FEASIBILITY REPORT

FORD BROOK ESTATES
STREET RECONSTRUCTIONS

CITY IMPROVEMENT PROJECT NO. 19-01

October 18, 2018

Prepared By:

City of Ramsey
Engineering Department
7550 Sunwood Drive NW
Ramsey, MN 55303
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October 18, 2018

Honorable Mayor and City Council
City of Ramsey
7550 Sunwood Drive NW
Ramsey, MN 55303

Re: Feasibility Report - City of Ramsey Improvement Project #19-01
Ford Brook Estates Street Reconstructions

Dear Mayor and City Council Members:

Transmitted herewith is a Feasibility Report for the proposed Ford Brook Estates Street Reconstructions project including; 180th Lane from Trunk Highway 47 to Krypton Street, and Krypton Street from 180th Lane to its termini cul-de-sac. The report examines the feasibility of reconstructing the bituminous street section and completing other appurtenant improvements.

This Feasibility Report examines the scope of the proposed improvements, explores estimated costs and available funding sources, defines a preliminary project schedule, and determines the necessity, feasibility and general cost-effectiveness of the proposed improvements, including any alternate designs, as well as whether the improvements would best be completed separately or in conjunction with another project.

I would be happy to discuss this report with you at your convenience. Please feel free to contact me at 763-433-9825 or bwestby@cityoframsey.com with any questions.

Sincerely,
City of Ramsey

Bruce Westby, PE
City Engineer

Enclosure

C: Kurt Ulrich, City Administrator
Leonard Linton, Civil Engineer IV

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.

Bruce Westby, PE

Date: October 18, 2018 License No. 40116

I hereby certify that this plan, specification or report was reviewed for Quality Control and Quality Assurance purposes and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Leonard Linton, PE

Date: October 18, 2018 License No. 21112

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1. EXECUTIVE SUMMARY

City Improvement Project No. 19-01 proposes to reconstruct streets within the Ford Brook Estates neighborhood including 180th Lane and Krypton Street. The streets total approximately 860 linear feet (0.16 miles) in length. A map showing the location and scope of the proposed improvements is included as ***Figure 1*** in ***Appendix A.***

The streets were constructed in 1981 as rural sections with bituminous pavement to a width of 24 feet, and are generally centered within a 66-foot wide right-of-way.

The storm sewer system consists of ditches along both sides of the road within the right-of-way and drainage and utility easements. Storm runoff collects in the ditch along TH 47 and is carried north to Ford Brook.

The existing bituminous pavement section ranges from 1.2 to 6.4 inches thick, with a median thickness of 4.3 inches, and the aggregate base ranges from 2.4 to 6.8 inches thick, with a median thickness of 4.1 inches. This was determined from Ground Penetrating Radar (GPR) analysis performed by Braun Intertec in 2017, as well as from field observations and record plan documents. Copies of Braun Intertec's GPR results are attached in ***Appendix C***. The pavement section was built on silty sand and lean clay subgrade materials generally not considered ideal for pavement support.

City Staff evaluates and rates the condition of pavement sections on all City streets on an annual basis using the Pavement Surface Evaluation and Rating (PASER) system. In the summer of 2018, the pavement section of the above referenced street segments were rated with a PASER rating of 2 which indicates these streets require complete reconstruction. City staff patch the streets at least once per year, particularly before winter so the streets can be plowed without further damaging the pavement in the process. Pictures of the streets are located in ***Appendix A***.

Proposed improvements include removing the existing bituminous pavement and aggregate base along with 2 feet of the unsuitable subgrade material. Two (2) feet of select granular sand will then be placed over geotextile fabric, with drain tile added at the low points, followed by 4 inches of aggregate base, and 3.5 inches of bituminous pavement, generally meeting the City of Ramsey's standard pavement design.

Existing ditches will require re-grading due to the soil corrections for residential streets, however, driveway culverts are not anticipated to be affected by this project. Drain tile will be added to properly drain the soil corrections. No other storm sewer improvements are proposed with this project.

The engineer's opinion of probable costs for completing the proposed improvements outlined in this report is $239,464.57. Estimated costs include 5-percent contingency costs plus 23-percent indirect costs for administrative, engineering, finance and legal costs. A summary of the engineer's opinion of probably costs is included in ***Appendix B***.

A total of 8 assessable parcels have been identified. Staff recommends applying 25-percent of the eligible project costs equally across the 8 assessable properties using the "per lot" assessment method. Eligible project costs include everything except subgrade correction costs. This results in a proposed preliminary assessment rate of $3,919.90 per assessable parcel.

Staff recommends ordering a special benefit consultation report for this project to verify the proposed assessment amount will not exceed the benefit to the properties. If the report concludes the benefit to the properties is less than the proposed preliminary assessment rate, Staff will then propose to lower the assessment rate accordingly during the Assessment Hearing, which is scheduled for October 8, 2019. If the report verifies the assessment rate as proposed is justified, Staff will propose to adopt the final assessment roll using the rate as preliminarily proposed.

Two (2) soil borings were completed by Braun Intertec to assist with the preparation of this report. Pavement design recommendations were offered by Braun Intertec, and Staff considered and incorporated Braun's recommendations to varying degrees while preparing this report. Ground Penetrating Radar (GPR) was conducted on all street segments within the project. The GPR identifies existing bituminous pavement and aggregate base thicknesses, and is used to help Staff determine the appropriate treatment. Copies of Braun Intertec's GPR results and Geotechnical Exploration are attached in ***Appendix C***.

This improvement project, which is listed in the City's current 10-year Capital Improvement Plan, is proposed to be funded using a combination of special assessments to benefiting properties, street reconstruction bond proceeds, and storm sewer funds.

Staff has not yet discussed the proposed improvements with local property owners. However, Staff has scheduled a neighborhood information meeting for November 8, 2018 for the purpose of explaining the proposed improvements and assessments in more detail, and to gather public input on the project, including any information which should be explored in more detail during development of plans and specifications. Staff will incorporate comments and present this information to Council during the Public Hearing on November 13, 2018.

This project would best be constructed as a stand-alone project and is necessary, feasible, and cost-effective from an engineering standpoint, and can be constructed as proposed herein.

2. INTRODUCTION

2.1 Authorization

The preparation of this report was authorized by the Ramsey City Council on August 28, 2018. This project has been designated as City Improvement Project No. 19-01.

2.2 Program Overview

In support of the City's long-term Street Maintenance Program, the existing bituminous pavement section will be reconstructed, and existing ditches will be re-graded to enhance drainage. Other appurtenant work will be completed as outlined in this report.

The City's pavement evaluation process involves a visual evaluation of each street's pavement surface based on the type, extent and severity of each pavement distress observed. Numerous types of pavement distresses may exist within a pavement section including, but not limited to, alligator cracking, block cracking, longitudinal cracking, transverse cracking, rutting, raveling, shoving, potholes and patches. This field data is then used to rate the pavement condition.

The City uses the Pavement Surface Evaluation and Rating (PASER) system to rate pavement condition. A PASER rating is a numerical index between 1 and 10 indicating the condition of a pavement based on the various pavement distresses recorded during visual observations. A PASER rating of 10 represents brand new pavement, while a PASER rating of 1 represents a pavement section that has fallen into complete disrepair requiring full reconstruction.

In the summer of 2018, City Staff evaluated and rated the condition of the pavement along the Ford Brook Estates street segments. A PASER rating of 2 was assigned to 180th Lane and Krypton Street.

2.3 Scope

City of Ramsey Improvement project 19-01 proposes to perform subgrade soil corrections, reconstruct the existing bituminous pavement, re-shape the ditches to enhance drainage, and to complete other appurtenant work on 180th Lane from Trunk Highway 47 to Krypton Street, and on Krypton Street from 180th Lane to its termini cul-de-sac which totals approximately 860 linear feet (0.16 miles) in length.

The existing bituminous pavement section is proposed to be reconstructed by replacing the existing bituminous pavement, aggregate base, and 2 feet of unsuitable subgrade material with 2 feet of select granular borrow placed on geotextile fabric, 4 inches of imported or reclaimed aggregate base, and 3.5 inches of bituminous pavement. The resulting pavement design will generally meet current City design standards for residential pavement sections.

A map showing the location and scope of the proposed improvements is included as ***Figure 1*** in ***Appendix A***.

3. EXISTING CONDITIONS

3.1 Existing Pavement, Soil, and Traffic Conditions.

All streets proposed to be improved were constructed in 1981 with bituminous pavement, class 5 aggregate base, and ditches. The streets are generally centered within a 66-foot wide right-of-way.

Pavement maintenance treatments applied to the street segments included crack seal and seal coat improvements in 1987, an overlay in 1997, and crack seal and seal coat improvements in 2002 and 2012. Spot patching has been performed on an as-needed basis, and has been a yearly treatment recently. In 2018, Staff assigned a PASER rating of 2 on both street segments.

In September of 2018, City Staff recorded a traffic volume of 54 average annual daily traffic (AADT) on 180th Lane west of TH 47. Since Krypton Street is only accessed by 180th Lane, it can be reasonably stated that Krypton Street would have even less traffic. The speed limit is 30 mph for these street segments.

Braun Intertec was employed to complete a Geotechnical Exploration and Engineering Review for this project, which included two (2) soil borings spaced at approximately 600-feet along 180th Lane/Krypton Street, including 1 boring in the cul-de-sac on Krypton Street. The locations of the borings are shown in the Soil Boring Location Map in the Appendix of Braun's report, attached in ***Appendix C***.

The soil borings provide information on existing bituminous pavement and aggregate base course thicknesses, subgrade soil conditions, existing ground water elevations, and potential issues, which may be encountered during construction. All borings terminated at a nominal depth of 11 feet below the existing ground surface. There was no groundwater observed during the soil borings. Based on the work proposed and the lack of groundwater at a depth of 11 feet below the existing ground surface, groundwater is not anticipated to be encountered during work completed with this proposed project.

The soil borings generally indicate the existing bituminous pavement thickness ranges between 4 to 5 inches, and aggregate base thickness is 5 inches. The subgrade generally consists of silty sand, lean clay with sand, and lean clay. This lean clay layer varies from 2 to 9 feet below existing ground. Poorly graded sand was found below the lean clay layer at 4 to 9 feet below existing ground and generally extends to the bottom of the borings (11 feet).

Braun Intertec was employed to complete a ground penetrating radar (GPR) analysis for the project area, which included driving the GPR equipped vehicle throughout all street segments within the project area. A summary table and charts of the GPR Analysis are attached in ***Appendix C***. The GPR data determined a median bituminous pavement thickness of 4.3 inches, and a median aggregate base thickness of 4.1 inches. The median street pavement and base section thickness was 8.2 inches, with a minimum section of 6.1 inches located on 180th Lane, 111 feet west of the intersection with Trunk Highway 47.

3.2 Watermain

Watermain does not exist on site.

3.3 Sanitary Sewer

Sanitary sewer does not exist on site.

3.4 Storm Sewer / Drainage

The storm sewer system consists of ditches along both sides of the road within the right-of-way and drainage and utility easement, which direct stormwater runoff to the ditch along TH47 and north to Ford Brook.

3.5 Streets

3.5.1 Existing Typical Sections

The pavement width of 180th Lane and Krypton Street is 24 feet. The cul-de-sac on Krypton Street is 85 feet in diameter. The streets are centered within a 66-foot wide City-owned right-of-way, with a 120-foot wide right-of-way around the cul-de-sac on Krypton Street.

3.5.2 Maintenance History

Ford Brook Estates was originally constructed in 1981. 180th Lane and Krypton Street received crack seal and seal coat improvements in 1987, an overlay in 1997, crack seal and seal coat improvements in 2002 and 2012.

3.6 Land Use

The parcels within the construction area are zoned rural developing.

4. PROPOSED IMPROVEMENTS

4.1 Street and Stormwater Improvements

4.1.1 Street Improvements

The streets in Ford Brook Estates are proposed to be reconstructed by matching existing widths and elevations with bituminous pavement and ditch sections to carry storm water runoff to Ford Brook, due to the observed presence of clay at the pavement surface, full-depth reclamation is not proposed.

The proposed surface improvements are shown on ***Figure 1*** in ***Appendix A***.

Street Design:
180th Lane and Krypton Street are currently rural residential streets with ditch sections, 24-feet wide to the edge of pavement. The cul-de-sac on Krypton Street is 85-feet in diameter. Existing and proposed traffic counts are consistent with typical residential streets.

180th Lane and Krypton Street mainline street segments are proposed to be reconstructed at their current width. The Krypton Street cul-de-sac is proposed to be reconstructed to a diameter of 100-feet. This will bring the cul-de-sac up to current City standards and allow school buses to use the cul-de-sac. Anoka-Hennepin School District can no longer stop on Highway 47 to pick up or drop off students. A typical section for the proposed pavement reconstruction improvements is shown in ***Figure 2*** in ***Appendix A***.

City Staff is proposing a pavement section design of 1.5 inches bituminous wear course, 2 inches bituminous base course, and 4 inches of aggregate base course. This pavement section would be constructed over 2 feet of imported select granular subgrade after it is shaped and compacted. The select granular is placed on top of geotextile fabric which will help keep the select granular from being contaminated by clay subgrade materials.

4.1.2 Storm Sewer Improvements

The existing ditch sections are in good condition. Re-shaping the ditches will be required due to the subgrade soil corrections, but ditches will be restored to existing grades. The existing driveway culverts are not planned to be replaced. No stormwater treatment improvements are required for this project since the streets are proposed to be reconstructed at their current width.

4.1.3 Geotechnical Considerations

Braun Intertec, Inc. (Braun) completed a Geotechnical Exploration and Engineering Review including two (2) soil borings, located mid-block 180th Lane and the Krypton Street cul-de-sac. The locations of the borings are shown in the Boring Location Map in the Appendix of Braun's report, attached in ***Appendix C***. Braun recommends completing a 6-

8 inch deep reclamation of the existing bituminous pavement and placing 4-inches of aggregate base class 5 or reclaim material, and 3.5-inches of new bituminous pavement. The subgrade discovered was lean clay and it is noted additional work may be required, especially if this material gets wet when exposed. City Staff is in close agreement and propose allowing full-depth reclamation material as an option for the contractor, placing 4-inches of aggregate base class 5 or reclaim material, and 3.5-inches of new bituminous pavement. 2-feet of lean clay subgrade will be removed and replaced with 2-feet of select granular borrow material.

The proposed improvements should have a service life of approximately 60-years, assuming maintenance such as overlays, crack sealing and seal coating is routinely performed.

4.1.4 Other Considerations

Driveways:
Existing driveway aprons may need to be reconstructed to varying degrees. The limits of construction will vary with each driveway apron based on the elevation of the street abutting the driveway and the driveway pavement type. During design, Staff will evaluate the construction limits for each driveway and will incorporate this into the plans, but as with all street reconstruction projects, the exact limits of construction will be determined in the field during construction. Right-of-entry forms will be obtained from private property owners where work is required outside City right-of-ways and easements.

Irrigation Systems:
Developed properties along the project corridor may have private irrigation systems. Staff will notify property owners of pending construction as far in advance as practical to allow them time to move their irrigation systems out of harm's way before work begins.

Parking Restrictions:
Parking is currently provided along both sides of the streets and is not currently restricted except for overnight parking per City code. During this project, parking will be restricted during allowable working hours.

Pavement Corings:
Existing pavement thicknesses have been found to be inconsistent throughout the City. It is now standard practice to have City Staff on-site during pavement installation to insure the proper quantities are being placed. As further conformation, Staff is proposing to collect GPR data or to have pavement corings taken at the conclusion of all reconstruction projects. This is already a requirement on all State Aid projects, and will leave more data on the pavement section for future street maintenance projects.

4.2 Stormwater Treatment

No stormwater retention and/or treatment improvements will be required as a result of this project.

4.3 Water Main Improvements

No watermain improvements are proposed with this project.

4.4 Sanitary Sewer Improvements

No sanitary sewer improvements are proposed with this project.

4.5 Construction Method

The existing pavement will be reconstructed by first removing the existing bituminous pavement, and class 5 aggregate base. Then, the existing subgrade will be corrected by excavating 2-feet of subgrade soils and replacing them with 2-feet of select granular borrow which will be placed on geotextile fabric. However, if during construction it is determined the subgrade soils are suitable enough to allow one or both street segments to be constructed by scarifying 1 or more feet of subgrade soils, this method will then be utilized with concurrence from a soils engineer.

After acceptance of the subgrade material, 4-inches of aggregate base will be installed, followed by 3.5-inches of bituminous pavement in two separate lifts.

4.6 Private Utilities

Staff has not yet met with the telephone, gas, power and cable utilities regarding this project. During preparation of plans and specifications, Staff will meet with the private utility companies to discuss the proposed improvements as noted in the project schedule within this report. The alignment and footprint of the streets will be considered to minimize impacts to private utilities. No impacts to power poles or street lights are anticipated with this project.

Should any utility company indicate they wish to upgrade, replace and/or otherwise modify their services during this project, any such upgrades, replacements and/or modifications will be at the sole discretion and cost of the utility company.

4.7 Permits

Permits that are anticipated to be required as part of the proposed improvements include:

- MPCA General Stormwater Permit (NPDES)…..Grading and Storm Water

A stormwater permit from the Lower Rum River Watershed Management Organization will not be required with this project as street reconstruction projects are exempt.

4.8 Right-of-Ways / Easements

City Staff will obtain required right of entries on a case by case basis.

5. FINANCING

5.1 Opinion of Cost

A detailed opinion of probable costs for the proposed improvements can be found in ***Appendix B*** of this report. The opinion of probable costs incorporates anticipated 2019 construction costs for the proposed improvements with 5-percent contingency costs, plus 23-percent indirect costs for administrative, engineering, financing and legal costs.

City Staff prepared the Feasibility Report in-house as part of Staff's normal duties.

Braun Intertec prepared the Geotechnical Exploration and Engineering Review, included in ***Appendix C***, at a cost of $3,974.78.

5.2 Funding

5.2.1 Assessments

A portion of the project costs is proposed to be recovered through special assessments levied against the 8 identified benefitting properties; 4 along 180th Lane, and 4 along Krypton Street. Assessments are proposed to be collected for eligible improvements benefiting residential properties with direct access to the improved segments of Ford Brook Estates as described below. A preliminary assessment summary is included below in ***Table 1***.

Residential Assessments:
Special assessments are proposed to be levied against residential properties having direct access to improved streets. To be consistent with previous applications of the Special Assessments Policy, each residential property is proposed to be assessed using the "per lot" method.

Each residential property is preliminarily proposed to be assessed at the rate of $3,919.90 per lot. Since State Statute and the City Charter do not allow for assessments to exceed the benefit to the property, Staff requests Council authorization to order a benefit appraisal consultation for this project in accordance with the City's Special Assessment Policy.

The Preliminary Assessment Map and Roll are included in ***Appendix B***.

TABLE 1
Proposed Preliminary Assessments – 180th Lane, and Krypton Street

STREET SEGMENT	ASSESSMENT PER LOT	No. OF LOTS	TOTAL ASSESSMENTS
180th Lane Residential Assessment	$3,919.90	4	$15,679.60
Krypton Street Residential Assessment	$3,919.90	4	$15,679.60
TOTAL PROJECT ASSESSMENTS			**$31,359.20**

5.2.2 City Contribution

The City contribution to the project would include all funding in excess of the amount collected through special assessments to benefiting properties. No funds have been budgeted for this project. The City's share of eligible project costs related to surface (street) improvements is proposed to come from the previously encumbered 5-year Street Reconstruction and Overlay Program bonds. Stormwater Utility Funds are proposed to pay for all storm sewer improvements.

Table 2 illustrates the proposed project funding based on the design proposed within this report. This funding program assumes construction will occur in 2019.

TABLE 2
Proposed Project Funding

	ASSESSMENTS	CITY FUNDS	TOTAL
Surface	$ 31,359.20	$ 194,880.41	$ 226,239.61
Storm Sewer	-	$ 13,224.96	$ 13,224.96
TOTAL	$ 31,359.20	$ 208,105.37	$ 239,464.57

Total Project Cost		**$ 239,464.57**
Less Special Assessments	-	$ 31,359.20
Subtotal	=	**$ 208,105.37**
Less City Bonding Funds	-	$ 194,880.41
Subtotal	=	**$ 13,224.96**
Less Stormwater Utility Funds	-	$ 13,224.96
TOTAL Remaining Cost	=	**$ 0**

6. PROJECT SCHEDULE

The proposed project schedule is as follows:

Council Orders Feasibility Report ..... August 28, 2018

Council Accepts Feasibility Report / Orders Public Hearing .....October 23, 2018

Staff Conducts Neighborhood Information Meeting .....November 8, 2018

Staff Publishes Notices of Public Hearing.....October 26 & November 2, 2018

Council Conducts Public Hearing / Authorizes Plans and Specifications.....November 13, 2018

Staff Conducts Private Utility Coordination Meeting .....November, 2018

Council Approves Plans and Specifications / Authorizes Ad for Bids..... January 22, 2019

Staff Receives Bids ..... February 20, 2019

Council Awards Contract..... February 26, 2019

Contractor Begins Construction..... May, 2019

Contractor Completes Construction..... August 16, 2019

Council Orders Assessment Hearing ..... September 10, 2019

Council Conducts Assessment Hearing .....October 8, 2019

7. CONCLUSIONS AND RECOMMENDATIONS

City of Ramsey Improvement Project No. 19-01 proposes to construct subgrade corrections, reconstruct the bituminous pavement section, and complete miscellaneous appurtenant work on the following street segments within the Ford Brook Estates residential subdivision:

1. 180th Lane (approx. 560 linear feet) – Trunk Highway 47 to Krypton Street.
2. Krypton Street (approx. 310 linear feet) – 180th Lane to south cul-de-sac.

It is the recommendation of City Staff that City Project No. 19-01 is feasible, necessary, and cost-effective from an engineering standpoint, and this project would best be constructed as a stand-alone project as proposed herein.

The following Staff recommendations related to the proposed project are presented for Council consideration and concurrence:

1. Staff recommends correcting the subgrade soils by excavating 2-feet of existing subgrade and replacing it with clean imported select granular material on top of geotextile fabric, all at 100% City cost (non-assessable).

2. Staff recommends constructing new bituminous pavement per the City's standard residential pavement section of 4-inches aggregate base class 5 (or reclaim), 2-inches new bituminous base course, and 1 ½"-inches new bituminous wear course.

3. Staff recommends expanding the Krypton Street cul-de-sac to a diameter of 100-feet.

4. Staff recommends excluding private irrigation system work from this project. Instead, Staff will notify property owners of pending construction as far in advance as possible, and instruct them to relocate their irrigation system(s) away from the construction area during construction, then allow replacement in or near the original location after construction is complete.

5. Staff recommends holding a neighborhood information meeting on November 8, 2018 to inform property owners of the proposed improvements and to gather their input prior to competing plans and specifications and requesting Council approval to advertise for bids as outlined in the project schedule.

6. Order an assessment appraisal consultation to ensure special assessments do not exceed the benefit received as a result of the improvements.

The City Council is asked to act on the following items related to the proposed project:

1. Accept the preliminary residential special assessment rate of $3,919.90 per lot.

2. Authorize an assessment appraisal consultation to ensure all special assessments are commensurate with benefit received from the proposed improvements.

3. Adopt Resolution #18-219 accepting this Feasibility Report and ordering the Public Hearing for November 13, 2018.

APPENDIX A

Figure 1 – Project Scope
Figure 2 – Typical Section
Project Site Pictures


5745
5725
5665
180TH LANE
KRYPTON STREET
18030
18029
5706
18012
18013
SAINT FRANCIS BOULEVARD (TH 47)
IODINE STREET
FORD BROOK ESTATES
PROJECT SCOPE
0
150
300
450
SCALE FEET
City of
RAMSEY

FIGURE 1

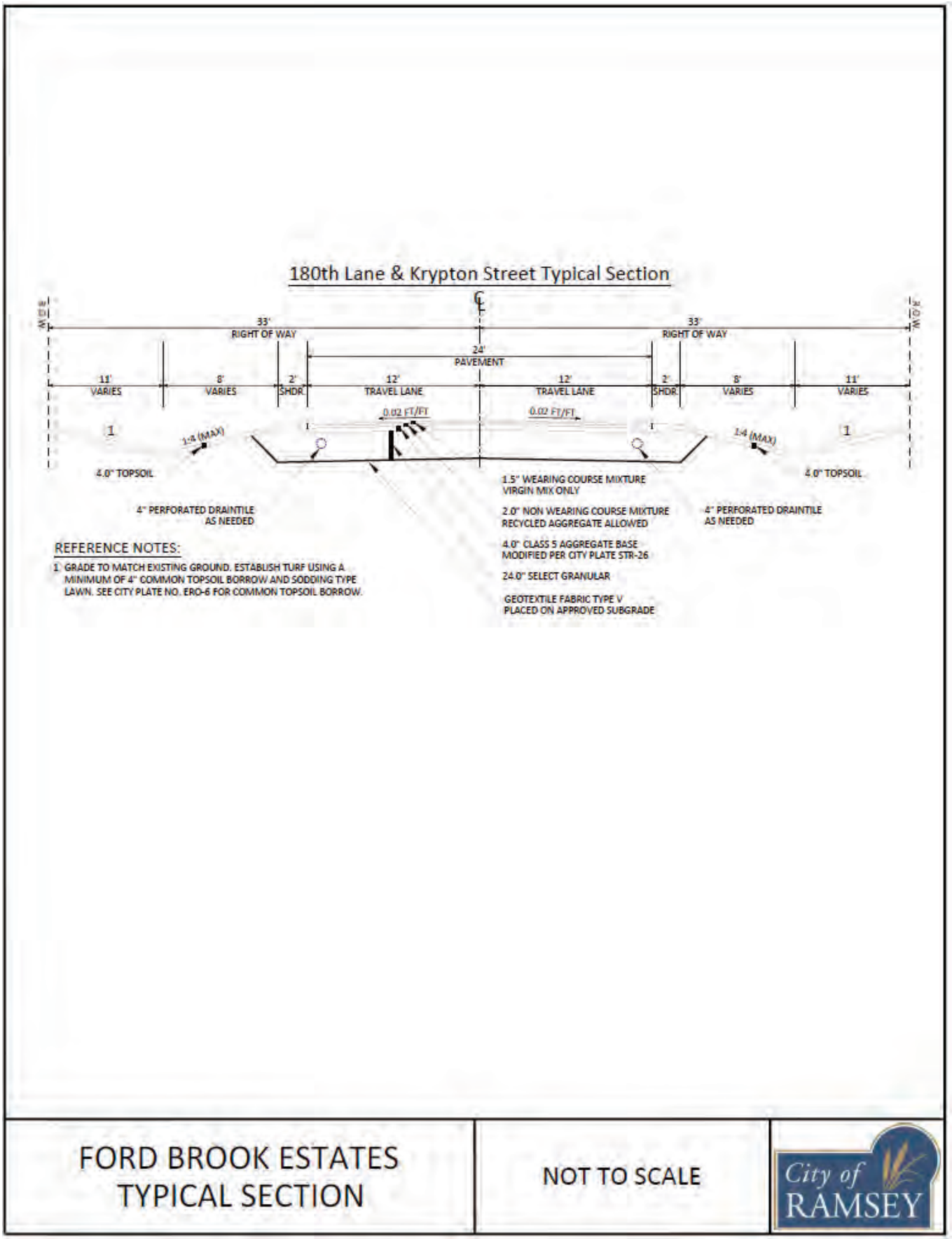
180th Lane & Krypton Street Typical Section
33'
RIGHT OF WAY
33'
RIGHT OF WAY
24'
PAVEMENT
11'
VARIES
8'
VARIES
2'
SHDR.
12'
TRAVEL LANE
12'
TRAVEL LANE
2'
SHDR.
8'
VARIES
11'
VARIES
0.02 FT/FT
0.02 FT/FT
1:4 (MAX)
1:4 (MAX)
4.0" TOPSOIL
4.0" TOPSOIL
4" PERFORATED DRAINTILE AS NEEDED
4" PERFORATED DRAINTILE AS NEEDED
1.5" WEARING COURSE MIXTURE VIRGIN MIX ONLY
2.0" NON WEARING COURSE MIXTURE RECYCLED AGGREGATE ALLOWED
4.0" CLASS 5 AGGREGATE BASE MODIFIED PER CITY PLATE STR-26
24.0" SELECT GRANULAR
GEOTEXTILE FABRIC TYPE V PLACED ON APPROVED SUBGRADE
REFERENCE NOTES:
1 GRADE TO MATCH EXISTING GROUND. ESTABLISH TURF USING A MINIMUM OF 4" COMMON TOPSOIL BORROW AND SODDING TYPE LAWN. SEE CITY PLATE NO. ERO-6 FOR COMMON TOPSOIL BORROW.
FORD BROOK ESTATES
TYPICAL SECTION
NOT TO SCALE
City of RAMSEY

FIGURE 2

PROJECT SITE PICTURES

Picture 1: 180th Lane from TH 47

Picture 2: 180th Lane from Krypton Street

Picture 3: Krypton Street from 180th Lane

Picture 4: Krypton Street cul-de-sac

APPENDIX B

Opinion of Probable Costs (Preliminary Engineer's Estimate)
Preliminary Assessment Map
Preliminary Assessment Roll

19-01 FORD BROOK ESTATES STREET RECONSTRUCTIONS					
Preliminary Engineer's Estimate					
Street Construction					
Item No.	**Description**	**Unit**	**Estimated Quantity**	**Unit Cost**	**Cost Extension**
1	Mobilization	LS	1	$ 7,000.00	$ 7,000.00
2	Remove Concrete Pavement – Driveways	SF	1,001	$ 2.50	$ 2,502.50
3	Remove Bituminous Pavement – Driveways	SY	67	$ 7.00	$ 469.00
4	Remove Bituminous Pavement	SY	2,761	$ 3.50	$ 9,663.50
5	Sawing Concrete Pavement – Full Depth	LF	126	$ 4.00	$ 504.00
6	Sawing Bituminous Pavement – Full Depth	LF	102	$ 2.50	$ 255.00
7	Salvage and Install Mail Box Support	EA	8	$ 200.00	$ 1,600.00
8	Temporary Mail Box Cluster	EA	1	$ 400.00	$ 400.00
9	Common Excavation (EV)	CY	180	$ 21.00	$ 3,780.00
10	Subgrade Excavation, Remove Unsuitable Material (EV)	CY	2,540	$ 10.00	$ 25,400.00
11	Select Granular Borrow (CV)	CY	3,050	$ 15.00	$ 45,750.00
12	Common Topsoil Borrow (CV)	CY	185	$ 31.00	$ 5,735.00
13	Geotextile Fabric Type V	SY	4,600	$ 1.50	$ 6,900.00
13	Aggregate Base Class 5	CY	451	$ 15.00	$ 6,765.00
14	Mill Bituminous Pavement (2' wide x 1.5" deep)	SY	15	$ 20.00	$ 300.00
15	Bituminous Material for Tack Coat	GAL	209	$ 2.40	$ 501.60
16	Type SP 9.5 Wearing Course Mixture	TON	247	$ 71.00	$ 17,537.00
17	Type SP 12.5 Non Wearing Course Mixture	TON	329	$ 64.00	$ 21,056.00
18	Type SP 9.5 Wearing Course Mixture – Driveways	TON	8	$ 71.00	$ 568.00
19	6" Concrete Driveway Pavement	SF	733	$ 7.25	$ 5,314.25
20	Traffic Control	LS	1	$ 2,500.00	$ 2,500.00
21	Silt Fence, Type MS	LF	350	$ 2.50	$ 875.00
22	Sodding Type Lawn	SY	1,400	$ 7.00	$ 9,800.00
				Total Street Construction Cost	*$ 175,175.85*
				5% Contingency Cost	*$ 8,758.79*
				23% Indirect Cost	*$ 42,304.97*
				Total Street Project Cost	*$ 226,239.62*
Storm Sewer Construction					
Item No.	**Description**	**Unit**	**Estimated Quantity**	**Unit Cost**	**Cost Extension**
1	4" Perforated Pipe Drain	LF	502	$ 20.00	$ 10,040.00
2	4" PVC Pipe Drain Cleanout	EA	1	$ 200.00	$ 200.00
				Total Storm Sewer Construction Cost	*$ 10,240.00*
				5% Contingency Cost	*$ 512.00*
				23% Indirect Cost	*$ 2,472.96*
				Total Storm Sewer Project Cost	*$ 13,224.96*
				Total Estimated Project Cost	**$ 239,464.57**


5745
5725
5665
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FORD BROOK ESTATES
ASSESSABLE PROPERTIES
0
150
300
450
SCALE FEET
City of
RAMSEY

PRELIMINARY ASSESSMENT ROLL – 19-01 FORD BROOK ESTATES STREET RECONSTRUCTIONS							
PID	**NAME / OWNER**	**ADDRESS**	**CITY**	**STATE**	**ZIP**	**ASSESSABLE UNITS**	**PROPOSED ASSESSMENT**
23225110004	ROLEY JEFFREY B	5665 180TH LN NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110005	MONSERUD LISA	5725 180TH LN NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110006	LINDBERG RANDY L & CYNTHIA A	5745 180TH LN NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110007	WALZ GERALD E & DARLENE M	18030 KRYPTON ST NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110008	KRUGER TODD B & KATHY A	18012 KRYPTON ST NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110009	KLUCKING JOHN & LAVONNE	18013 KRYPTON ST NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110010	BOEHLKE JAMIE	18029 KRYPTON ST NW	RAMSEY	MN	55303	1	$ 3,919.90
23225110011	DEBROBANDER SANDRA	5706 180TH LN NW	RAMSEY	MN	55303	1	$ 3,919.90
TOTALS						**8**	**$ 31,359.20**

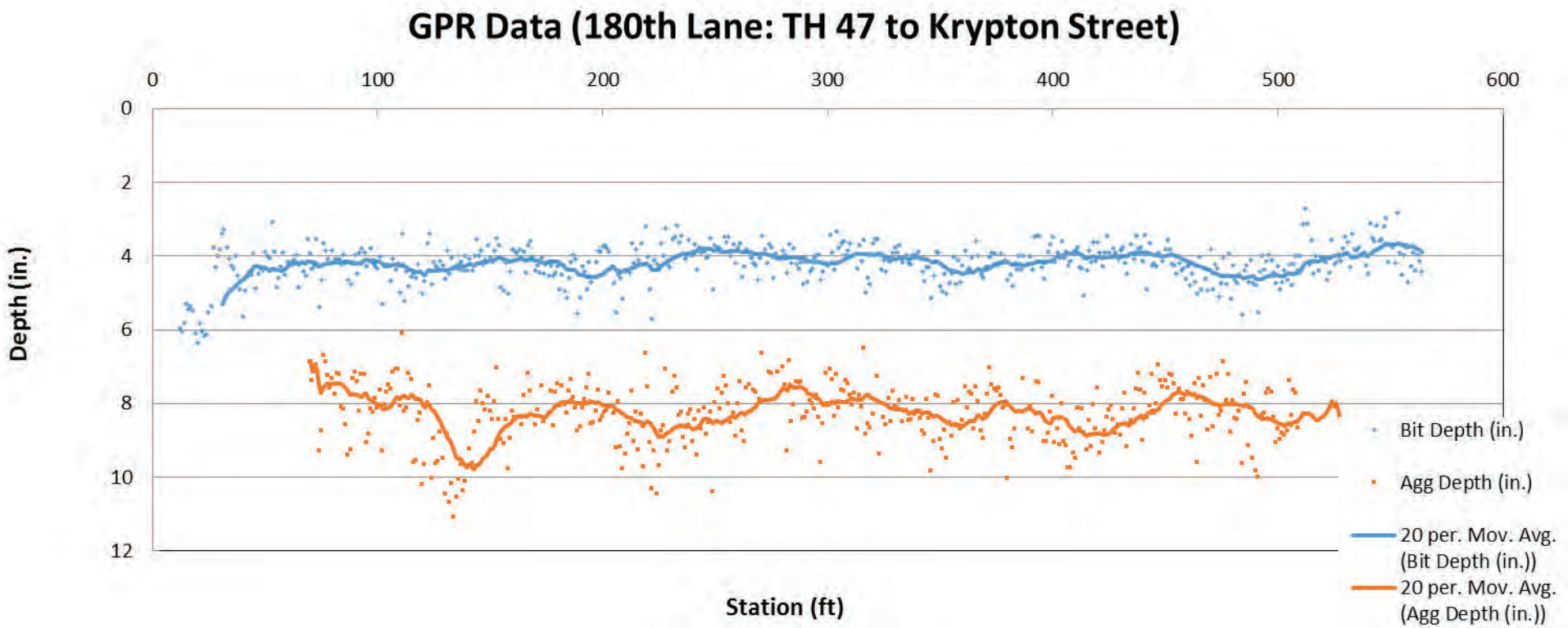
APPENDIX C

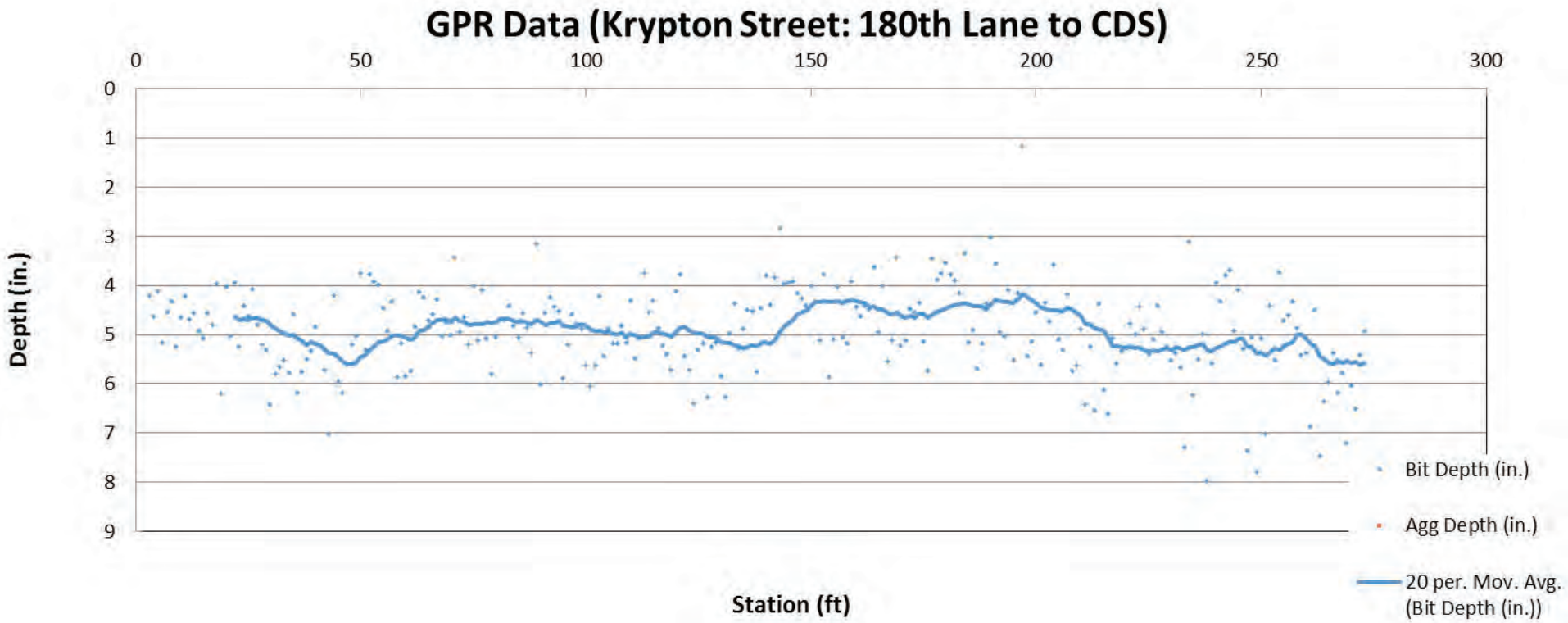
Street Segment Summary
Ground Penetrating Radar (GPR) Results
Geotechnical Exploration and Engineering Review

STREET SEGMENT SUMMARY

Street	Segment Description	Length	Width	Curb	2018 Rating	Year Built	Maint. 1	Maint. 2	Maint. 3	Maint. 4
180th Lane	TH 47 / Krypton Street	556	24	n/a	2	1981	SC 1 1987	OL 1997	SC 2 2002	SC 3 2012
Krypton Street	180th Lane / CDS	308	24	n/a	2	1981	SC 1 1987	OL 1997	SC 2 2002	SC 3 2012

Ford Brook Estates GPR Summary										
Project Segment		Pavement			Aggregate			Section		
Street	Segment Description	Min	Max	Med	Min	Max	Med	Med	Min	Location
180th Lane	TH 47 / Krypton Street	2.7	6.4	4.2	2.4	6.8	4.1	8.2	6.1	111' west of TH 47.
Krypton Street	180th Lane / CDS	1.2	8.0	4.9	n/a	n/a	n/a	n/a	n/a	Base not picked up due to ambient noise.
Project Summary		*1.2*	*8.0*	*4.3*	*2.4*	*6.8*	*4.1*	*8.2*	*6.1*	*180th Lane 111' west of TH 47.*


GPR Data (180th Lane: TH 47 to Krypton Street)
0
100
200
300
400
500
600
0
2
4
6
8
10
12
Depth (in.)
Station (ft)
Bit Depth (in.)
Agg Depth (in.)
20 per. Mov. Avg. (Bit Depth (in.))
20 per. Mov. Avg. (Agg Depth (in.))


GPR Data (Krypton Street: 180th Lane to CDS)
0
50
100
150
200
250
300
0
1
2
3
4
5
6
7
8
9
Depth (in.)
Station (ft)
Bit Depth (in.)
Agg Depth (in.)
20 per. Mov. Avg. (Bit Depth (in.))

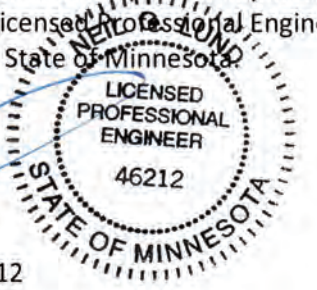
Geotechnical Evaluation Report

2018-2019 Reconstruction Projects
Ford Brook Estates Subdivision (Area C)
Ramsey, Minnesota

Prepared for

City of Ramsey

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.



Neil G. Lund, PE
Senior Engineer
License Number: 46212
April 4, 2018

BRAUN INTERTEC
The Science You Build On.

Project B1705491

Braun Intertec Corporation

BRAUN INTERTEC
The Science You Build On.

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

April 4, 2018

Project B1705491

Bruce Westby, PE
City of Ramsey
7550 Sunwood Drive NW
Ramsey, MN 55303

Re: Geotechnical Evaluation
2018-2019 Reconstruction Projects
Ford Brook Estates Subdivision (Area C)
Ramsey, Minnesota

Dear Mr. Westby:

We are pleased to present this Geotechnical Evaluation Report for the 2018-2019 Reconstruction Projects (Area C) in Ramsey, Minnesota. Our results and recommendations in light of the geotechnical issues influencing design and construction are presented in the attached report, which we request you read in its entirety.

Remarks

Thank you for making Braun Intertec Corporation your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please call Neil Lund at 952.995.2284.

Sincerely,

BRAUN INTERTEC CORPORATION

Neil G. Lund, PE
Senior Engineer

Colette Brandenburg for
Matthew S. Oman, PE
Principal – Principal Engineer

Table of Contents

Description **Page**

Table of Contents (continued)

Description **Page**

Appendix

A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the proposed 2018-2019 Reconstruction Projects in Ramsey, Minnesota. The projects will be in three subdivisions as summarized in Table 1. The project described in this report is for the Ford Brook Estates subdivision (Area C); the other reports are provided under separate cover.

Table 1. Project Area Details

Subdivision	Approximate Street Length (feet)	Borings
The North Forty (Area A)	2,939	ST-A1 to ST-A5
Stanhope Terrace (Area B)	2,763	ST-B1 to ST-B5
Ford Brook Estates (Area C)	**7,369**	**ST-C1 to ST-C15**

The proposed projects will include pavement reconstruction and storm sewer improvements.

A.2. Purpose

The purpose of this geotechnical evaluation was to characterize subsurface geologic conditions at selected exploration locations and provide geotechnical recommendations for the design and construction of the Ramsey 2018-2019 Reconstruction Projects.

A.3. Background Information and Reference Documents

To facilitate our evaluation, we were provided with or reviewed the following information or documents:

- A base map of the project area provided by the City of Ramsey.
- *Geologic Atlas of Anoka County* available from the Minnesota Geological Survey.

A.4. Project Area Conditions

Based on our referenced documents and past experience, the native soils underlying the project area include sandy alluvium.

The Ford Brook Estate subdivision is zoned residential.

The current streets are surfaced with bituminous pavement with rural cross-sections. The topography of each project area is slightly rolling.

A.5. Scope of Services

Our scope of services for this project was originally submitted as a quote to Mr. Bruce Westby of the City of Ramsey, for which we received authorization to proceed on June 8, 2017. Tasks performed in accordance with our authorized scope of services included:

- Staking and clearing exploration locations of underground utilities.
- Performing 25 penetration test borings and extending them to a nominal 10 feet below the current pavement surface. Fifteen borings were performed for Area C.
- Performing laboratory moisture content tests and mechanical analyses (#200 sieve only) on selected penetration test samples.
- Preparing this report containing a CAD sketch, exploration logs, a summary of the geologic materials encountered, results of laboratory tests, and recommendations for subgrade preparation, pavement thickness design, and utility placement.

Exploration locations and surface elevations at the exploration locations were determined using GPS technology that utilizes the Minnesota Department of Transportation's (MnDOT's) permanent GPS Virtual Reference Network (VRN).

Our scope of services was performed under the terms of our July 18, 2016 General Conditions.

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 tests, 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: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) laboratory test results and (5) 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. Pavement Materials

The borings first encountered an average bituminous pavement thickness of 3.9 inches as shown in Table 2. The aggregate base averaged 4.9 inches.

Table 2. Pavement Thickness Summary

Boring	Subdivision	Street	Pavement Thickness (inches)		Notes
			Bituminous	Aggregate Base	
ST-C1	Ford Brook Estates	Junkite St	4	5	
ST-C2		180th Ave	5	5	
ST-C3		180th Ave	3	5	
ST-C4		180th Ave	3	4	
ST-C5		180th Ave	4	4	
ST-C6		180th Ave	6	4	3 inches of bituminous and 4 inches of aggregate base underlay the surface section
ST-C7		Iodine St	3	5	
ST-C8		Germanium St	3	4	
ST-C9		Flourine St	3	5	
ST-C10		Erkium St	5	---	Aggregate base not noted
ST-C11		Erkium St	3	6	
ST-C12		180th Ln	3	6	
ST-C13		Iodine St	4	5	
ST-C14		180th Ln	5	5	
ST-C15		Krypton St	4	5	
AREA C AVERAGE			**3.9**	**4.9**	

B.2.b. Geologic Materials

Table 3 provides a summary of the soil boring results, in the general order we encountered the strata. Please refer to the Log of Boring sheets in the Appendix for additional details. The Descriptive Terminology of Soil sheet in the Appendix includes definitions of abbreviations used in Table 3.

Table 3. Subsurface Profile Summary*

Strata	Soil Type - ASTM Classification	Range of Penetration Resistances	Commentary and Details
Pavement section	N/A	N/A	▪ See Table 1.
Fill	SP-SM, SP, SC, CL	6 to 28 blows per foot (BPF)	▪ Overwhelmingly SP-SM or SP. ▪ General penetration resistance of about 10 BPF. ▪ Moisture condition moist to wet. ▪ Thicknesses at boring locations varied from 1 to 6 feet. ▪ Limited clayey layers (ST-C5, ST-C14).
Alluvium	SP, SP-SM, CL, SC	3 to 28 BPF	▪ General penetration resistances of less than 10 BPF in sands (loose), or 3 to 7 BPF in clays (soft to medium). ▪ Sands typically brown to light brown, fine-grained and moist. ▪ Clays generally present near observed water; usually gray in color, with limited sandy soil content. Present in ST-C3, ST-C5, ST-C14, ST-C15. ▪ Moisture condition variable above the apparent water table, though generally moist. ▪ Water table penetrated in a limited number of borings (see Table 3).
Swamp deposits	SM, CH	1 to 7 BPF	▪ Present in two locations: ST-C6 and ST-C11. ▪ SM layer was black, 4 to 5 feet thick and included organic fines and trace wood pieces (ST-C6). ▪ Underlain by gray, fat clay to boring termination depth in ST-C11.

*Abbreviations defined in the attached Descriptive Terminology of Soil sheet.

For simplicity in this report, we define fill to mean existing, uncontrolled, or undocumented fill.

B.2.c. Groundwater

Groundwater was observed during our drilling operations as shown in Table 4.

Table 4. Groundwater Observation Summary

Boring	Surface Elevation (ft)*	Observed Groundwater Depth (ft)	Corresponding Groundwater Elevation (ft)
ST-C3	882	7	875
ST-C4	883	9	874
ST-C10	889	8 1/2	880 1/2

*Rounded to nearest 1/2-foot.

The groundwater elevation was approximately between 874 and 880 1/2 feet. Seasonal and annual fluctuations of groundwater should be anticipated.

B.3. Laboratory Test Results

Laboratory test results, including moisture content, organic content, and mechanical analysis (#200 sieve only) tests, are summarized in Table 5. The moisture contents of the sandy fill and native soils were around 3 to 15 percent, indicating the materials ranged from below to above their optimum moisture contents for compaction. The higher moisture contents of noted clayey soils, ranging from 15 to 37 percent, are likely near or above their optimum moisture contents for compaction.

Table 5. Laboratory Testing Results

Borehole	Soil Classification	Depth	%<#200 Sieve	Water Content (%)	Organic Content (%)
ST-C1	SP-SM	5	6	4	---
ST-C3	SP-SM	5	---	18	---
ST-C7	SP	7 1/2	---	8	---
ST-C10	SP-SM	5	12	10	---
ST-C11	SM	5	---	15	2
ST-C13	SP-SM	2 1/2	---	9	---
ST-C14	CL	2 1/2	---	15	2
ST-C14	CL	5	98	37	--

C. Basis for Recommendations

C.1. Design Details

C.1.a. Traffic Loads

Traffic counts for the streets were not available. Based on the residential zoning in the project areas, we anticipate they will experience approximately 50,000 equivalent single axle loads (ESALs) over a 20-year service life.

C.1.b. Anticipated Grade Changes

Based on the nature of construction, we anticipate grade changes will be minimal.

C.1.c. Utility Depths

Design utility depths were not available. We also assume storm sewer improvements will be less than 10 feet below grade.

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

C.2.a. Reuse of Pavement Materials

Our borings encountered a bituminous layer averaging nearly 4 inches thick, and an aggregate base that was almost 5 inches thick. The pavement was underlain with sandy fill material in nearly all of the soil borings.

In our opinion, full-depth reclamation (FDR) can be utilized in order to obtain materials for aggregate base on the projects, assuming the material can be stockpiled or processed on site, or hauled to an off-site location to be sorted and reused. A proper reclamation depth will likely vary be between 6 and 8 inches. It may be possible to increase this thickness locally depending on the conditions encountered and nature of the subbase materials.

We recommend thorough quality control practices, including frequent sieve analyses of the reclaimed material, if the product will be reused directly on site as aggregate base or as a stabilizing material with minimal processing.

C.2.b. Pavement Subgrades

The pavement subgrades will consist almost exclusively of sandy materials, though areas of clayey sand or lean and fat clay were also present.

We anticipate the subgrade soils present beneath the streets will generally be suitable for pavement support in their current condition or with minor rework such as surface compaction. The exception is the swamp-deposited soils, which should be removed from excavations for pavements and in utility trenches. The shallow clayey sand or lean clay fill, present in ST-C5, ST-C14 and ST-C15, may be wet or become wet upon exposure. These soils in particular may require additional work, such as drying or moisture conditioning, before they can be properly compacted.

C.2.c. Utility Support and Impact of Groundwater

The reuse of the utility trench backfill soils will have potential impacts on the pavement subgrades. If the backfill is not properly compacted, there is the potential for subgrade instability and settlement (and premature deterioration) of the driving surface. We anticipate the trench soils will consist mostly of granular soils (poorly graded sand and poorly graded sand with silt). In some cases, poor or unsuitable soils will be encountered that should be removed or will need additional effort to properly compact.

Depending on the conditions at the time of excavation, drying of the clayey and silty soils may be necessary to achieve the levels of compaction recommended for utility support. Clayey and particularly silt-rich trench soils that are exposed to moisture will be more susceptible to strength loss and may also become unstable, which will require moisture conditioning or removal and replacement with suitable soils. Fat clay and organic soils (ST-C6, ST-C11) should not be used as utility support or backfill material.

Groundwater was present in a limited number of borings (see Table 4), which may affect the placement of storm sewer. A coarse stabilizing aggregate could help with utility placement in wet or saturated conditions in these soils.

D. Recommendations

D.1. Pavements

D.1.a. Subgrade Preparation and Proofrolls

For preparation of any exposed subgrades prior to placement of new pavement sections or reclaimed aggregate (see below), we recommend proofrolling the subgrade soils with a loaded tandem-axle truck. This will assist in identifying any soft or weak areas that will require additional soil correction work. Areas that yield or rut more than 1 to 2 inches due to wheel traffic, depending on conditions, should be corrected. Failed areas should be compacted, or if too wet, we recommend that the upper 1 to 2 feet of the resulting subgrade be scarified, dried to a proper moisture content (see Table 6), and compacted to a 100 percent of its standard Proctor maximum dry density (ASTM D 698).

If there are areas that still cannot be compacted, we recommend subexcavating the unstable materials to a minimum depth of 1 to 2 feet, depending on the outcome of the proofroll and the replacement material. The soils should be replaced with suitable, properly compacted materials such as select granular material, aggregate base, or larger diameter crushed aggregate ("3-inch minus").

D.1.b. Backfill and Material Compaction

We recommend compacting soils used as backfill for subcuts or material replacement to a minimum of 100 percent of standard Proctor density within 3 feet of the top of the subgrade. For fills more than 3 feet below final subgrades, 95 percent compaction is sufficient. The moisture content of the fill and backfill should be as shown in the table below depending on the classification of the backfill soils.

Table 6. Compaction Recommendations Summary

Reference	Relative Compaction, percent (ASTM D 698 – Standard Proctor)	Moisture Content Variance from Optimum, percentage Points
Below pavements, within 3 feet of subgrade elevations	100	-3/+3 (sandy soils) -2/+1 (clayey soils)
Below pavements, more than 3 feet below subgrade elevations Below utilities	95	-3/+3 (sandy soils) -2/+3 (clayey soils)

D.1.c. Design Sections

Laboratory tests to determine an R-value for pavement design were not included in the scope of this project. Given the most common soils in the top 5 feet of pavement sections, which include poorly graded sand with silt and poorly graded sand, we recommend using an R-value of 50 for pavement thickness design. Note that some shallow clayey soils, such as in Boring ST-C11, may need to be removed to achieve this value and make the pavement section in Table 7 appropriate.

Table 7 shows our recommendations for materials for the pavement section. The thicknesses are typical of those used by the City of Ramsey.

Table 7. City of Ramsey Bituminous Pavement Thickness Design

Layer	Thickness (inches)	MnDOT Specification/Designation
Bituminous Wear	1 1/2 (1 lift)	SPWEA240C
Bituminous Non-wear	2 (1 lift)	SPNWB230C*
Aggregate Base (Class 5 or 6) or Reclaim	4	3138 3135

*For small quantities, SPWEA240C can be used for the entire thickness.

The above pavement design is based upon a 20-year performance life. This is the amount of time before major reconstruction is anticipated. This performance life assumes maintenance such as seal coating and crack sealing is routinely performed. The actual pavement life will vary depending on variations in weather, traffic conditions and maintenance.

D.1.d. Materials and Compaction

We recommend specifying pavement materials as recommended in Table 6.

We recommend compacting the aggregate base or reclaim materials to meet the requirements of MnDOT specification 2211.3.D.2.c. (Penetration Index Method). We recommend compacting bituminous pavements to at least 92 percent of the maximum theoretical Rice density per the Maximum Density Method (specification 2360.3.D.1), with bituminous materials and placement practices meeting the requirements of MnDOT Specification 2360.

D.2. Utilities

D.2.a. Subgrades and Trench Backfill

The native and fill soils encountered at likely utility elevations generally appear suitable for pipe and utility structure support and we anticipate that utilities can be installed per manufacturer bedding requirements. However, we encountered some wet, clayey or silty soils in some borings; these soils may have limited stability and not be suitable for backfill or support of utilities if wet. We recommend providing a contingency for further subcutting and soil replacement of utility backfill soils in such soils.

In addition, the swamp-deposited clays and silty sands (ST-C6, ST-C11) are not considered suitable backfill materials under any circumstances. These soils should be removed and replaced with suitable grading materials where encountered during excavation. At pipe elevations, we recommend a minimum subcut and replacement with crushed-faced rock that is free of material 1 inch in diameter or smaller.

A geotechnical engineer should observe all utility trench excavations and subcuts.

D.2.b. Excavation Side Slopes

The project area soils appear to meet OSHA Type C requirements in most cases. We recommend constructing excavation side slopes to lie back at a horizontal to vertical slope of 1 1/2 to 1 or flatter. In significant depths of organic soils these side slopes may need to be made flatter, or supplemental support may be necessary.

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, 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.

Trenches deeper than 20 feet must be designed by a professional engineer.

D.2.c. Selection, Placement and Compaction of Backfill

We recommend compacting backfill placed above and below utilities as shown in Table 6.

To achieve compaction over wet or waterbearing subgrades, we recommend the use of sands or gravel with MnDOT aggregate backfill material (Specification 3149.2E).

D.2.d. Excavation Dewatering

We recommend removing groundwater from the utility excavations if encountered, and removing any water that seeps into excavations from sidewalls or the adjacent sitework. Sumps and pumps will generally be suitable for short-term, small-scale water removal under the soil conditions likely to be encountered for this project. Alternative approaches should be considered for long-term or large-scale groundwater removal, particularly in sands such as those encountered on the project, which can become unstable during dewatering with pumps from within excavations.

D.2.e. Corrosion Potential

If founded in sandy soils, corrosion protection should not be required for ductile iron pipe. Type I cement may also be specified for concrete utilities.

Some clayey soils were present at likely utility depths, which are considered at least moderately corrosive to ductile iron pipe. We recommend corrosion protection or the use of corrosion-resistant pipe material if utilities will be bedded within such soils, particular if in close proximity to static groundwater. Soils with organic content should not be allowed as pipe support or as backfill around pipes.

D.3. Construction Quality Control

D.3.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade preparation, utility placement and pavement 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.3.b. Materials Testing

We recommend density tests be taken in excavation backfill and additional required fill placed below pavements and utilities. This includes DCP tests for aggregate base or reclaim and imported granular materials.

We recommend Gyratory tests on bituminous mixes to evaluate strength and air voids and density tests to evaluate compaction.

D.3.c. Pavement Subgrade Proofroll

We recommend that proofrolling of the pavement subgrades be observed by a geotechnical engineer to determine if the results of the procedure meet project specifications and to delineate the extent of additional pavement subgrade preparation work that may be necessary.

D.3.d. 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.

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 1/2 foot intervals.

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 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 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. 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.

Appendix


ST-C14
ST-C13
ST-C2
ST-C3
ST-C4
ST-C5
ST-C6
ST-C1
ST-C7
ST-C8
ST-C9
ST-C10
ST-C11
ST-C12
180TH LANE
18OTH AVENUE
ERKIUM STREET
VARD (STATE HIGHWAY 47)
JUNKITE STREET
IODINE STREET
GERMANIUM STREET
FLOURINE STREET
ERKIUM STREET
COUNTY ROAD 27 (179TH LANE)

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C1**

LOCATION: N: 195376, E: 462823 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	P200 %	Tests or Notes
897.2	0.0							
896.4	0.8	PAV	4 inches of bituminous over 5 inches of aggregate base.					
895.2	2.0	FILL	FILL: Poorly Graded Sand with Silt, fine-grained, with Gravel, dark brown, moist.					
		FILL	FILL: Poorly Graded Sand with SILT, fine- to coarse-grained, with Gravel, brown, moist.	14				
				10		4	6	
890.2	7.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, light brown, moist, medium dense. (Alluvium)	12				
886.2	11.0			28				
			END OF BORING.					
			Water not observed while drilling.					
			Boring then backfilled.					

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C2**

LOCATION: N: 195624, E: 463131 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
894.5	0.0					
893.7	0.8	PAV	5 inches of bituminous over 5 inches of aggregate base.			
892.5	2.0	FILL	FILL: Poorly Graded Sand with Silt, fine-grained, trace Gravel, dark brown, moist.			
890.5	4.0	FILL	FILL: Poorly Graded Sand, fine-grained, brown, moist.	28		
		SP	POORLY GRADED SAND, fine-grained, brown, moist, loose to medium dense. (Alluvium)	10		
				19		
883.5	11.0			19		
			END OF BORING.			
			Water not observed while drilling.			
			Boring then backfilled.			

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C3**

LOCATION: N: 195609, E: 463651 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
881.8	0.0						
881.1	0.7	PAV	3 inches of bituminous over 5 inches of aggregate base.				
		FILL	FILL: Poorly Graded Sand with Silt, fine-grained, brown to dark brown, wet.	16			
				4		18	
874.8	7.0				▽		
		CL	LEAN CLAY, gray, moist, rather soft. (Alluvium)	4			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate.
872.3	9.5						
		SP	POORLY GRADED SAND, fine- to coarse-grained, gray, waterbearing, very loose. (Alluvium)	3			
870.8	11.0		END OF BORING.				
			Water observed at 7 feet with 9 1/2 feet of hollow-stem auger in the ground.				
			Boring then backfilled.				

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C4**

LOCATION: N: 195602, E: 464086 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
883.0	0.0					
882.4	0.6	PAV / FILL	3 inches of bituminous over 4 inches of aggregate base. FILL: Poorly Graded Sand with Silt, fine-grained, dark brown, moist to wet.	11		
879.0	4.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, wet, loose to medium dense. (Alluvium)	11		
				12	▽	
			Waterbearing at 9 feet.			
872.0	11.0		Intermixed with gray, Lean Clay at sampler tip.	6		
			END OF BORING. Water observed at 9 feet with 9 1/2 feet of hollow-stem auger in the ground. Boring then backfilled.			

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C5**

LOCATION: N: 195599, E: 464519 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
890.3	0.0					
889.6	0.7	PAV	4 inches of bituminous over 4 inches of aggregate base.			
888.3	2.0	FILL	FILL: Poorly Graded Sand with Silt, fine-grained, dark brown, moist.			
887.3	3.0	FILL	FILL: Clayey Sand, brown, moist.	8		
885.3	5.0	FILL	FILL: Poorly Graded Sand, fine-grained, brown, moist.			
883.3	7.0	CL	LEAN CLAY, with Sand, brown, moist, rather soft. (Alluvium)	5		
879.3	11.0	SC	CLAYEY SAND, trace Gravel, brown to gray, moist, rather stiff to stiff. (Alluvium)	13		
				12		
			END OF BORING.			
			Water not observed while drilling.			
			Boring then backfilled.			

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BRAUN INTERTEC

LOG OF BORING

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GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C6**

LOCATION: N: 195594, E: 464693 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
885.7	0.0					
884.3	1.4	PAV	6 inches of bituminous over 4 inches of aggregate base over 3 inches of bituminous over 4 inches of aggregate base.			
		FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, dark brown to brown, moist.	13		
880.7	5.0	SM	SILTY SAND, fine-grained, organic, trace wood pieces, black, wet, very loose. (Swamp Deposit)	1		
				7		
876.7	9.0	SM	SILTY SAND, fine- to medium-grained, dark gray, wet, loose. (Alluvium)	6		
874.7	11.0		END OF BORING. Water not observed while drilling. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C7**

LOCATION: N: 195304, E: 463197 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
899.4	0.0						
898.7	0.7	PAV	3 inches of bituminous over 5 inches of aggregate base.				
		FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, dark brown, moist.				
897.4	2.0	SP	POORLY GRADED SAND, fine- to medium-grained, brown, moist, very loose to medium dense. (Alluvium)	13			
				9			
				3		8	
888.4	11.0		Fine- to coarse-grained, with Gravel, wet at 10 feet.	2			
			END OF BORING.				
			Water not observed while drilling.				
			Boring then backfilled.				

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C8**

LOCATION: N: 195252, E: 463659 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
887.7	0.0					
887.1	0.6	PAV / FILL	3 inches of bituminous over 4 inches of aggregate base.			
			FILL: Poorly Graded Sand, fine-grained, dark brown to brown, moist.	24		
				10		
880.7	7.0	SP	POORLY GRADED SAND, fine-grained, brown, moist to wet, very loose to loose. (Alluvium)	10		
				2		
876.7	11.0		END OF BORING.			
			Water not observed while drilling.			
			Boring then backfilled.			

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C9**

LOCATION: N: 195286, E: 464075 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/6/17** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
886.4	0.0					
885.7	0.7	PAV	3 inches of bituminous over 5 inches of aggregate base.			
		FILL	FILL: Poorly Graded Sand with Silt, fine-grained, dark brown, moist.	15		
882.4	4.0	SP	POORLY GRADED SAND, fine-grained, brown, wet, loose. (Alluvium)	7		
				7		
875.4	11.0			8		
			END OF BORING.			
			Water not observed while drilling.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

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GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C10**

LOCATION: N: 195282, E: 464524 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/6/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	P200 %	Tests or Notes
888.8	0.0							
888.4	0.4	BIT	5 inches of bituminous.					
		FILL	FILL: Poorly Graded Sand with Silt, fine-grained, dark brown and brown, moist.	8				
884.8	4.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, wet, very loose to loose. (Alluvium)	4		10	12	
				7	▽			
877.8	11.0		Waterbearing at 10 feet.	10				
			END OF BORING.					
			Water observed at 8 1/2 feet with 9 1/2 feet of hollow-stem auger in the ground.					
			Boring then backfilled.					

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C11**

LOCATION: N: 195903, E: 464272 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
881.7	0.0						
880.9	0.8	PAV	3 inches of bituminous over 6 inches of aggregate base.				
		FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, dark brown, moist to wet.				
878.7	3.0			12			
		SM	SILTY SAND, fine-grained, slightly organic, black, wet, loose. (Swamp Deposit)	7		15	OC=2%
873.7	8.0			3			
		CH	FAT CLAY, trace fibers and roots, gray, wet, soft. (Swamp Deposit)	3			
870.7	11.0						
			END OF BORING. Water not observed while drilling. Boring then backfilled.				

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C12**

LOCATION: N: 195998, E: 464525 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
893.2	0.0					
892.4	0.8	PAV	3 inches of bituminous over 6 inches of aggregate base.			
		FILL	FILL: Poorly Graded Sand with Silt, fine-grained, brown, moist.	15		
889.2	4.0	SP	POORLY GRADED SAND, fine-grained, brown, moist to wet, medium dense. (Alluvium)	11		
				18		
882.2	11.0		Reddish brown Silty Sand lenses at 10 feet.	22		
			END OF BORING.			
			Water not observed while drilling.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C13**

LOCATION: N: 195813, E: 463033 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
889.6	0.0						
888.8	0.8	PAV	4 inches of bituminous over 5 inches of aggregate base.				
		FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, dark brown, moist.				
887.6	2.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, loose to medium dense. (Alluvium)	13		9	
				15			
				9			
878.6	11.0			5			
			END OF BORING.				
			Water not observed while drilling.				
			Boring then backfilled.				

BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C14**

LOCATION: N: 495994, E: 462578 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	P200 %	Tests or Notes
884.7	0.0							
883.9	0.8	PAV	5 inches of bituminous over 5 inches of aggregate base.					
		FILL	FILL: Lean Clay with Sand, slightly organic, dark brown, moist. Poorly Graded Sand with Silt layer at 2 feet.	6		15		OC=2%
880.7	4.0	CL	LEAN CLAY, gray, moist, soft to medium. (Alluvium)	3		37	98	
				7				
875.7	9.0	SP	POORLY GRADED SAND, fine-grained, brown, moist, loose. (Alluvium)	8				
873.7	11.0		END OF BORING. Water not observed while drilling. Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project B1705491
GEOTECHNICAL EVALUATION
City of Ramsey 2018-2019 Reconstruction Projects
Ramsey, Minnesota

BORING: **ST-C15**

LOCATION: N: 195692, E: 462332 See attached sketch.

DRILLER: SC | METHOD: 3 1/4" HSA, Autohammer | DATE: **7/5/17** | SCALE: **1" = 4'**

Elev. feet	Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
887.1	0.0					
886.3	0.8	PAV	4 inches of bituminous over 5 inches of aggregate base.			
		FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, dark brown, moist.			
885.1	2.0	CL	LEAN CLAY, gray, moist, medium. (Alluvium)	7		
883.1	4.0	SP	POORLY GRADED SAND, fine-grained, brown, moist, loose to medium dense. (Alluvium)	11		
				8		
876.1	11.0			7		
			END OF BORING.			
			Water not observed while drilling.			
			Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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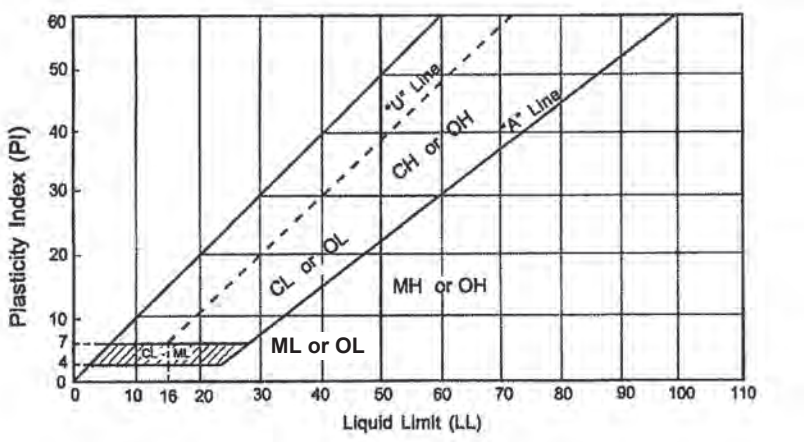
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487
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 Less than 5% 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 Less than 5% 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	Liquid limit - oven dried / 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	Liquid limit - oven dried / 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-inch (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60}/D_{10}$ $C_c = \frac{(D30)^2}{D_{10} \times D_{60}}$
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. Sand 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" lines.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcg	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liquid limit, %	**C**	Cohesion, psf
PL	Plastic limits, %	**Ø**	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 about "A" line

Relative Density of Cohesionless Soils

Very Loose..... 0 to 4 BPF
Loose..... 5 to 10 BPF
Medium dense ..... 11 to 30 PPF
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. All samples were taken with the standard 2" OD split-tube samples, except where noted.

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

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.

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: TW indicates thin-walled (undisturbed) tube sample.

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