacting backfill and fill in accordance with the criteria presented below in Table 5.

Table 5. Compaction Recommendations Summary

Reference	Recommended Soil types for fill	Relative Compaction, minimum percent (ASTM D 698 – standard Proctor)	Moisture Content Variance from Optimum, percentage points
Below foundations and slabs	Granular soils with less than 20 percent fines	98	-1 to +3
Below foundations and slabs, beneath groundwater levels	Granular soils containing less than 70% passing the #40 sieve and less than 10% passing the #200 sieve	98	+/- 3
Below pavements, within 3 feet of subgrade elevations	Non-Organic Mineral soils, Ideally Granular	100	+/- 1
Below pavements, more than 3 feet below subgrade elevations	Non-Organic Mineral soils	95	+/- 3
Below landscaped surfaces	Mineral soils or topsoil	90	+/- 5

D.2. Spread Footings

D.2.a. Embedment Depth

For frost protection, we recommend embedding perimeter footings at least 42 inches below the lowest exterior grade in heated portions of the building. Interior footings may be placed directly below floor slabs. We recommend embedding building footings not heated during construction, and footings in unheated areas at least 60 inches below the lowest exterior grade.

D.2.b. Net Allowable Bearing Pressure

We recommend sizing spread footings to exert a net allowable bearing pressure of up to 3,500 pounds per square foot (psf). This value includes a safety factor of at least 3 with regard to bearing capacity failure. The net allowable bearing pressure can be increased by one-third its value for occasional transient loads, but not for repetitive loads due to traffic, or for other live loads from snow or occupancy.

The final bearing capacity of the soils should be re-evaluated during final design and may be modified depending on the final building loads.

D.2.c. Settlement

We estimate that total and differential settlements among the footings will amount to less than one-inch and one-half inch, respectively, under the reported (or assumed) loads.

4.3. Helical Pier Foundation System

Helical piers may be used as an alternative foundation system where it is not practical to remove the fill and organic soils due to site constraints, groundwater conditions, or if potential environmental impacts limit the generation of spoil piles or make it cost prohibitive to remove soils from the site.

Helical piers consist of hollow tubes or solid square steel shafts, typically 1 ½ to 3 ½ inches in diameter, to which a series of steel plates are attached. Because the shafts are structurally slender, helical piers derive most of their capacity through plate bearing. Once the number, size and spacing of the plates has been determined based on loading requirements, the piers are screwed into the ground until a specified torque and minimum depth are met.

The helical anchors could be placed along the footing lines and beneath columns and incorporated into a grade beam foundation to support the structure. Similarly, the piers can be incorporated into a structural slab to support the floor or tracks.

Organic soils can also be corrosive to the helical anchor shafts. We recommend evaluating the corrosivity of the soils with respect to the helical anchor shafts. Using galvanized steel shafts, or grouting around the shafts can reduce the effects of corrosion.

A number of options are available regarding the type of the helical piers to be used. Once building loads are known and the design of the structure has progressed, the type, length, and number of helices can be evaluated. The specialty contractor doing the installation should calculate the final design length, capacity and number, size and spacing of the helical anchors.

4.3.a. Embedment Depth

We recommend that helical piers be extended into the native glacial soils, which appear to be present at depths on the order of 1 to 22 feet below existing grades. Note that the entire lead section of each pier – including all bearing plates – should extend into or penetrate the anticipated bearing stratum.

4.3.b. Capacity

Ultimate capacities on the order of 80 to 120 kips can typically be developed depending on the type of shaft, number of helices, and embedment depth of the piers. Upon completion of the building design, further analyses of the pier capacities can be determined. If independent observation is provided during installation, a factor of safety of 2.0 can be used to determine pier working capacities.

The specialty contractor doing the installation should calculate the final design length, capacity and number, size and spacing of the helical anchors.

4.3.c. Grouting

The relatively soft swamp deposited soils within the upper 20 feet of the subgrade will likely not provide sufficient lateral support to the anchor shafts. As a result, we recommend encasement of the shafts in grout to provide lateral stability. An added benefit of the grout encasement of the anchor shaft will be increased, but not total protection against corrosion, as organic soils are generally considered corrosive.

4.3.d. Settlement

Structure settlement varies according to pier type, load capacity and the composition/consistency of the bearing strata. We currently estimate structures or improvements supported on helical piers will not likely settle more than ½ inch, however, final settlement estimates would be dependent on design and installation depth.

4.4. Rammed Aggregate Piers

Another alternative for foundation support of the structures is rammed aggregate piers (i.e. stone columns). Rammed aggregate piers were recently identified as the preferred foundation system and for floor slab support. This system will not require full removal of unsuitable soils. These piers are composed of densely compacted, well-graded aggregates such as highway/roadway base course. They are constructed by drilling a shaft or advancing a mandrel through the looser or softer soil, densifying and pre-stressing the soil at the base of the hole with a proprietary high-energy impact compactor, and backfilling the hole with thin lifts of aggregate compacted to about 100 percent of its maximum modified Proctor dry density, ASTM D 1557.

High capacity side friction is developed in aggregate pier foundation elements, caused by build-up of lateral soil stresses during compaction of the aggregate. In addition to the side friction provided by the undulating sides of the aggregate piers and the increased lateral soil stresses, the bottoms of the aggregate piers are supported by a combination of pre-stressing and densification of the subsoils at the bottom of aggregate pier cavities during compaction. This develops aggregate "bulbs" at the bottom of the aggregate piers.

This process creates a series of very stiff, very dense foundation elements that reduce settlement from structural loads. Conventional footing foundations and floor slabs constructed over the aggregate pier-reinforced soil accomplish the load transfer.

In our opinion, the soils beneath the proposed structures can be improved with aggregate piers. If neighboring structures are sensitive to vibrations, we recommend vibrations be further evaluated and that the licensed design/build contractor be consulted to provide further information in regards to vibration. Since aggregate piers are a proprietary system, the design should be customized for this project by a licensed design/build contractor such as Ground Improvement Engineering (formerly Geopier Midwest).

4.5. Embankments and Pavements

Based on the current design information, we recommend budgeting to remove swamp deposited/organic soils from below the proposed track alignment and embankment areas where they are raising grade. It appears the embankments will have significant amounts of new fill (more than 5 feet and typically 8 or 9 feet) based on available drawings.We anticipate there may be areas other than those noted by the borings where organic soils may be present, especially in areas where parking lots or green space currently exist.

Parking and drive areas can typically tolerate larger magnitudes of settlement as compared to buildings, but may settle differentially, created low areas, or “birdbaths” throughout paved areas. Because of the large amount of pavement area, we presume large sheet drainage cannot be created to reduce the amount of ponding water that occurs in areas of differential settlement on this site. With the large raise in grade (about 8 feet) in areas across the site, there will be significant post-construction settlement. If a construction delay is allowed there will be some post-construction settlement, but to a lesser extent. Bituminous pavement handles differential settlement, cracking, maintenance and repairs much better than concrete. This is well suited for bituminous pavements as opposed to concrete pavements. If concrete pavement is used, we should review the area that concrete pavement will be used to see if additional earthwork is needed to minimize pavement performance problems.
Cracking and differential settlement (with ponding) will occur in some areas, which is not an uncommon condition for parking lots. A solution to reduce ponding is to keep grades as steep as possible.

Shallow utilities and curb and gutter could also be floated on the new embankment with some settlement. Utility lines would have to be properly pitched and constructed such that settlement to the pipe will still allow for positive flow. Settlement could also cause cracking in concrete curb and gutter resulting in earlier than normal maintenance costs for repairs. If the owner is not willing to accept some differential settlement and cracking in these areas, then the organic soils should be removed and replaced.

If the organic soils are not removed beneath light poles bases, settlements exceeding several inches could occur. We recommend removing all fill and organics beneath light pole bases, or extending foundations through the unsuitable material to the underlying glacial soils.

We also understand there are concerns regarding dewatering and deep soil corrections due the impacts it may have on the local groundwater and the potential for contaminated soils. If these issues render an excavate/backfill approach as not feasible, we recommend supporting the embankments on aggregate piers as well to reduce the risk of differential settlement along the embankment.

4.6. Retaining Walls

There is a proposed retaining wall about 8 feet in height located in the southern portion of the site. We recommend completely removing the fill and organic soils below the proposed wall, including the oversized area. If there are short walls in other areas of the site, it is possible they can be constructed without significant, or any, excavation below the walls depending on the wall height and settlement tolerance of the wall. Prior to final design, we should be made aware of proposed wall details and locations. We recommend considering wall types that are more accepting of settlement (Modular Block or Boulder).

Another option to avoid excavation and backfill near the proposed wall would be to use an aggregate pier system for both the retaining wall and the adjacent embankment. If there is a need to reduce differential settlement between areas of the embankment that are supported on aggregate piers and areas that are not, it may be necessary to use aggregate piers for the entire embankment area located on the south end of the site.

Again, if the depth of excavation and dealing with groundwater issues is a concern, these could also be supported on aggregate pier foundations, minimizing the depth of excavation and impacts of dewatering.

4.7. Utilities

With the large proposed raise in grade near the southern portion of the proposed site, we recommend removing the organic soils below utility areas. Storm sewers that are placed after a construction delay and after the embankment is constructed could be placed without subgrade correction in other areas of the site. Deeper utilities, such as sanitary and water, that are more sensitive to settlement should be placed on a prepared subgrade (the organic soils should be removed beneath the pipe). If utilities are placed after a construction delay after grading, additional subgrade correction is likely not necessary unless inverts are within soft or loose soils or within organics or silt layers.

We recommend budgeting for some periodic subgrade correction, sand stabilizing material, aggregate stabilizing material and separation geotextile fabric for utility construction. Isolated pockets of poor soils will likely be encountered. Proper engineering analysis during construction can likely mitigate the extent of any necessary subgrade correction.

4.8. Infiltration Rates

Based on the most recent site plan, there are two infiltration areas located in the northern portion and two infiltration areas located in the southern portion of the site. Based on the borings in the proposed infiltration areas, Table 6 below provides some preliminary infiltration rates based on the “Design Infiltration Rates”, *Minnesota Storm Water Manual*. This table may be revised upon final design and location of the infiltration areas.

Table 6. Preliminary Infiltration Rates

Hydrologic Soil Group	Soil Classification	Infiltration Rate (inches/hour)

A	SP, SP-SM	0.8
B	SP-SM, SM	0.45
C	ML	0.2
D	SC, CL, OH, OL	0.06

Note: A separation distance of 3 feet is required between the bottom of the infiltration practice and the elevation of the seasonally high water table (saturated soil).

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with a truck-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 ½- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout.

E.2. Material Classification and Testing

E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

E.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled as noted on the boring logs.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.3. Use of Report

This preliminary report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects. Upon completion of final design, our report will be reviewed and updated as needed.

6.4. Remarks

The results and recommendations presented in this letter should be considered preliminary. We recommend additional borings be conducted once the final location of the building is known, as well as anticipated building loads. The results of the environmental site investigation may also affect our recommendations.

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If you have any questions regarding this letter, please contact Josh Kirk at 952.995.2222 or Matt Ruble at 952.995.2224.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
AssociatePrincipal/Project Engineer
License Number: 45005

Reviewed by:

Ray A. Huber, PE
Vice President/Principal Engineer

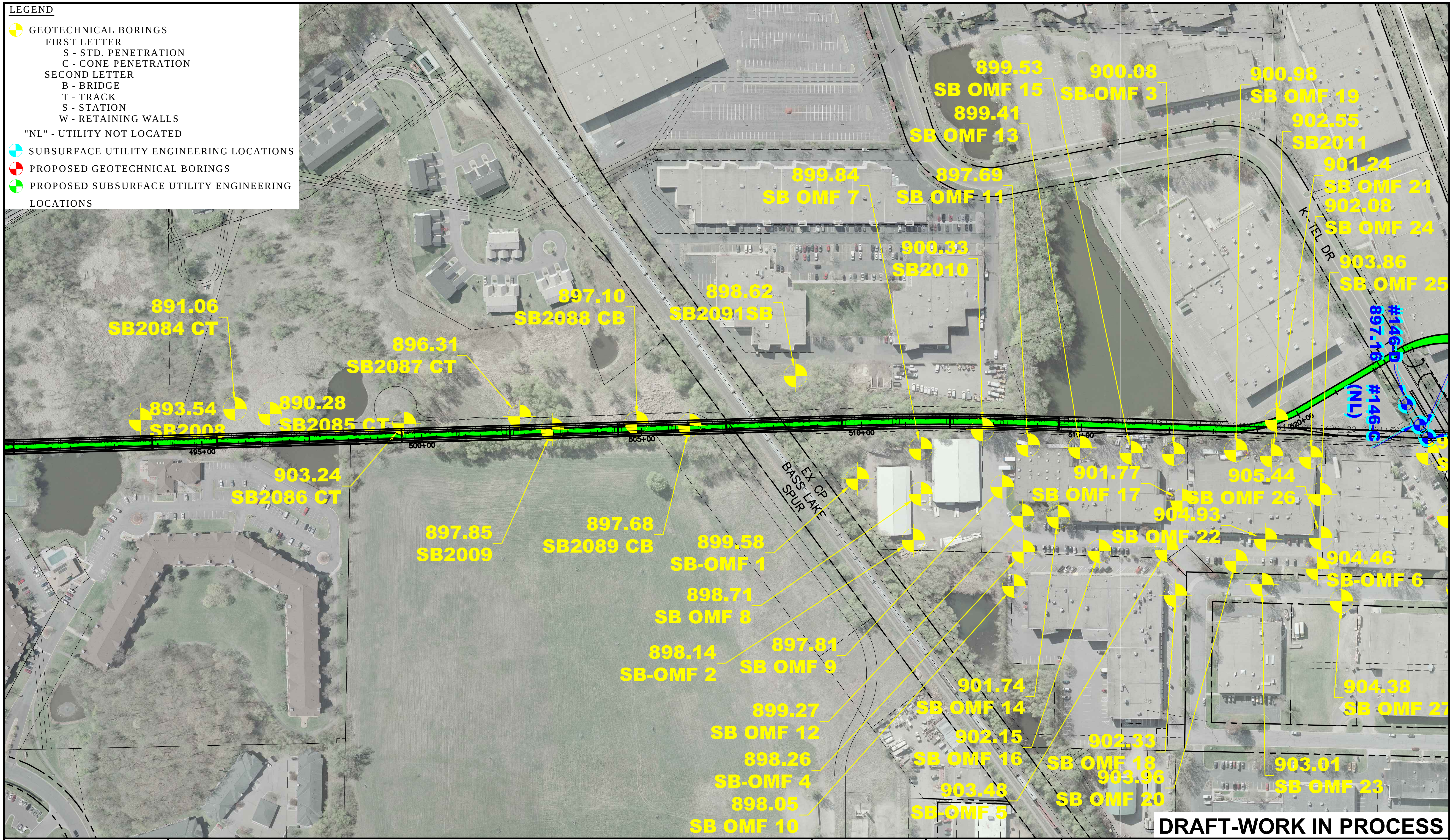
Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Soil Boring Location Sketch
Preliminary Engineering Plan-OMF Facility
Standard Penetration Borings OMF-1 through OMF-30
Descriptive Terminology of Soil

c: Mr. Jeff Stewart: SPO

APPENDIX



DRAFT-WORK IN PROCESS

SOUTHWEST Green Line LRT Extention

SOUTHWEST LIGHT RAIL

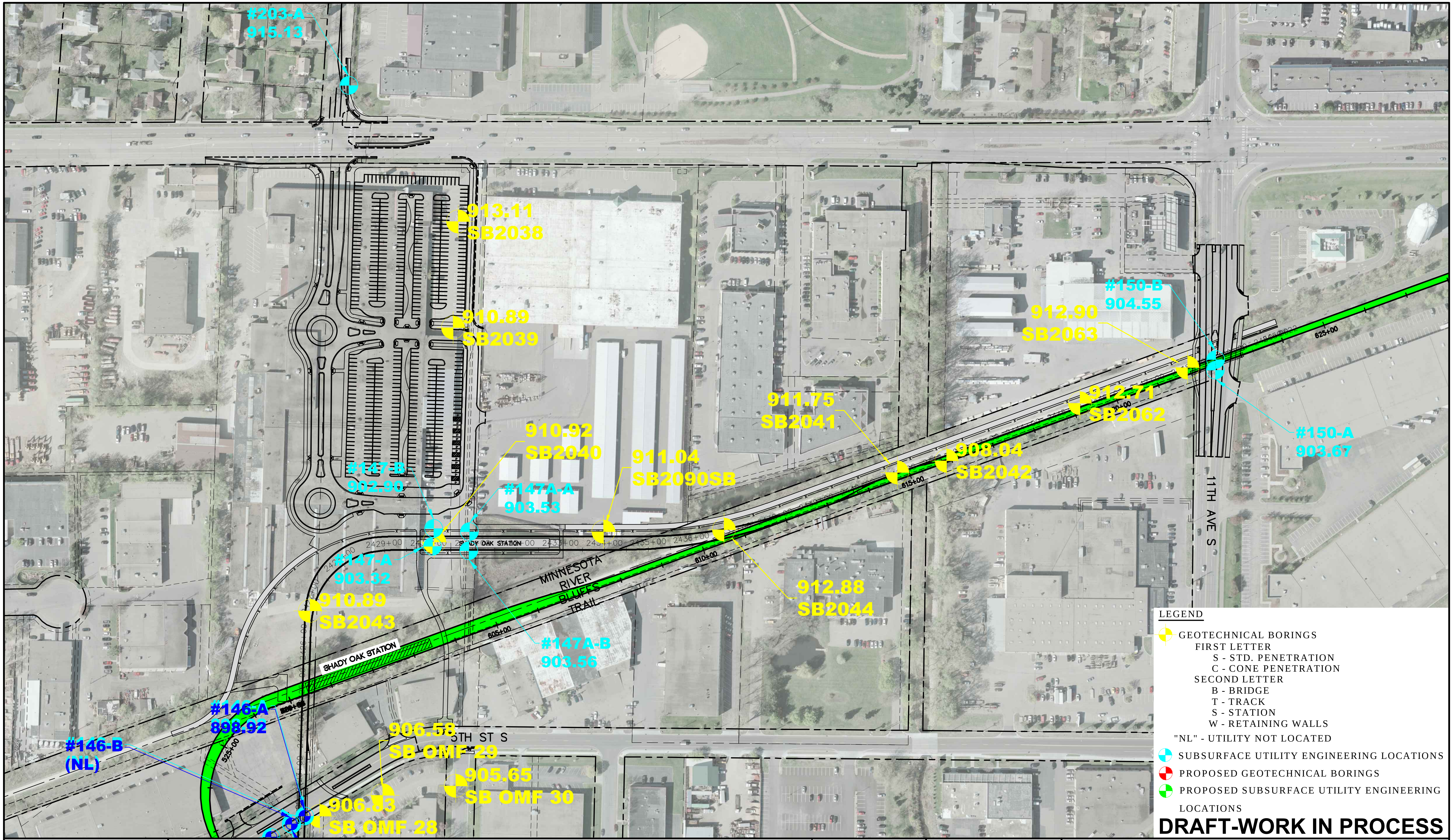
SOIL BORINGS
SHEET 11 OF 12

IRT: N/A
REV: 0
DATE: 06/30/2014

NORTH
0 50 100 200

METROPOLITAN COUNCIL
AECOM
SRF Consulting Group, Inc.

Aug. 28 2014 11:34 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



LEGEND

- GEOTECHNICAL BORINGS
  - FIRST LETTER
    - S - STD. PENETRATION
    - C - CONE PENETRATION
  - SECOND LETTER
    - B - BRIDGE
    - T - TRACK
    - S - STATION
    - W - RETAINING WALLS
- "NL" - UTILITY NOT LOCATED
- SUBSURFACE UTILITY ENGINEERING LOCATIONS
- PROPOSED GEOTECHNICAL BORINGS
- PROPOSED SUBSURFACE UTILITY ENGINEERING LOCATIONS

DRAFT-WORK IN PROCESS

SOUTHWEST
Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 12 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

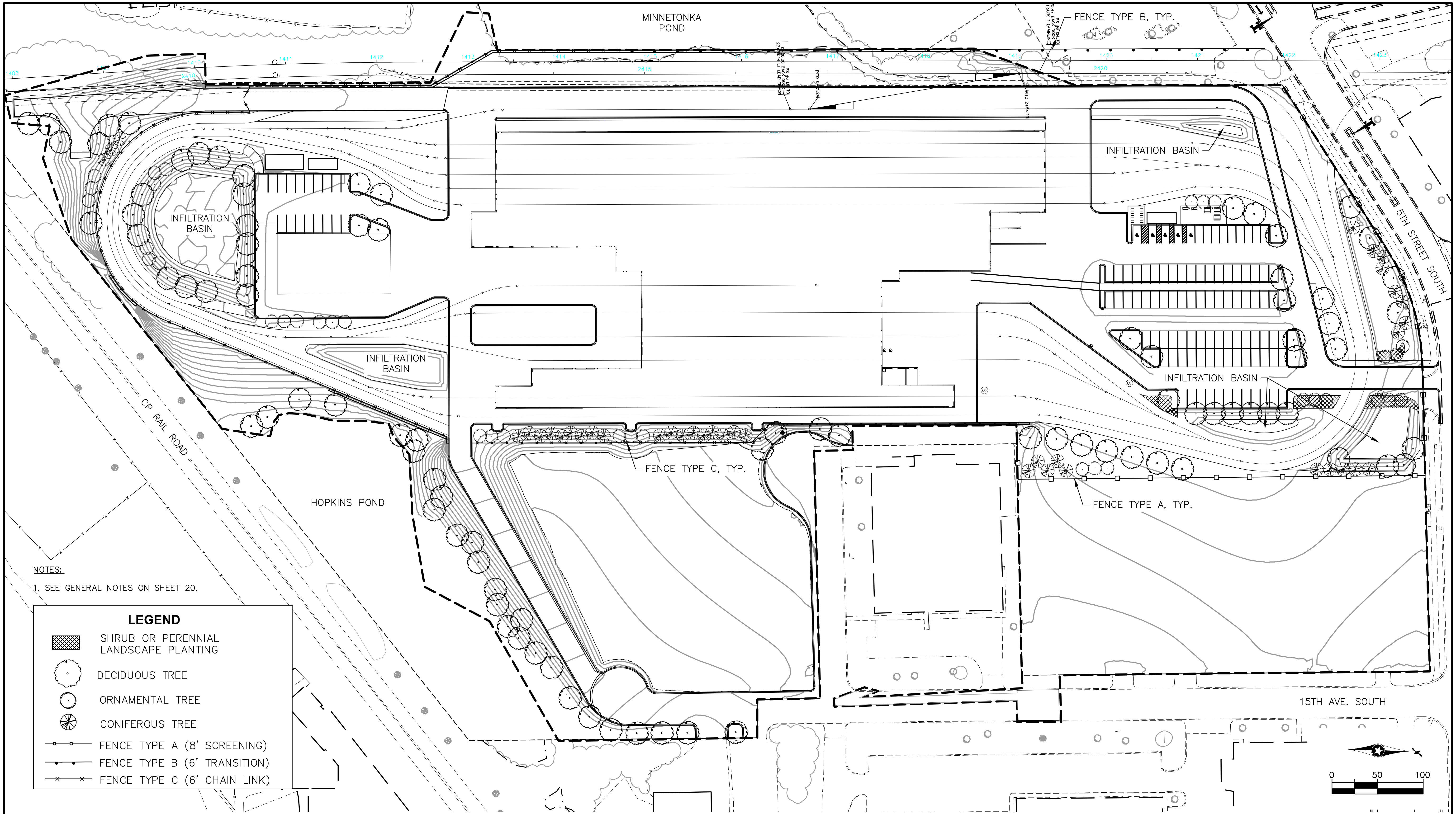
NORTH
0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.

Aug, 28 2014 11:35 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



NOTES:

1. SEE GENERAL NOTES ON SHEET 20.

LEGEND

▨ SHRUB OR PERENNIAL LANDSCAPE PLANTING

⊙ DECIDUOUS TREE

○ ORNAMENTAL TREE

⊛ CONIFEROUS TREE

—○— FENCE TYPE A (8' SCREENING)

—●— FENCE TYPE B (6' TRANSITION)

—×— FENCE TYPE C (6' CHAIN LINK)

Jun. 13 2014 11:21 am H:\Projects\7984\3200_PEC-W\CAD\OMF\PLAN SHEET\LANDSACPE\OMF-LANDSCAPE-PLANS.dwg By: sjergens

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

AECOM

SRF Consulting Group, Inc.

PRELIMINARY DESIGN

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST - VOLUME 4 (OMF)
LANDSCAPING
SITE PLAN - OVERALL

SHEET 21 OF 288

DISCIPLINE: LANDSCAPE

SHEET NAME: LS-100

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-1** LOCATION: N: 144481.4; E: 490030.2. See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: 7/1/13	SCALE: 1" = 4'

Elev. feet 899.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist.				
898.6	1.0	FILL	FILL: Poorly Graded Sand with Silt, trace Gravel, brown, wet.				
				9		10	P200=11%
895.6	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, wet to 7 1/2 feet then waterbearing.				
				20			
					▽		
				21			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed wile drilling. Groundwater levels fluctuate.
889.6	10.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, loose. (Glacial Outwash)	8			
				9		19	P200=4%
				8			
				6			
				9			*Water observed at 7 feet with 7 feet of hollow-stem auger in the ground. Water observed at 7 feet with 29 1/2 feet of hollow-stem auger in the ground.
				10			Boring then backfilled with bentonite grout.
868.6	31.0		END OF BORING.*				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:25

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-2**

LOCATION: N: 144608.9 E: 490169.8.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **7/1/13**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 898.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
897.1	1.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist.				
		FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Silt inclusions, brown, wet to 5 feet then waterbearing.	6			Faint petroleum odor detected at 2 feet.
891.1	7.0			2	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate.
889.1	9.0	CL	Slightly Organic Lean Clay, with Sand, trace shells, black, wet. (Swamp Deposit)	2		34	OC=4%
886.1	12.0	ML	SILT, trace Roots, gray, waterbearing, rather soft. (Alluvium)	4			
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, medium dense to loose. (Glacial Outwash)	14			
879.1	19.0			6		13	P200=1%
		SC	CLAYEY SAND, fine- to medium-grained, trace of Gravel, with Sand lenses at 20 feet, brown, waterbearing, rather stiff to very stiff. (Glacial Till)	11			
				13			*Water observed at 5 feet with 5 feet of hollow-stem auger in the ground. Water observed at 5 feet with 29 1/2 feet immediately after withdrawal of auger.
867.1	31.0			24			Boring then backfilled with bentonite grout.
			END OF BORING.*				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:25

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-3**

LOCATION: N: 145200.6; E: 489973.9.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: 7/1/13

SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 900.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.8	0.4	PAV	4 inches of Bituminous.				
898.1	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist.				
888.1	12.0	PT	PEAT, with Organic Clay layer at 2 feet, dark brown to black, wet. (Swamp Deposit) with fibers at 6 feet. with gray Silt layer at 10 to 12 feet.	4 3 2 3	▽	209	OC=35%
886.1	14.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, gray, waterbearing, loose. (Alluvium)	7		19	P200=16%
881.1	19.0	SP	POORLY GRADED SAND, medium- to coarse-grained, with Gravel, gray, waterbearing, loose. (Glacial Outwash)	6			
871.1	29.0	SP	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, with occasional lenses of brown Silt, grayish brown, waterbearing, loose. (Glacial Outwash)	9 8		24	P200=4% *Water observed at 4 feet with 4 feet of hollow-stem auger in the ground. Water observed at 4 feet with 29 1/2 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.
869.1	31.0	CL	SANDY LEAN CLAY, trace Gravel, with frequent Sand lenses, brown, wet, rather stiff. (Glacial Till)	11			
			END OF BORING.*				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:25

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-4** LOCATION: N: 144858.8; E: 490196.2. See attached sketch.
DRILLER: S. McLean / METHOD: 3 1/4" HSA, Autohammer	DATE: 7/2/13 / SCALE: 1" = 4'

Elev. feet 898.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
897.2	1.1	PAV	8 inches of Bituminous over 5 inches of Aggregate Base.				
894.3	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist.	19	▽		
889.3	9.0	FILL	FILL: Poorly Graded Sand, fine- to coarse-grained, with Gravel, with occasional Lean Clay lenses, brown, waterbearing.	9 8		 9	 P200=2%
886.3	12.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose. (Glacial Outwash)	10			
884.3	14.0	SC	CLAYEY SAND, with Gravel, brown, waterbearing, medium. (Glacial Till)	6			
867.3	31.0	SP	POORLY GRADED SAND, with Gravel, with inclusions of coarse Sand, brown, waterbearing, loose to medium dense. (Glacial Outwash)	12 8 10 13		 17	Clayey Sand layer at 15 feet. P200=4% *Water observed at 4 feet with 4 feet of hollow-stem auger in the ground. Water observed at 4 feet with 29 1/2 feet immediately after withdrawal of auger. Boring then backfilled with bentonite grout.
			END OF BORING*				

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-5**

LOCATION: N: 145184.9; E: 490192.1.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: 7/2/13

SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 903.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.5	2.0	FILL	FILL: Clayey Sand, trace Gravel, brown, moist.				
899.5	4.0	FILL	FILL: Silty Sand, slightly Organic, fine- to medium-grained, trace Gravel, trace Bituminous, black, moist.	12		10	OC=2%
894.5	9.0	FILL	FILL: Sandy Lean Clay, slightly Organic, with Gravel, black, wet.	4 4	▽	 12	 OC=2%
889.5	14.0	ML	SILT, trace roots, gray, waterbearing, very loose to loose. (Alluvium) With waterbearing Sand lense at 12 feet.	3 6			
884.5	19.0	CL	LEAN CLAY, with Sand, gray, wet, rather stiff. (Glacial Till) With waterbearing Sand lense at 16 feet.	9			
874.5	29.0	SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	8 20			*Water observed at 9 feet with 9 feet of hollow-stem auger in the ground. Water observed at 5 1/2 feet with 29 1/2 feet immediately after withdrawal of auger. Boring then backfilled with bentonite grout.
872.5	31.0	CL	LEAN CLAY, with Silt inclusions, gray, wet, medium. (Glacial Till)	8			
			END OF BORING.*				

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-6**

LOCATION: N: 145527.4; E: 490234.7.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: 7/2/13

SCALE: 1" = 4'

Elev. feet 904.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
904.1	0.4	PAV	4 1/2 inches of Bituminous.				
902.5	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, brown, moist.				
895.5	9.0	FILL	FILL: Poorly Graded Sand, fine- to coarse-grained, with Gravel, brown, moist to 7 feet then waterbearing.	11 11 12		 18 13	 P200=4%
892.5	12.0	SC	CLAYEY SAND, with Gravel, brown to 10 feet then gray, waterbearing, rather stiff. (Glacial Till)	9		10	
885.5	19.0	CL	SANDY LEAN CLAY, trace Gravel, brownish gray, wet, rather stiff to stiff. (Glacial Till)	13 10			
875.5	29.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, brownish gray, waterbearing, loose to medium dense. (Glacial Till)	12 10			*Water observed at 7 feet with 7 feet of hollow-stem auger in the ground.
873.5	31.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff. (Glacial Till)	11			Water observed at 7 feet with 29 1/2 feet immediately after withdrawal of auger. Boring then backfilled with bentonite grout.
			END OF BORING.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:25

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-7** LOCATION: N: 144625.4; E: 489961.8. See attached sketch.

DRILLER: J. Chermak | METHOD: 3 1/4" HSA, Autohammer | DATE: 6/6/14 | SCALE: 1" = 4'

Elev. feet 899.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.1	0.7	PAV	7 inches of Bituminous.				
		FILL	FILL: Poorly Graded Sand with Silt, fine- to coarse-grained, with Gravel, brown, moist.	22		5	P200=7%
894.8	5.0				▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
892.8	7.0	FILL	FILL: Peat, with fibers, with fine gray Sand layer at 5 feet, black, wet.	6		91	
891.8	8.0	FILL	FILL: Sandy Lean Clay, trace Gravel, brown and gray, wet.	2			
		ML	SILT, with roots, gray, waterbearing, rather soft. (Swamp Deposit/Alluvium)	4		29	DD=102 pcf
887.8	12.0						
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash)	9			
				12			
				6			Jetted.
			Gravel layer at 20 feet.	7			
				14			
				13			
873.8	26.0						
			END OF BORING. Water observed at 8 feet while drilling. Water observed at 4 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-8** LOCATION: N: 144625.4; E: 490064.6. See attached sketch.

DRILLER: J. Chermak | METHOD: 3 1/4" HSA, Autohammer | DATE: **6/6/14** | SCALE: **1" = 4'**

Elev. feet 898.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.0	0.7	AGG	8 inches of Aggregate Base.				
		FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.				
				24		12	
894.7	4.0		Fine-grained at 3 feet.				
893.7	5.0	SC	CLAYEY SAND, trace Gravel, black, wet. (Topsoil Fill)		▽		
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, gray, waterbearing, very loose to medium dense. (Glacial Outwash)	15			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				4		15	P200=11%
886.7	12.0			10			
		SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, with lenses of Silty Sand, gray, waterbearing, loose to medium dense. (Glacial Outwash)	5			Jetted.
				6			
				5			
				9			Jetted.
				14			
872.7	26.0			13			
			END OF BORING. Water observed at 5 feet while drilling. Water observed at 4 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:25

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-9** LOCATION: N: 144810.7; E: 490048.6. See attached sketch.

DRILLER: J. Chermak	METHOD: 3 1/4" HSA, Autohammer	DATE: 6/6/14	SCALE: 1" = 4'

Elev. feet 897.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
896.9	1.0	PAV	4 3/4 inches of Bituminous over 7 inches of Aggregate Base.			
895.8	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, brown, moist.			
893.8	4.0	FILL	FILL: Poorly Graded Sand, fine- to medium-grained, with Gravel, brown, waterbearing.	6	▽	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
892.8	5.0	SM	SILTY SAND, fine- to medium-grained, trace organics, black, wet. (Topsoil/Fill)			
890.8	7.0	CL	LEAN CLAY, trace roots, gray and brown, wet, soft. (Alluvium)	3		
871.8	26.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	13*		*No sample recovery.
				9		
				9		
				12		
			Gravel layers from 17 to 25 feet.	16		Jetted.
				7		
				7		
				10		

END OF BORING.

Water observed at 2 1/2 feet while drilling.

Water observed at 7 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:25

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-10**

LOCATION: N: 144837.4; E: 490274.2.
See attached sketch.

DRILLER: J. Chermak

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/16/14**

SCALE: **1" = 4'**

Elev. feet 898.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
897.0	1.0	PAV	5 1/4 inches of Bituminous over 6 1/2 inches of Aggregate Base.				*END OF BORING AT 31 FEET.
895.0	3.0	FILL	FILL: Clayey Sand, trace Gravel, with lenses of Lean Clay, dark brown and black, moist.	5			Water observed at 12 feet while drilling.
888.0	10.0	PT	PEAT: with fibers, black, wet. (Swamp Deposit)	3 2	∇		Water observed at 9 feet with 29 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.
886.0	12.0	SM	SILTY SAND, trace roots, gray, wet, very loose. (Alluvium)	1		16	P200=16% An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
883.0	15.0	SP	POORLY GRADED SAND, fine- to medium-grained, brown, waterbearing, very loose. (Glacial Outwash)	4			
881.0	17.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose. (Glacial Outwash)	10			
868.0	30.0	SP	POORLY GRADED SAND, fine- to coarse-grained, brown, waterbearing, medium dense to loose. (Glacial Outwash)	18 13 10 13			Jetted. Jetted.
867.0	31.0	CL	SANDY LEAN CLAY, trace Gravel, with layers of Silty Sand, gray, wet, very stiff.* (Glacial Till)	24			Jetted.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:21

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-11**

LOCATION: N: 144869.4; E: 489953.6.
See attached sketch.

DRILLER: J. Chermak	METHOD: 3 1/4" HSA, Autohammer	DATE: 6/6/14	SCALE: 1" = 4'

Elev. feet 897.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
896.5	1.2	PAV	5 3/4 inches of Bituminous over 8 1/2 inches of Aggregate Base.				
893.7	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown to black, wet.	5	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
890.7	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, black, waterbearing.	5		20	OC=1%
888.7	9.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with layers of dark gray to black Poorly Graded Sand, brown, waterbearing.	7			
883.7	14.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff to rather soft. (Glacial Till)	14 4*			Jetted. *No sample recovery.
880.7	17.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, loose. (Glacial Till)	9			
871.7	26.0	SC	CLAYEY SAND, trace Gravel, brown, wet, rather stiff to stiff. (Glacial Till)	15 12 12 14		11	P200=27% Jetted.

END OF BORING.

Water observed at 2 1/2 feet while drilling.

Water observed at 11 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-12**

LOCATION: N: 144856.9; E: 490114.7.
See attached sketch.

DRILLER: J. Chermak

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/6/14**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 899.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.3	1.0	FILL	FILL: Lean Clay, black, wet. (Topsoil Fill)				
895.3	4.0	FILL	FILL: Clayey Sand, trace Gravel, dark brown, moist.	17		9	
890.3	9.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, with wood chunks, brown to black, wet to 5 feet then waterbearing.	6 6	▽	 13	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
873.3	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, very loose to loose. (Glacial Outwash) Gravel layer at 15 feet.	4 9 6 5 6 4 4			Jetted.
			END OF BORING. Water observed at 5 feet while drilling. Water observed at 5 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-13** LOCATION: N: 144987.7; E: 489959.4. See attached sketch.
DRILLER: M. Barber	METHOD: 3 1/4" HSA, Autohammer
DATE: **6/13/14**	SCALE: **1" = 4'**

Elev. feet 899.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.7	0.8	PAV	3 inches of Bituminous over 5 1/2 inches of Aggregate Base.				
895.4	4.0	FILL	FILL: Clayey Sand, trace Gravel, gray, moist.	6			
893.4	6.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, brown, wet.	5		12	P200=11%
890.4	9.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with Peat lenses, gray with layers of black, waterbearing. (Swamp Deposit)	4	∇		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
887.4	12.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, loose. (Glacial Outwash)	5			
873.4	26.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, very loose to loose. (Glacial Outwash)	8 5 9 4 6 8		17	P200=4%
			END OF BORING. Water observed at 6 1/2 feet while drilling. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-14** LOCATION: N: 144938; E: 490117.4. See attached sketch.

DRILLER: M. Barber	METHOD: 3 1/4" HSA, Autohammer	DATE: 6/13/14	SCALE: 1" = 4'

Elev. feet 901.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.7	2.0	FILL	FILL: Silty Sand, fine-grained, trace roots, black. (Topsoil Fill)				
892.7	9.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, with chunks of bituminous at 2 feet, dark brown and brown, moist.	8			
			An organic layer at 5 feet.	11		10	P200=26%
				16			
889.7	12.0	CL	LEAN CLAY, slightly organic, trace roots, gray and black, wet. (Swamp Deposit)	4			
885.7	16.0	ML	SILT, trace roots, gray, wet to 14 feet then waterbearing, very loose. (Alluvium)	2			
					▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				3			
875.7	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, loose. (Glacial Outwash)	9		20	P200=4%
				10			
				6			
			Gravel at 25 feet.	7			
			END OF BORING. Water observed at 14 feet while drilling. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-15**

LOCATION: N: 145104.2; E: 489971.4.
See attached sketch.

DRILLER: M. Beck

METHOD: 3 1/4" HSA, Autohammer

DATE: 6/13/14

SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 899.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.9	0.6	PAV	4 inches of Bituminous over 3 inches of Aggregate Base.				
895.5	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, gray, wet.	5	▽	12	P200=19% An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
893.5	6.0	PT	PEAT, black, wet. (Swamp Deposit)	4			
890.5	9.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel and roots, gray, waterbearing, very loose. (Alluvium)	3			
880.5	19.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, waterbearing, very loose to loose. (Glacial Outwash)	4 4 3 5		19	
873.5	26.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brownish gray, waterbearing, very loose to loose. (Glacial Outwash)	5 4 6			
			END OF BORING. Water observed at 3 1/2 feet while drilling. Water observed at 6 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-16**

LOCATION: N: 145031.5; E: 490194.5.
See attached sketch.

DRILLER: J. Chermak

METHOD: 3 1/4" HSA, Autohammer

DATE: 6/16/14

SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 902.2	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.0	1.2	PAV ■	5 1/2 inches of Bituminous over 8 1/2 inches of Aggregate Base.				
898.2	4.0	FILL ▨	FILL: Silty Sand, fine-grained, trace Gravel, black, moist.	13			
895.2	7.0	FILL ▨	FILL: Lean Clay, gray, wet.	9			
880.2	22.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	7	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				6			
				12		18	P200=4%
				11			
				7			Jetted.
				7			
876.2	26.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose. (Glacial Outwash)	8			
				5			

END OF BORING.

Water observed at 7 1/2 feet while drilling.

Water observed at 18 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-17**

LOCATION: N: 145220; E: 490080.2.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: 6/11/14

SCALE: 1" = 4'

Elev. feet 901.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
900.9	0.9	PAV	4 inches of Bituminous over 8 inches of Aggregate Base.				
899.8	2.0	FILL	FILL: Lean Clay, black, wet.			27	
897.8	4.0	FILL	FILL: Lean Clay, with Sand layers, gray and brown, wet.	11		14	
889.8	12.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown and gray, waterbearing, loose to medium dense. (Glacial Outwash)	8	▽		
				12			
				14			
883.8	18.0	SC	CLAYEY SAND, trace Gravel, brown, wet, rather stiff to very stiff. (Glacial Till)	12		10	
				17			
877.8	24.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Till)	10			
				9		11	P200=29%
				12			
875.8	26.0	SC	CLAYEY SAND, trace Gravel, brown, wet, stiff. (Glacial Till)	13			

END OF BORING.

Water observed at 4 feet while drilling.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-18**

LOCATION: N: 145204.7; E: 490295.
See attached sketch.

DRILLER: J. Chermak

METHOD: 3 1/4" HSA, Autohammer

DATE: 6/16/14

SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 902.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.1	1.2	PAV	5 1/2 inches of Bituminous over 8 inches of Aggregate Base.				
		SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, light brown and brown, moist to 7 1/2 feet then waterbearing, medium dense to loose. (Glacial Outwash)	12		3	P200=4%
				10			
				12	▽		
				9			
				8		14	P200=4%
887.3	15.0						
		SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, loose. (Glacial Till)	8			
885.3	17.0						
		CL	SANDY LEAN CLAY, trace Gravel, brownish gray, wet, rather stiff. (Glacial Till)	10			
882.3	20.0						
		SC	CLAYEY SAND, trace Gravel, brown, wet, rather stiff. (Glacial Till)	10			
				11			
877.3	25.0						
		SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense. (Glacial Till)	13			
876.3	26.0						

END OF BORING.

Water observed at 7 1/2 feet while drilling.

Water observed at 19 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-19** LOCATION: N: 145342; E: 489965.6. See attached sketch.
DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer
DATE: **6/10/14**	SCALE: **1" = 4'**

Elev. feet 901.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
899.5	1.5	PAV	8 inches of Bituminous over 10 inches of Aggregate Base.			
899.0	2.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.			
893.0	8.0	PT	PEAT, well decomposed, black, wet. (Swamp Deposit)	5 3 19	∇	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
884.0	17.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash) Gravel layer at 15 feet.	10 12 10		
882.0	19.0	CL	SANDY LEAN CLAY, trace Gravel, with waterbearing Poorly Graded Sand seam at 18 feet, brown, wet, rather stiff. (Glacial Till)	11		
875.0	26.0	SC	CLAYEY SAND, trace Gravel, brown and gray, wet, stiff to very stiff. (Glacial Till)	15 29 21		
			END OF BORING. Water observed at 6 feet while drilling. Water observed at 6 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:22

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-20**

LOCATION: N: 145342.3; E: 490217.3.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/10/14**

SCALE: **1" = 4'**

Elev. feet 904.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
903.5	0.5	PAV	2 inches of Bituminous over 4 inches of Aggregate Base.			
900.0	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, with occasional Lean Clay lenses, dark brown, moist.	6		
878.0	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown and gray, moist to 10 feet then waterbearing, loose to medium dense. (Glacial Outwash)	6		
				23	▽	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				10		
				11		
				13		
			Lean Clay layer at 17 feet.	14		
				29		
				17		
				20		

END OF BORING.

Water observed at 10 feet while drilling.

Water observed at 8 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:20

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-21**

LOCATION: N: 145422.8; E: 489977.7.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/9/14**

SCALE: **1" = 4'**

Elev. feet 901.2	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.9	1.3	PAV	7 inches of Bituminous over 8 inches of Aggregate Base.				
897.2	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, brown, moist.	4		46	
889.2	12.0	PT	PEAT, with fibers, dark brown to black, wet. (Swamp Deposit)	4 4 4	▽	 344	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. OC=74%
885.2	16.0	ML	SILT, with Gravel, dark brown, wet. (Swamp Deposit)	4 7			
879.2	22.0	CL	LEAN CLAY, with Peat lenses, with frequent waterbearing Sand and Gravel layers, gray and brown, wet. (Swamp Deposit/Alluvium)	8 10			
875.2	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense. (Glacial Outwash)	32 38			
			END OF BORING. Water observed at 6 1/2 feet while drilling. water observed at 6 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:30

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-22**

LOCATION: N: 145409.8; E: 490168.1.
See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: 6/11/14	SCALE: 1" = 4'

Elev. feet 905.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
903.0	2.0	FILL	FILL: Clayey Sand, brown and black, wet.				
901.0	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, brown, moist.	13		6	
898.0	7.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, brown, wet.	12	▽		
893.0	12.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, brown, waterbearing.	12			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				10			
886.0	19.0	SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown and gray, waterbearing, loose to medium dense. (Glacial Outwash)	8			
				14		10	P200=5%
				15			
883.0	22.0	CL	SANDY LEAN CLAY, gray and light brown, wet, rather stiff. (Glacial Till)	10		20	
879.0	26.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, loose to dense. (Glacial Outwash)	10			
				31			
			END OF BORING. Water observed at 7 feet with 7 feet of hollow-stem auger in the ground. Water observed at 7 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:20

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-23** LOCATION: N: 145401.3; E: 490270.9. See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: **6/10/14**	SCALE: **1" = 4'**

Elev. feet 903.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.7	1.3	PAV	6 1/2 inches of Bituminous over 11 1/2 inches of Aggregate Base.				
898.0	5.0	FILL	FILL: Poorly Graded Sand, fine- to coarse-grained, light brown, moist.	11	▽		
891.0	12.0	FILL	FILL: Poorly Graded Sand, fine- to medium-grained, with Gravel, with layer of fine gray Sand at 5 feet, brown, waterbearing.	15 8 9		17	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. P200=5%
888.0	15.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	14			
884.0	19.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard. (Glacial Till)	23 32		17	
881.0	22.0	SC	CLAYEY SAND, trace Gravel, brown, wet, very stiff. (Glacial Till)	22			
877.0	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, brown, waterbearing, medium dense. (Glacial Outwash)	20 16			
			END OF BORING. Water observed at 5 feet while drilling. Water observed at 6 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-24**

LOCATION: N: 145512.2; E: 489981.5.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/11/14**

SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 902.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.2	0.9	PAV	6 inches of Bituminous over 5 inches of Aggregate Base.				
885.1	17.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, moist to 4 feet then waterbearing, medium dense. (Glacial Outwash)	15 12 17 13 20 17	▽	14	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. P200=7%
880.1	22.0	CL	SANDY LEAN CLAY, trace Gravel, brown and gray, wet, rather stiff. (Glacial Till) Gravel layer at 20 feet.	9 12			
876.1	26.0	SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	8 15			
			END OF BORING. Water observed at 4 feet while drilling. Water observed at 4 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:20

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-25** LOCATION: N: 145534.3; E: 490065.9. See attached sketch.
DRILLER: S. McLean METHOD: 3 1/4" HSA, Autohammer	DATE: **6/9/14** SCALE: **1" = 4'**

Elev. feet 903.9	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
903.1	0.8	PAV	2 1/2 inches of Bituminous over 7 1/2 inches of Aggregate Base.				
901.9	2.0	FILL	FILL: Lean Clay, trace Gravel, brown, wet.				
899.9	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, brown, wet.	9			
879.9	24.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, orange brown to brown to gray, waterbearing, medium dense. (Glacial Outwash)	11	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				18		9	P200=7%
				14			
				19			
				15			
				15			
				20		9	
				19			
877.9	26.0	SC	CLAYEY SAND, with Silty Sand layers, brown to gray, wet, very stiff. (Glacial Till)	20			
			END OF BORING. Water observed at 5 feet while drilling. Water observed at 7 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:21

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-26**

LOCATION: N: 145534.6; E: 490164.7.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/10/14**

SCALE: **1" = 4'**

Elev. feet 905.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
904.9	0.5	PAV	1 1/2 inches of Bituminous over 4 1/2 inches of Aggregate Base.				
		FILL	FILL: Poorly Graded Sand, fine- to medium-grained, brown, moist.	24			
901.4	4.0	SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained to 10 feet then medium-grained, with Gravel, brown, moist to 7 feet then waterbearing, loose to medium dense. (Glacial Outwash)	13			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
					▽		
				17		9	P200=7%
				19			
				9			
				12			
888.4	17.0	SC	CLAYEY SAND, brown to gray, wet, stiff to very stiff. (Glacial Till)	13			
				22		9	
884.4	21.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	18			
				16			
879.4	26.0		END OF BORING. Water observed at 7 feet while drilling. Water observed at 7 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:21

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-27**

LOCATION: N: 145582; E: 490308.4.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/11/14**

SCALE: **1" = 4'**

Elev. feet 904.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
903.8	0.6	SC	CLAYEY SAND, dark brown, moist. (Topsoil)			
		PT	PEAT, with fibers, black, wet. (Swamp Deposit) Sand lenses at 2 feet.	8 6		
897.4	7.0	CL	LEAN CLAY, with fibers, gray, wet, rather soft. (Swamp Deposit/Alluvium) Sand lenses at 10 feet.	4 5		
892.4	12.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with frequent Gravel layers, gray, waterbearing, medium dense. (Glacial Outwash)	15 13* 12 16 13 13	▽	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate. *No sample recovery. Pushed rock.
878.4	26.0		END OF BORING. Water observed at a depth of 12 feet while drilling. Boring immediately backfilled with bentonite grout.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:32

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **OMF-28** LOCATION: N: 145778.3; E: 489971.8. See attached sketch.

DRILLER: J. Chermak
METHOD: 3 1/4" HSA, Autohammer
DATE: 6/16/14
SCALE: 1" = 4'

Elev. feet 906.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		PAV	5 1/4 inches of Bituminous over 8 3/4 inches of Aggregate Base.				
905.6	1.2						
		FILL	FILL: Poorly Graded Sand, fine- to medium-grained, trace Gravel, light brown, moist.				
				12			
902.8	4.0						
		FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, dark brown and brown, moist.				
				19		6	P200=14%
899.8	7.0						
		SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, light brown and brown, waterbearing, loose to medium dense. (Glacial Outwash)	8	∇		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				12		18	P200=4%
				7			
892.8	14.0						
		CL	SANDY LEAN CLAY, trace Gravel, brown, wet, medium. (Glacial Till)				
				6			
				8*			*No sample recovery.
				8			
884.8	22.0						
		SM	SILTY SAND, fine- to medium-grained, trace Gravel, with frequent lenses of Lean Clay, brown, waterbearing, loose. (Glacial Till)	9			
				9			
880.8	26.0						
			END OF BORING. Water observed at 7 1/2 feet while drilling. Water observed at 19 1/2 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:21

BRAUN℠
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-29**

LOCATION: N: 145825.5; E: 490115.3.
See attached sketch.

DRILLER: J. Chermak	METHOD: 3 1/4" HSA, Autohammer	DATE: 6/16/14	SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 906.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
905.4	1.2	PAV	5 3/4 inches of Bituminous over 8 inches of Aggregate Base.				
902.6	4.0	FILL	FILL: Poorly Graded Sand, fine-grained, light brown, moist.	18		4	P200=4%
900.6	6.0	FILL	FILL: Silty Sand, fine-grained, dark brown, moist.	25			
894.6	12.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, brown, moist to 7 1/2 feet then waterbearing, medium dense. (Glacial Outwash)	11 14	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
892.6	14.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff. (Glacial Till)	11			
884.6	22.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with lenses of Lean Clay, brownish gray, waterbearing, loose. (Glacial Till)	9 8 7			
880.6	26.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff to rather stiff. (Glacial Till)	13 12			

END OF BORING.

Water observed at 7 1/2 feet while drilling.

Water observed at 19 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:21

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **OMF-30**

LOCATION: N: 145847; E: 490281.3.
See attached sketch.

DRILLER: S. McLean

METHOD: 3 1/4" HSA, Autohammer

DATE: **6/11/14**

SCALE: **1" = 4'**

Elev. feet 905.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
903.7	2.0	PAV	7 1/2 inches of Bituminous over 13 1/2 inches of Aggregate Base.				
		FILL	FILL: Lean Clay, black, wet.	8			
				4		19	
898.7	7.0				▽		
		SP-SM	POORLY GRADED SAND with SILT, with Gravel, brown, waterbearing, loose to medium dense. (Glacial Outwash)	6			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				7		20	
				10			
888.7	17.0			12			
		SC	CLAYEY SAND, trace Gravel, brown, wet, very stiff. (Glacial Till)	20			
				18			
881.7	24.0			21			
879.7	26.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	16			
			END OF BORING. Water observed at 7 feet while drilling. Water observed at 7 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/12/14 15:23

BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	**Group Name** [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	**GW**	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	**GP**	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	**GM**	Silty gravel [d,f,g]
			Fines classify as CL or CH	**GC**	Clayey gravel [d,f,g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	**SW**	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	**SP**	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	**SM**	Silty sand [f,g,h]
			Fines classify as CL or CH	**SC**	Clayey sand [f,g,h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	**CL**	Lean clay [k,l,m]
			PI < 4 or plots below "A" line [j]	**ML**	Silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OL** **OL**	Organic clay [k,l,m,n] Organic silt [k,l,m,o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	**CH**	Fat clay [k,l,m]
			PI plots below "A" line	**MH**	Elastic silt [k,l,m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	**OH** **OH**	Organic clay [k,l,m,p] Organic silt [k,l,m,q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			**PT**	Peat

a. Based on the material passing the 3-in (75mm) sieve.

b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.

c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

d. If soil contains ≥15% sand, add "with sand" to group name.

e. Gravels with 5 to 12% fines require dual symbols:

GW-GM	well-graded gravel with silt
GW-GC	well-graded gravel with clay
GP-GM	poorly graded gravel with silt
GP-GC	poorly graded gravel with clay

f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

g. If fines are organic, add "with organic fines" to group name.

h. If soil contains ≥ 15% gravel, add "with gravel" to group name.

i. Sands with 5 to 12% fines require dual symbols:

SW-SM	well-graded sand with silt
SW-SC	well-graded sand with clay
SP-SM	poorly graded sand with silt
SP-SC	poorly graded sand with clay

j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.

l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.

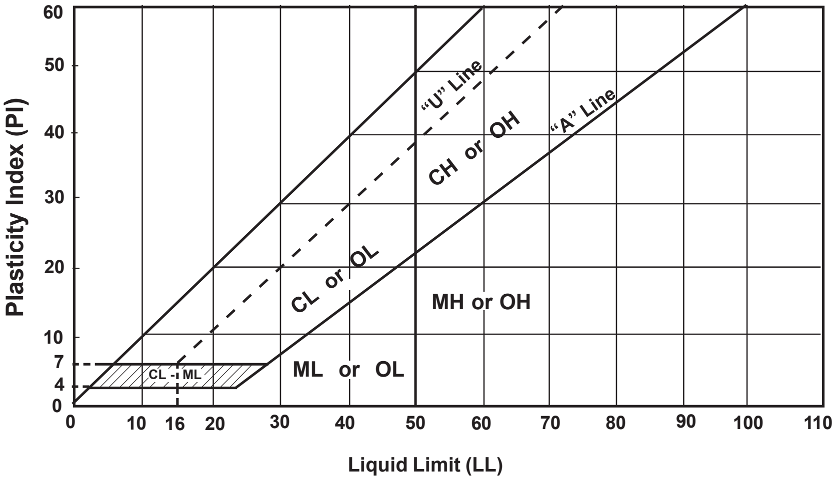
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.

n. PI ≥ 4 and plots on or above "A" line.

o. PI < 4 or plots below "A" line.

p. PI plots on or above "A" line.

q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.