Geotechnical Evaluation Report

Bever Park Sanitary Lift Station and Force Main
Bever Park Road
Cedar Rapids, Iowa

Prepared for

Watersmith Engineering

Professional Certification:
I hereby certify that this 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 Iowa. My license renewal date is December 31, 2019.

LICENSED PROFESSIONAL ENGINEER
ANDREW WILLIAM SCHWEIZER
24749
4/18/19
IOWA

Andrew Schweizer, PE
Project Engineer
License Number: 24749
April 18, 2019

Project: B1903141

Braun Intertec Corporation

BRAUN INTERTEC
The Science You Build On.

Braun Intertec Corporation
1901 16th Avenue SW, Suite 2
Cedar Rapids, IA 52404

Phone: 319.365.0961
Fax: 319.365.1306
Web: braunintertec.com

April 18, 2019

Project B1903141

Brad Roeth, PE
Watersmith Engineering
1029 Hershey Avenue
Muscatine, IA 52761

Re: Geotechnical Evaluation Report
Bever Park Sanitary Lift Station and Force Main
Bever Park Road
Cedar Rapids, Iowa

Dear Mr. Roeth:

We are pleased to present this Geotechnical Evaluation Report for the proposed Bever Park Sanitary Lift Station and Force Main project in Cedar Rapids, Iowa. Thank you for making Braun Intertec 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 us at 319-365-0961.

Sincerely,

Braun Intertec Corporation

Andrew Schweizer, PE
Project Engineer

Matthew R. Glisson, PE
Principal/Principal Engineer

AA/EOE

Table of Contents

Description **Page**

Appendix

A. Introduction

A.1. Project Description

We understand that the City of Cedar Rapids intends to construct a new, sanitary lift station and force main located in Bever Park, northeast of the existing Duck Pond. We also understand that the proposed lift station will be constructed to a depth of approximately 15 feet below existing grade and that that the force main will run along the west side of Bever Park Road to south, ending near the Bever Park Swimming Pool. The proposed force main is approximately 2,000 feet in length and will be constructed to depths of up to 10 feet below existing grade.

A.2. Background Information and Reference Documents

To facilitate our evaluation, we received a conceptual site layout created by Watersmith Engineering. The provided drawing displays the proposed lift station and force main locations and approximate boring locations. We also relied on aerial images from Google Earth™.

B. Results

B.1. Boring Logs

B.1.a. Log of Boring Sheets

The Appendix includes Log of Boring sheets for our test borings. The logs identify and describe the penetrated geologic materials and present the results of standard penetration tests (SPT) performed within them, laboratory testing results and groundwater measurements. We inferred strata boundaries from changes in the penetration test samples and the auger cuttings. The boundary depths will 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

We assigned geologic origins to the materials shown on the logs and referenced within this report based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance testing performed for the project, (4) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past, and

(5) laboratory testing results on material samples retrieved during drilling.

B.2. Geologic Profile

Table 1 summarizes the soil boring results in the general order we encountered the strata.

Table 1. Subsurface Profile Summary*

Strata	Soil Type - ASTM Classification	Penetration Resistances (Blows Per Foot)	Commentary and Details
Topsoil	---	---	▪ Present in all borings except Boring B-3 to depths of 4 inches below existing grade. ▪ Dark brown to black. ▪ Moisture condition is generally moist.
Pavement	---	---	▪ Asphaltic pavement present in Boring B-3 to a depth of approximately 6 inches below existing grade. ▪ Approximately 6 inches of aggregate base material was encountered below the pavement.
Existing Fill	---	10	▪ Present at all borings to depths ranging from approximately 3 to 6 feet below existing grade. ▪ Generally lean clay with varying amounts of sand and gravel. ▪ Moisture condition is generally moist. ▪ Brown to dark brown.
Alluvial	CL, SC	5 to 7	▪ Present at all borings to depths ranging from auger refusal depths of 7 feet to 11 feet below existing grade. ▪ Generally lean clay and clayey sand with varying amounts of sand and gravel. ▪ Moisture condition generally moist. ▪ Gray to dark brown.
Residuum	GP-GC	50 blows/4" to 50 blows/5"	▪ Present at Boring B-1 to an end-of-boring depth of approximately 15 feet below existing grade. ▪ Generally very dense. ▪ Moisture condition generally moist. ▪ Brown in color.

*Abbreviations defined in the attached Descriptive Terminology sheets.

B.3. Groundwater

We observed groundwater while drilling in all borings at a depth ranging from approximately 5 to 6 1/2 feet below existing grade. Project planning should anticipate seasonal and annual fluctuations of groundwater.

C. Sanitary Sewer Recommendations

C.1. Design Details

Based on our correspondence with you, we understand the new sanitary sewer force main along Bever Park Road will be constructed to depths of up to 10 feet below existing grade.

C.2. Excavations

All excavation 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. The project specifications should reference to these OSHA requirements.

Based on the samples taken from our borings, the existing fill could classify as Type B (lean clays) in accordance with OSHA guidelines, which require 1H:1V (horizontal:vertical) slopes or flatter. The native, lean clay and clayey sand appear to be Type C soil, which requires 1½H:1V slopes or flatter. Note that submerged soil is classified as Type C in accordance with OSHA guidelines. Soil and groundwater conditions may vary away from our boring locations and the contractor should continuously assess the soil types throughout the project. If excavations cannot achieve the required excavation slopes due to the constraints of project limits, the contractor should use trench boxes or other shoring measures.

C.3. Excavation Dewatering

The borings encountered groundwater at depths ranging from approximately 6 to 6 1/2 feet below existing grade in the areas of the force main. Based on the provided excavation depths, we anticipate excavations for the sanitary sewer force main will encounter groundwater. Due to the granular soils encountered in the areas of the force main, we anticipate the dewatering effort will need to consist of well points. A dewatering contractor should review our boring logs to determine means and methods.

Note that static groundwater levels may be higher or lower during construction than those observed while drilling. To better assess groundwater conditions and dewatering requirements, we recommend the project team consider digging test pits prior to construction in areas near the planned excavations.

C.3.a. Selecting Excavation Backfill and Additional Required Fill

We consider onsite soils with less than two percent organic content by weight suitable for reuse as general backfill and fill. Based on the results of our laboratory testing, we anticipate the contractor will need to moisture conditioning the clayey soils prior to compaction. Clayey soils are 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, should consist of sand, silty sand, clayey sand, sandy lean clay, or lean clay. We recommend, however, that the plastic index of the material not exceed 15 and the liquid limit not exceed 48.

Pipe bedding materials should comply with the pipe manufacturer's requirements or City of Cedar Rapids specifications.

C.4. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 8 inches. We recommend compacting backfill and new fill within the sewer excavations to 95 percent of the material's maximum dry density according to ASTM International Standard (ASTM) D698. We also recommend moisture contents of backfill and fill be placed at ±3 percentage points of optimum moisture content for sand and -1 to +3 percentage points of optimum moisture content for clayey soils.

C.5. Construction Quality Control

We recommend taking density tests in excavation backfill and additional required fill. The project documents should require the contractor to remove snow and ice from cut and fill areas prior to grading. The project documents should also not allow the contractor to place fill on frozen subgrades or to use frozen soils as fill.

D. Lift Station Recommendations

D.1. Design Details

The project team did not provide specific details about the construction of the proposed lift station. Based on our experience with similar structures, we assume it will be a reinforced-concrete, box-like structure that will house the lift station equipment and piping. We also assume that the structure will have a rectangular mat at the base and contact pressure at the base of the mat will be less than 1,000 pounds per square foot (psf).

Based on our correspondence with you, we understand that the proposed lift station will be constructed to a depth of approximately 15 feet below existing grade. We assume that most of the lift station structure will be below ground.

D.2. Site Preparation

D.2.a. Excavations

All excavation 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. The project specifications should reference to these OSHA requirements. The descriptions of the anticipated soil types, OSHA classifications and slope requirements in Section C.2. of this report apply to the proposed lift station.

Boring B-1, performed at the proposed lift station location, encountered residual material at a depth of approximately 11 feet below existing grade. Therefore, we anticipate rock excavations may be required to construct the lift station. Contractors should be aware of required residual rock excavation as conventional excavating methods (such as pneumatic breakers and backhoes) may not be viable based on our boring. We recommend contractors review our boring logs to determine means and methods.

D.2.b. Excavation Dewatering

Boring B-1 encountered groundwater at a depth of 5 feet below existing grade. Based on the proposed excavation depths, we anticipate that groundwater will be a significant factor in the excavation for the lift station. Due to the granular soils encountered in the areas of the force main, we anticipate the dewatering effort will need to consist of well points. A dewatering contractor should review our boring logs to determine means and methods.

Similar to our recommendations for the force main, groundwater may be higher or lower than revealed at our boring for the lift station. We also recommend performing a test pit prior to construction at the proposed lift station to better assess groundwater conditions and dewatering requirements.

D.2.c. Selecting Excavation Backfill and Additional Required Fill

We consider onsite soils with less than two percent organic content by weight suitable for reuse as general backfill and fill. However, we recommend that below-grade wall backfill consist of granular material (sand or gravel). Based on the results of our laboratory testing, we anticipate the contractor will need to moisture conditioning the clayey soils prior to compaction. Clayey soils are 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, should consist of sand, silty sand, clayey sand, sandy lean clay, or lean clay. We recommend, however, that the plastic index of the material not exceed 15 and the liquid limit not exceed 48.

D.2.d. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 8 inches. We recommend compacting backfill and new fill within the lift station excavations to 98 percent of the material's maximum dry density according to ASTM D698. We also recommend moisture contents of backfill and fill be placed at ±3 percentage points of optimum moisture content for sand and -1 to +3 percentage points of optimum moisture content for clayey soils.

D.3. Structural Support

D.3.a. Bearing

Based on our boring, we anticipate the lift station will bear on residual material at a depth of about 15 feet below grade. The residual material will provide adequate support for the lift station structure.

D.3.b. Settlement

We anticipate less than 1/2 inch of settlement for the lift station bearing on residual rock material.

D.4. Lateral Loads

We recommend that below-grade wall backfill consist of granular material (sand or gravel). We assume the walls of the lift station structure will be rigid, fixed by a structural slab at the top and not allowed to rotate. Therefore, the lateral earth pressures will be "at rest" pressures (K_0). The soils contributing to these lateral earth pressures will be those within a zone having an angle of about 60 degrees above horizontal at the base of the walls. Depending on the configuration of the excavation necessary to construct the walls, the soils in this zone may consist of granular backfill, lean clay, or bedrock. If the soils in this zone are a combination of materials, we recommend using the values that result in the highest pressure. We recommended using the parameters included in Table 2.

Table 2: Recommended Soil Parameters for Below-Grade Wall Design

Soil Type	$\gamma_{Saturated}$, unit weight (pcf)	$\gamma_{Submerged}$, unit weight (pcf)	Friction Angle (degrees)	K_0	K_a	K_p
Lean Clay	125	62.6	26	0.56	0.39	2.56
Sand	120	57.6	30	0.50	0.33	3.00
Gravel	125	62.6	32	0.47	0.31	3.25

At-rest lateral pressure due to intact bedrock is negligible. The values in Table 2 assume a level backfill with no surcharge. We would need to revise these values for sloping backfill or other dead or live loads located within a horizontal distance behind the walls that is equal to the height of the walls. Our design values do not consider lateral pressure due to water.

D.5. Construction Quality Control

We recommend taking density tests in excavation backfill and additional required fill. Backfill consisting of clean gravel or lean concrete does not require compaction or density testing.

We also recommend performing slump, air content, and strength tests of Portland cement concrete. Concrete delivered to the site should meet the temperature requirements of ASTM C94. The project documents should not allow the contractor to place concrete on frozen subgrades. The contractor should protect concrete from freezing until it achieves the necessary strength and should not permit frost to penetrate below footings at any time during construction.

E. Procedures

E.1. Penetration Test Borings

Watersmith Engineering staked the boring locations prior to the start of our field work and provided the boring coordinates and elevations to us. The boring logs in the Appendix include the boring coordinates and elevations. The Appendix also includes a boring location plan.

Once borings were staked and utilities located, we drilled the penetration test borings with a track-mounted drill rig equipped with hollow stem augers. We performed the borings in general accordance with ASTM D1586 and took penetration test samples at 2 1/2- to 5-foot intervals within the boring located at the lift station. We obtained bulk samples from the augers within the borings drilled for the proposed force main. The boring logs show actual sample intervals and corresponding depths.

The drillers checked for groundwater while advancing the penetration test borings, and again after auger withdrawal. We then filled the boreholes or allowed them to remain open for an extended period of observation, as noted on the boring logs.

E.2. Material Classification and Testing

We visually and manually classified the geologic materials encountered based on ASTM D2488. When we performed laboratory classification tests, we used the results to classify the geologic materials in accordance with ASTM D2487. The Appendix includes a chart explaining the classification system we used.

The exploration logs in the Appendix note most of the results of the laboratory tests performed on geologic material samples. We performed the tests in general accordance with ASTM or AASHTO procedures.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

We developed our evaluation, analyses and recommendations 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. Therefore, we must infer strata boundaries and thicknesses to some extent. Strata boundaries may also be gradual transitions, and project planning should expect the strata 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 performing additional exploration work, or starting construction. If future activity for this project reveals any such variations, you should notify us so that we may reevaluate our recommendations. Such variations could increase construction costs, and we recommend including a contingency to accommodate them.

F.1.b. Groundwater Levels

We made groundwater measurements under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. Note that the observation periods were relatively short, and project planning can expect groundwater levels to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. 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.

F.3. Continuity of Professional Responsibility

F.3.a. Plan Review

We based this report on a limited amount of information, and we made a number of assumptions to help us develop our recommendations. We should be retained to review the geotechnical aspects of the designs and specifications. This review will allow us to evaluate whether we anticipated the design correctly, if any design changes affect the validity of our recommendations, and if the design and specifications correctly interpret and implement our recommendations.

F.3.b. Construction Observations and Testing

We recommend retaining us to perform the required observations and testing during construction as part of the ongoing geotechnical evaluation. This will allow us to correlate the subsurface conditions exposed during construction with those encountered by the borings and provide professional continuity from the design phase to the construction phase. If we do not perform observations and testing during construction, it becomes the responsibility of others to validate the assumption made during the preparation of this report and to accept the construction-related geotechnical engineer-of-record responsibilities.

F.4. Use of Report

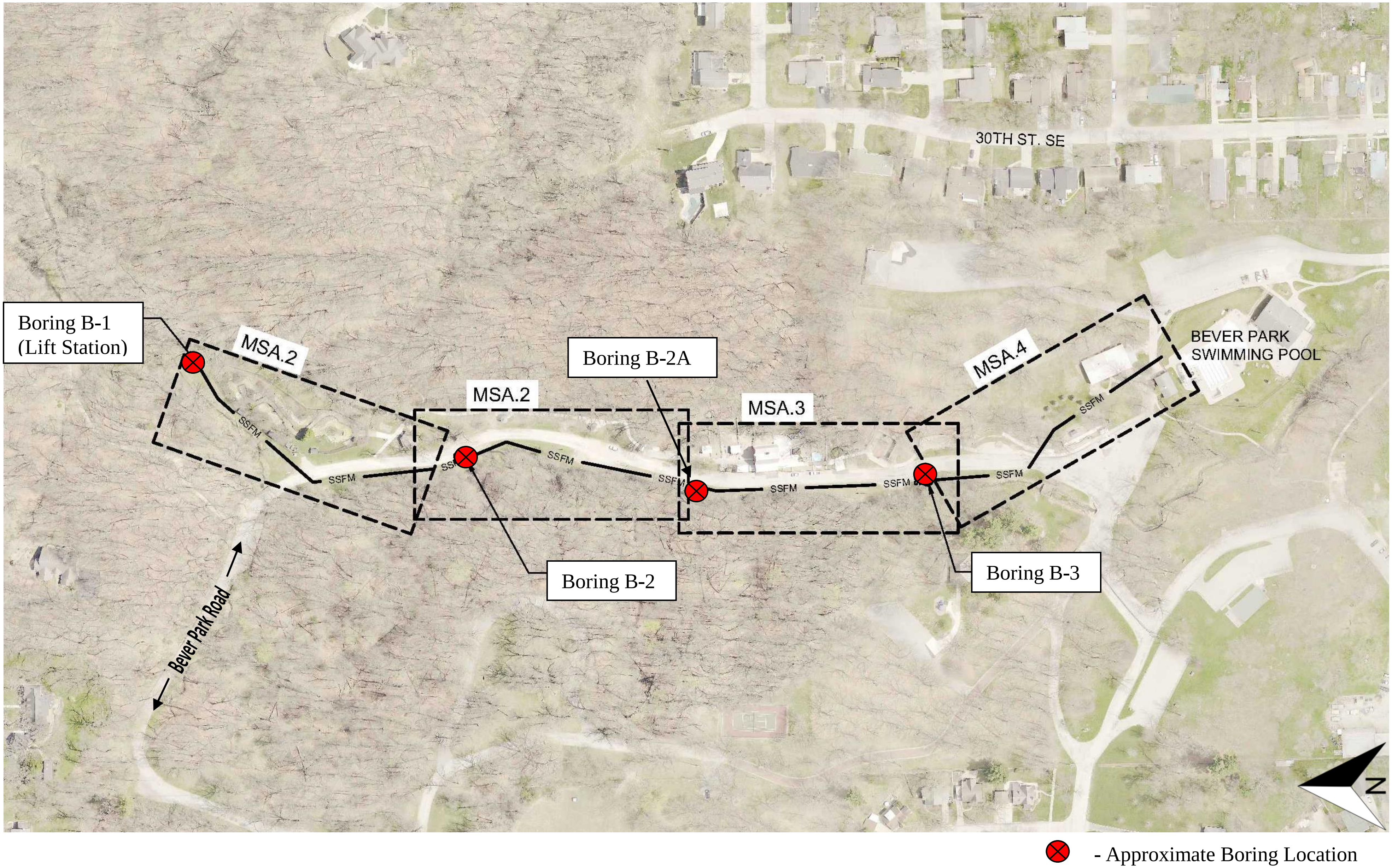
This report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation may not be appropriate for other parties or projects.

F.5. 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

BRAUN INTERTEC



INT		DATE
DRAWN BY:	AWS	4/15/2019
APP'D BY:	MRG	4/17/2019
JOB NO.	B1903141	
DWG. NO.	1	
SCALE	N/A	

Boring Location Plan
Bever Park Sanitary Lift Station and Force Main
Bever Park Road
Cedar Rapids, Iowa

BRAUN INTERTEC

BRAUN INTERTEC

LOG OF BORING

Braun Project B1903141 Geotechnical Evaluation Bever Park Lift Station and Force Main Bever Park Road Cedar Rapids, Iowa	BORING: **B-1** LOCATION: Northing: 3465433.589 Easting: 5430827.915

DRILLER: C.Gracey/T.Henkes	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/19	SCALE: 1" = 4'

Elev. feet 786.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
786.2	0.3	TS	Topsoil				
		FILL	FILL: Sandy Lean Clay, trace Gravel, brown, moist	10			No recovery.
783.5	3.0	CL	LEAN CLAY, trace Gravel, gray, moist, medium (Alluvium)	7	▽	21	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				5		25	
				5		28	
775.5	11.0	GP-GC	POORLY GRADED GRAVEL with CLAY, coarse grained, brown, moist, very dense (Residuum)	*			*50 blows for 5 inches.
				*			*50 blows for 4 inches.
771.5	15.0		END OF BORING. Water observed at 5 feet while drilling. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\CEDAR RAPIDS\2019\03141.GPJ BRAUN_V8_CURRENT.GDT 4/18/19 09:19

BRAUN INTERTEC

LOG OF BORING

Braun Project B1903141
Geotechnical Evaluation
Bever Park Lift Station and Force Main
Bever Park Road
Cedar Rapids, Iowa

BORING: **B-2**

LOCATION: Northing: 3464949.091
Easting: 5430661.696

DRILLER: C.Gracey/T.Henkes | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/4/19** | SCALE: **1" = 4'**

Elev. feet 788.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
788.1	0.3	TS	Topsoil				
		FILL	FILL: Lean Clay, trace Sand, dark brown, moist			19	
782.5	6.0	SC	CLAYEY SAND, fine- to coarse-grained, dark brown, moist (Alluvium)		▽	25	
778.5	10.0		END OF BORING. Water observed at 6 feet while drilling. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\CEDAR RAPIDS\2019\03141.GPJ BRAUN_V8_CURRENT.GDT 4/18/19 09:19

LOG OF BORING

BRAUN INTERTEC

Braun Project B1903141
Geotechnical Evaluation
Bever Park Lift Station and Force Main
Bever Park Road
Cedar Rapids, Iowa

BORING: **B-2A**

LOCATION: Northing: 3464514.499
Easting: 5430600.569

DRILLER: C.Gracey/T.Henkes	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/19	SCALE: 1" = 4'

Elev. feet 791.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
791.5	0.3	TS	Topsoil				
		FILL	FILL: Lean Clay, trace Sand, dark brown, moist			22	
785.8	6.0	SC	CLAYEY SAND, coarse grained, dark brown, moist (Alluvium)		▽	27	
781.8	10.0		END OF BORING. Water observed at 6.5 feet while drilling. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\CEDAR RAPIDS\2019\03141.GPJ BRAUN_V8_CURRENT.GDT 4/18/19 09:19

BRAUN INTERTEC

LOG OF BORING

Braun Project B1903141
Geotechnical Evaluation
Bever Park Lift Station and Force Main
Bever Park Road
Cedar Rapids, Iowa

BORING: **B-3**

LOCATION: Northing: 3464093.843
Easting: 5430627.137

DRILLER: C.Gracey/T.Henkes	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/19	SCALE: 1" = 4'

Elev. feet 801.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
800.5	0.5	PAV	Asphalt Pavement				
800.0	1.0	AGG	Aggregate Base				
		FILL	FILL: Lean Clay, trace Sand, brown, moist			17	
795.0	6.0	CL	SANDY LEAN CLAY, dark brown, moist (Alluvium)		▽	20	
794.0	7.0		AUGER REFUSAL AT 7 FEET. Water observed at 6.5 feet while drilling. Boring then backfilled.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\CEDAR RAPIDS\2019\03141.GPJ BRAUN_V8_CURRENT.GDT 4/18/19 09:19

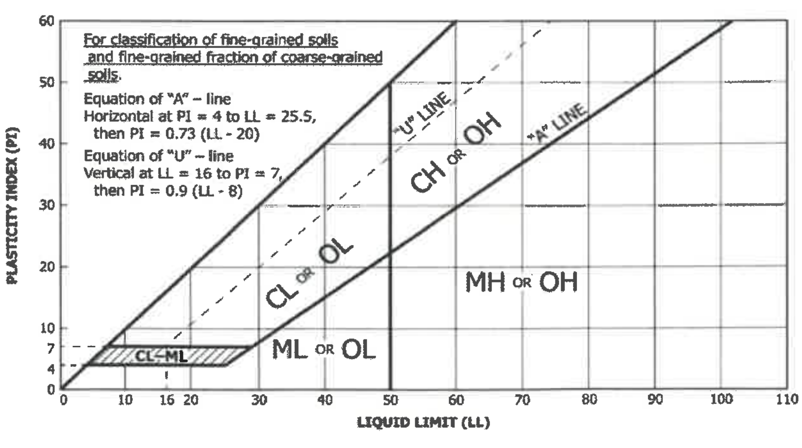
BRAUN INTERTEC
The Science You Build On.

Descriptive Terminology of Soil

Based on Standards ASTM D 2487-11/2488-09a
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification: Group Symbol	Soil Classification: 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[C])	$C_u \geq 4$ and $1 \leq C_c \leq 3$[D]	GW	Well-graded gravel[E]
			$C_u < 4$ and/or ($C_c < 1$ or $C_c > 3$)[D]	GP	Poorly graded gravel[E]
		Gravels with Fines (More than 12% fines[C])	Fines classify as ML or MH	GM	Silty gravel[E F G]
			Fines Classify as CL or CH	GC	Clayey gravel[E F G]
	Sands (50% or more coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines[H])	$C_u \geq 6$ and $1 \leq C_c \leq 3$[D]	SW	Well-graded sand[I]
			$C_u < 6$ and/or ($C_c < 1$ or $C_c > 3$)[D]	SP	Poorly graded sand[I]
		Sands with Fines (More than 12% fines[H])	Fines classify as ML or MH	SM	Silty sand[F G I]
			Fines classify as CL or CH	SC	Clayey sand[F G I]
Fine-grained Soils (50% or more passes 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] / 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] / 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 (75-mm) sieve.
B. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
C. 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
D. $C_u = D_{60} / D_{10}$ $C_c = (D_{30})^2 / (D_{10} \times D_{60})$
E. If soil contains ≥ 15% sand, add "with sand" to group name.
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. 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
I. If soil contains ≥ 15% gravel, add "with gravel" to group name.
J. If Atterberg limits plot in hatched area, soil is CL-ML, silty clay.
K. If soil contains 15 to < 30% 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



Particle Size Identification

Boulders.............. over 12"
Cobbles................ 3" to 12"
Gravel
- Coarse............. 3/4" to 3" (19.00 mm to 75.00 mm)
- Fine................. No. 4 to 3/4" (4.75 mm to 19.00 mm)

Sand
- Coarse.............. No. 10 to No. 4 (2.00 mm to 4.75 mm)
- Medium........... No. 40 to No. 10 (0.425 mm to 2.00 mm)
- Fine.................. No. 200 to No. 40 (0.075 mm to 0.425 mm)

Silt......................... No. 200 (0.075 mm) to .005 mm
Clay...................... < .005 mm

Relative Proportions[L, M]

trace............................. 0 to 5%
little.............................. 6 to 14%
with.............................. ≥ 15%

Inclusion Thicknesses

lens............................... 0 to 1/8"
seam............................. 1/8" to 1"
layer.............................. over 1"

Apparent 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	Blows Per Foot	Approximate Unconfined Compressive Strength
Very soft	0 to 1 BPF	< 1/4 tsf
Soft	2 to 4 BPF	1/4 to 1/2 tsf
Medium	5 to 8 BPF	1/2 to 1 tsf
Stiff	9 to 15 BPF	1 to 2 tsf
Very Stiff	16 to 30 BPF	2 to 4 tsf
Hard	over 30 BPF	> 4 tsf

Moisture Content:

Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp but no visible water.
Wet: Visible free water, usually soil is below water table.

Drilling Notes:

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6 inches into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6-inch increments, and added to get BPF.

Partial Penetration: If the sampler cannot be driven the full 12 inches beyond the initial 6-inch set, the number of blows for that partial penetration is shown as "No./X" (i.e., 50/2"). If the sampler cannot be advanced beyond the initial 6-inch set, the depth of penetration will be recorded in the Notes column as "No. to set X" (i.e., 50 to set 4").

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.

WL: WL indicates the water level measured by the drillers either while drilling or following drilling.

Laboratory Tests

DD	Dry Density, pcf	**OC**	Organic content, %	**PL**	Plastic limit, %
WD	Wet Density, pcf	q_p	Pocket penetrometer strength	**LL**	Liquid limit, %
P200	% Passing #200 sieve	**MC**	Moisture conent, %	**PI**	Plasticity Index, %