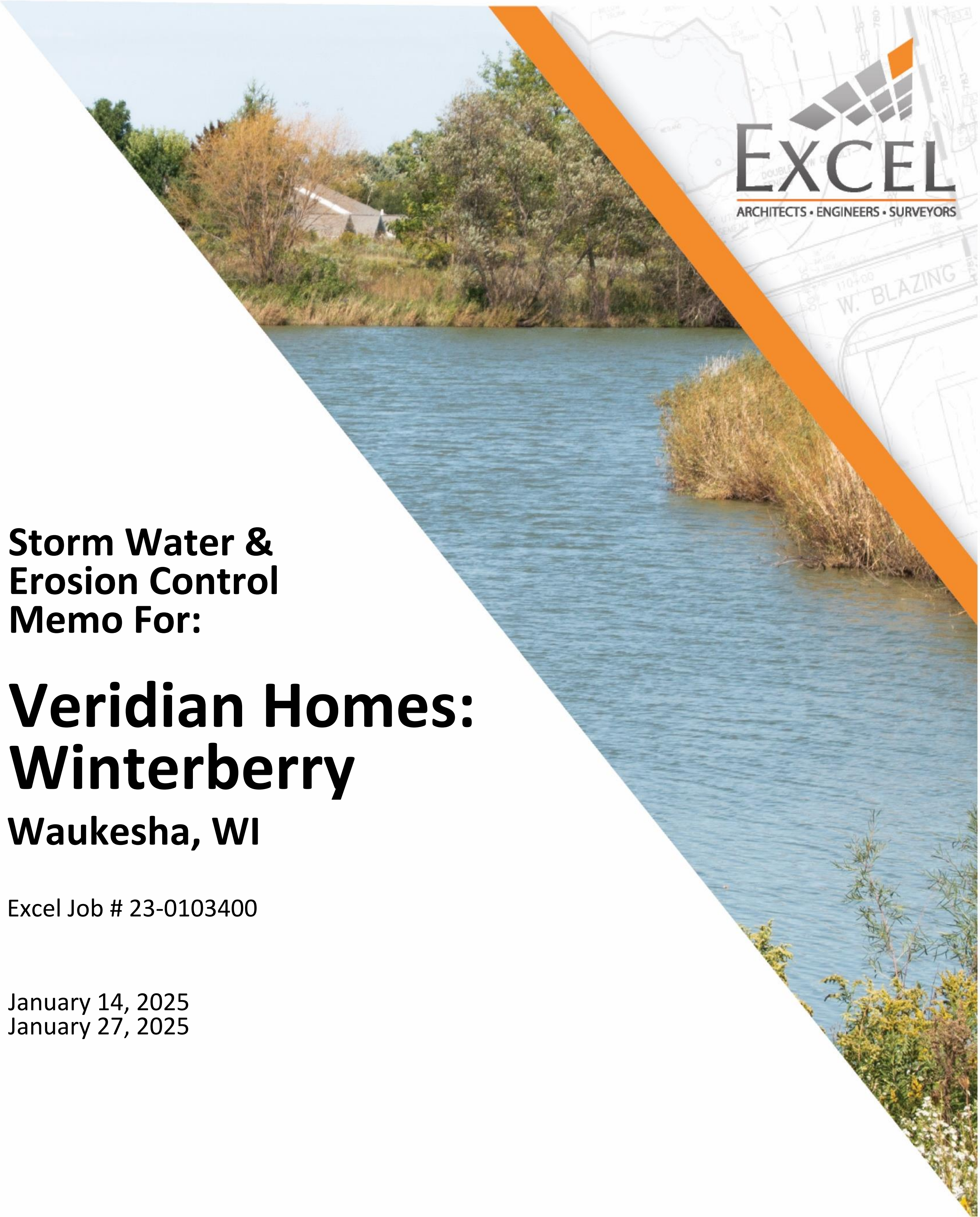

ARCHITECTS • ENGINEERS • SURVEYORS

Storm Water & Erosion Control Memo For:

Veridian Homes: Winterberry

Waukesha, WI

Excel Job # 23-0103400

January 14, 2025
January 27, 2025

Prepared by Grant Duchac PE
100 Camelot Drive • Fond du Lac, WI 54935
920-926-9800 • www.excelengineer.com

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Appendices

0.0 Introduction

0.1 Existing Conditions

The proposed development is located one half of a mile east of Meadowbrook Road on the north side of Summit Avenue, in the City of Waukesha, Wisconsin. The project site is bound by a multifamily development to the west and by single family residential developments to the east and north. The existing site is currently vacant. The northwest portion of the site currently drains to the north and the majority of the remaining portion of the site drains to the south to Summit Avenue. There are no wetlands within the areas to be developed on the site. The existing site can be seen in Appendix A.

0.2 Proposed Project Overview

The proposed project is a single family residential subdivision. The development is being completed in conjunction with the Springs at Meadowbrook, a multi-family development located adjacent to the south and west. The stormwater management plan for this project was completed as a part of the Springs at Meadowbrook multi-family development.

The purpose of this memo is to document revisions of the stormwater drainage from the approved Springs at Meadowbrook stormwater management plan. The approved stormwater management plan showed all stormwater drainage from the single family area flowing to the proposed provided stormwater ponds. Most of the stormwater from the proposed single family development will drain to the provided stormwater management ponds, however two areas will drain off-site instead of flowing to the ponds. To protect existing mature trees, an area along the north property boundary will drain to the north off-site, as it does in the existing condition. The area that drains to this area will be reduced from 8.90 acres to 1.52 acres, thereby substantially decreasing the flow to the adjoining area to the north (as shown in the calculations). Another area located along the east side of the project will drain to the south to the existing ditch in Summit Avenue. This area will incorporate drainage from on-site backyards and a large off-site drainage area from the east into a drainage ditch that flows south to Summit Avenue. The proposed stormwater ponds were not designed to incorporate any off-site drainage; therefore, with the large drainage area from the east, this off-site area cannot drain to the proposed stormwater pond.

The calculations show that with the off-site drainage areas the development will result in a reduction of peak flows and treat stormwater to meet local and state requirements. The proposed site can be seen in Appendix C.

1.0 Design Criteria

1.1 Soils

Soil characteristics were determined using the web soil survey. See Table 1 for a summary of the soils and hydrologic ratings indicated by the web soil survey and Appendix F for web soil survey map.

Table 1: Web Soil Survey

MAP SYMBOL	SOIL TYPE	HYDROLOGIC RATING
HmB2	Hochheim loam	D
ThB	Theresa silt loam	C
KwB	Knowles Silt Loam	C
KIA	Kendall Silt Loam	C
PrA	Pistakee Silt Loam	C

Fifteen test borings (15) soil borings were completed for the project site and nineteen (19) test borings from the former geotechnical report were used to evaluate the site. The complete geotechnical investigation with boring logs can be seen in Appendix GD.

1.2 Rainfall Data

NOAA Atlas 14, City of Waukesha rainfall depths with a MSE 3 distribution was used for stormwater calculations.

Table 2: NOAA Atlas 14 24-hour Rainfall Depth

DESIGN STORM	RAINFALL DEPTH (INCHES)
1-YEAR	2.40
2-YEAR	2.7
10-YEAR	3.81
100-YEAR	6.18

2.0 Stormwater Management Requirements

2.1 Peak Discharge

City of Waukesha- Maintain or reduce the 1-yr, 2-yr, 10-yr and 100-yr, 24 hour post development peak runoff discharge rates to the 1-yr, 2-yr, 10-yr and 100-yr, 24 hour pre-development peak runoff discharge rates respectively.

Wisconsin DNR- Maintain or reduce the 1-yr and 2-yr, 24 hour post development peak runoff discharge rates to the 1-yr and 2-yr, 24 hour predevelopment peak runoff discharge rates respectively.

The Pre and Post Development quantity numbers from the original Springs at Meadowbrook stormwater management plan are listed below:

Table 3: *Springs at Meadowbrook stormwater calculations*

Table 1

North Area Pre-Development vs Post-Development Rate Summary Table						
	Pre-Development	Post-Development Unrestricted	Post-Development Restricted (Allowable)	Post-Development Restricted (Actual)	Post-Development Total	HWL
1 YR, 24 HR (cfs)	26.78	16.77	10.01	5.84	22.61	925.51
2 YR, 24 HR (cfs)	35.08	21.39	13.69	7.31	28.70	925.67
10 YR, 24 HR (cfs)	69.49	40.04	29.45	12.03	52.07	926.31
100 YR, 24 HR (cfs)	151.56	83.34	68.22	19.01	102.35	927.67

Table 2

Southeast Area Pre-Development vs Post-Development Rate Summary Table						
	Pre-Development	Post-Development Unrestricted	Post-Development Restricted (Allowable)	Post-Development Restricted (Actual)	Post-Development Total	HWL
1 YR, 24 HR (cfs)	23.88	1.00	22.88	11.83	12.83	904.51
2 YR, 24 HR (cfs)	30.44	1.31	29.13	14.44	15.75	904.76
10 YR, 24 HR (cfs)	57.05	2.56	54.49	29.57	32.13	905.54
100 YR, 24 HR (cfs)	119.02	5.54	113.48	58.44	63.98	906.99

The Revised Pre and Post Development quantity numbers based on the updated plans are listed below:

Table 4: UPDATED Springs at Meadowbrook based on proposed single family development:

Table 1 UPDATED

North Area Pre-Development vs Post-Development Rate Summary Table:

	Pre-Development (25S)	Post-Development Unrestricted (32L off-site)	Post-Dev. Restricted (13P To pond)	Post-Development Restricted (13P Pond Actual Release)	Post-Development Total (14L Release)	HWL
1 YR, 24 HR (CFS)	25.42	17.58	18.90	2.15	17.41	925.41
2 YR, 24 HR (CFS)	33.32	22.41	22.52	2.80	22.62	925.57
10 YR, 24 HR (CFS)	65.88	41.89	36.19	5.36	42.59	926.17
100 YR, 24 HR (CFS)	143.91	87.16	65.57	9.17	89.87	927.46

Table 2 UPDATED

South Area Pre-Development vs Post-Development Rate Summary Table:

	Pre-Development (34L)	Post-Development Unrestricted (33L off-site)	Post-Dev. Restricted (19P To pond)	Post-Development Restricted (19P Pond Actual Release)	Post-Development Total (20L Release)	HWL
1 YR, 24 HR (CFS)	26.22	10.85	49.61	11.11	12.21	904.21
2 YR, 24 HR (CFS)	33.97	13.69	58.17	23.94	25.87	904.28
10 YR, 24 HR (CFS)	65.78	25.06	89.95	56.46	60.87	904.46
100 YR, 24 HR (CFS)	14.53	51.34	157.27	71.00	102.11	905.40

Table 5: Site Totals UPDATED Springs at Meadowbrook

TOTAL SITE Pre-Development vs Post-Development Rate Summary Table for UPDATED Areas:

	Pre-Development	Total Post-Development Release	Difference Pre to Post
1 YR, 24 HR (CFS)	51.64	29.62	-22.02
2 YR, 24 HR (CFS)	67.29	48.49	-18.08
10 YR, 24 HR (CFS)	131.66	103.56	-28.10
100 YR, 24 HR (CFS)	285.44	191.98	-93.46

Table 5 shows that the UPDATED post development release rates will be less than predevelopment release rates for all design storms.

The flow to the residential area at the north side of the development will be reduced.

Table 6: Off-Site Drainage to North Residential Subdivision

Off-site Drainage to North Residential Subdivision Summary Table:

	Pre-Development (cfs)	Post-Development (cfs)	Difference Pre to Post (cfs)
1 YR, 24 HR (CFS)	8.56	1.94	-6.62
2 YR, 24 HR (CFS)	11.18	2.47	-8.71
10 YR, 24 HR (CFS)	21.95	4.62	-17.33
100 YR, 24 HR (CFS)	47.65	9.61	-38.04

Table 6 shows that the post development release rates to the residential subdivision to the north of the project will be significantly less than pre-development release rates for all design storms.

Therefore, peak discharge requirements are met.

2.2 Stormwater Quality

<u>City Waukesha</u>- The site is considered a new development project and will be required to remove 80% of total suspended solids (TSS) from site runoff.

<u>Wisconsin DNR</u>- The site is considered a new development project and will be required to remove 80% of total suspended solids (TSS) from site runoff.

The site will treat stormwater using two wet ponds and filter strips. The ponds and filter strips will remove 80.03% TSS, more than the required 80% TSS.

\\job-files\2023 Job Files\230103400 Veridian - Waukesha Development 2023\230103404 Civil\storm water report and calculations\slamm\230103400-slamm.mdb

Outfall Output Summary

	Runoff Volume (cu. ft.)	Percent Runoff Reduction	Runoff Coefficient (Rv)	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Total of All Land Uses without Controls	1.944E+06		0.33	97.43	11827	
Outfall Total with Controls	1.926E+06	0.93 %	0.33	19.64	2362	80.03 %
Current File Output: Annualized Total After Outfall Controls	1.953E+06	Years in Model Run:	0.99		2395	

Print Output Summary to .csv File

Print Output Summary to Text File

Print Output Summary to Printer

Total Area Modeled (ac): 49.210

Total Control Practice Costs

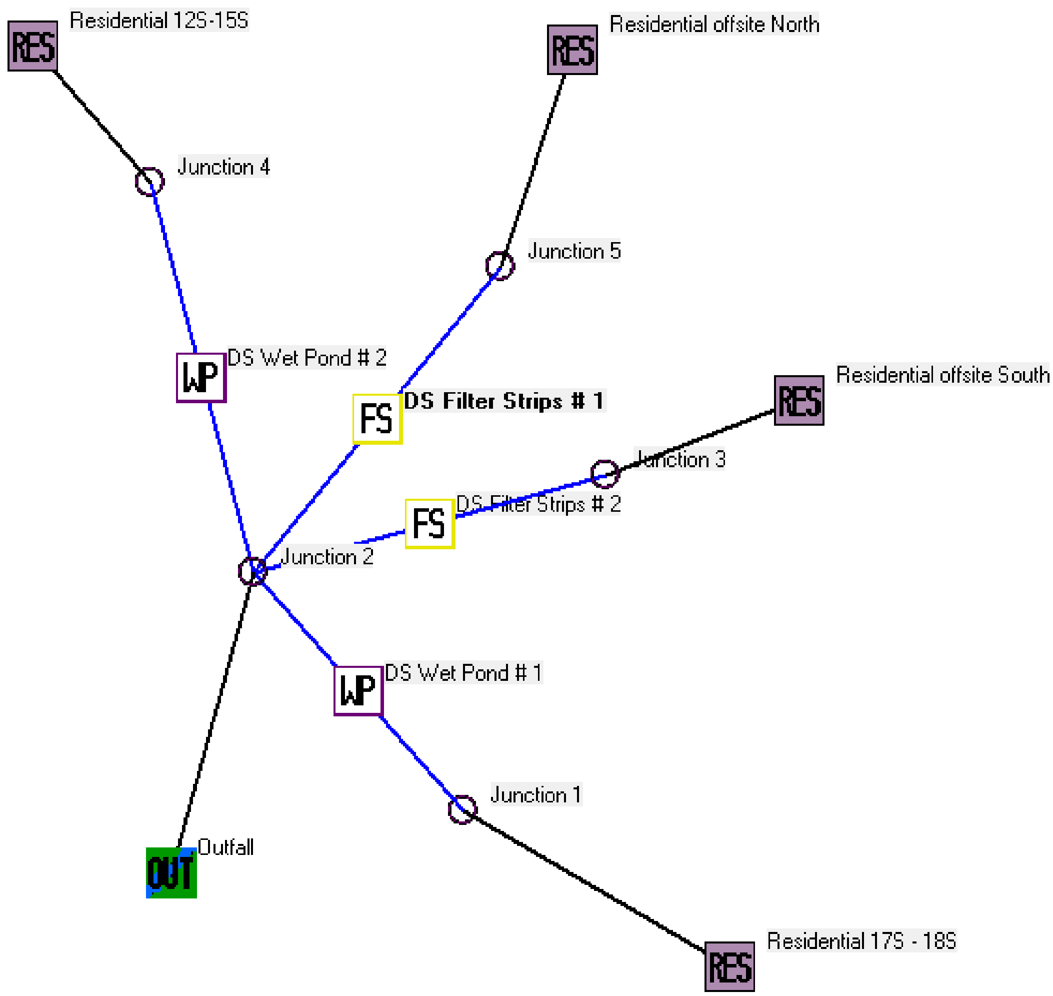
Capital Cost	N/A
Land Cost	N/A
Annual Maintenance Cost	N/A
Present Value of All Costs	N/A
Annualized Value of All Costs	N/A

Perform Outfall Flow Duration Curve Calculations

Receiving Water Impacts Due To Stormwater Runoff

(CWP Impervious Cover Model)

	Calculated Rv	Approximate Urban Stream Classification
Without Controls	0.33	Poor
With Controls	0.33	Poor



Therefore, stormwater quality requirements are met.

2.3 Infiltration

<u>Wisconsin DNR and City of Waukesha</u> - The proposed site is exempt from infiltration requirements per NR 151.124(4)(b)1, 151.124(4)(c)2 and Chapter 32.10 of the City of Waukesha stormwater management and erosion control code.

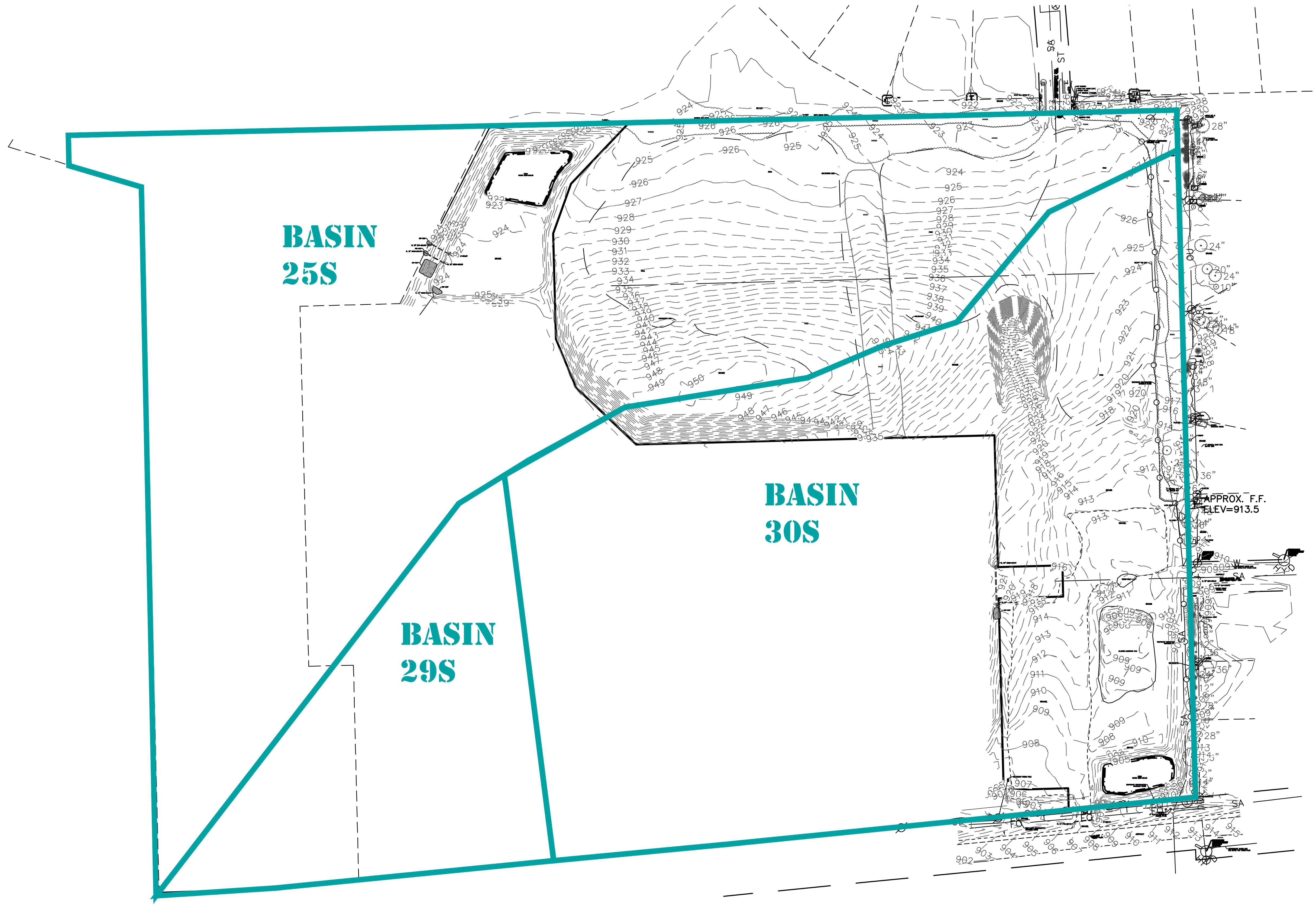
2.4 Emergency Overflow Route

Emergency overflow routes are provided at each stormwater management facility.

3.0 Erosion Control

The erosion control specifications, construction sequence, site stabilization notes, seeding notes, dewatering notes, and post construction and maintenance plan will be included on the construction plan set.

Appendix A: Springs at Meadowbrook Pre - Development Basin Areas



SPRINGS AT MEADOWBROOKS PRE-DEVELOPMENTS BASIN AREA(S)

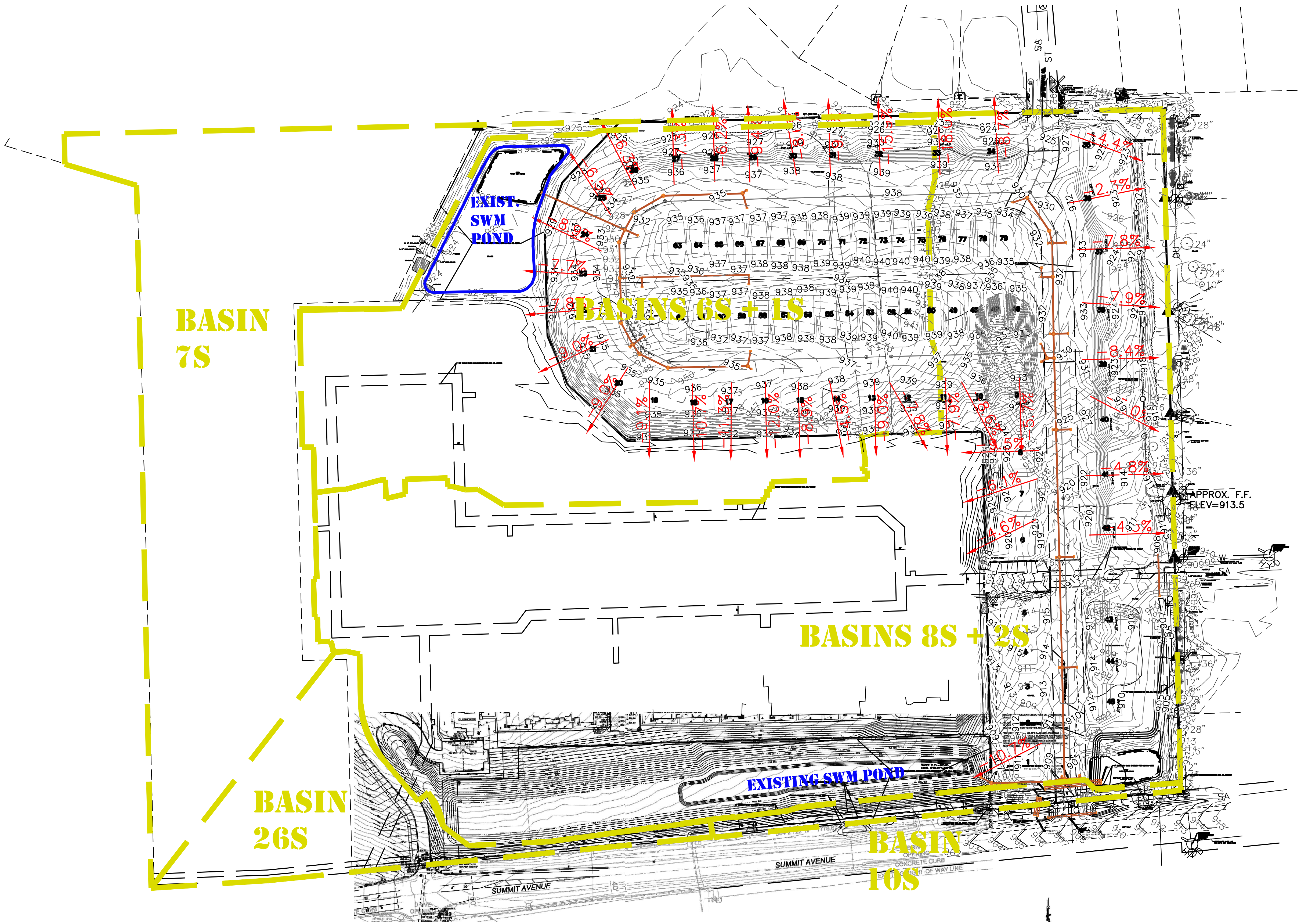
NORTH

1"= 200'

200' 0 200' 400'

SCALE 1"=200' (11X17) FEET

Appendix B: Springs at Meadowbrook Post - Development Basin Areas



SPRINGS AT MEADOWBROOKS POST-DEVELOPMENTS BASIN AREA(S)

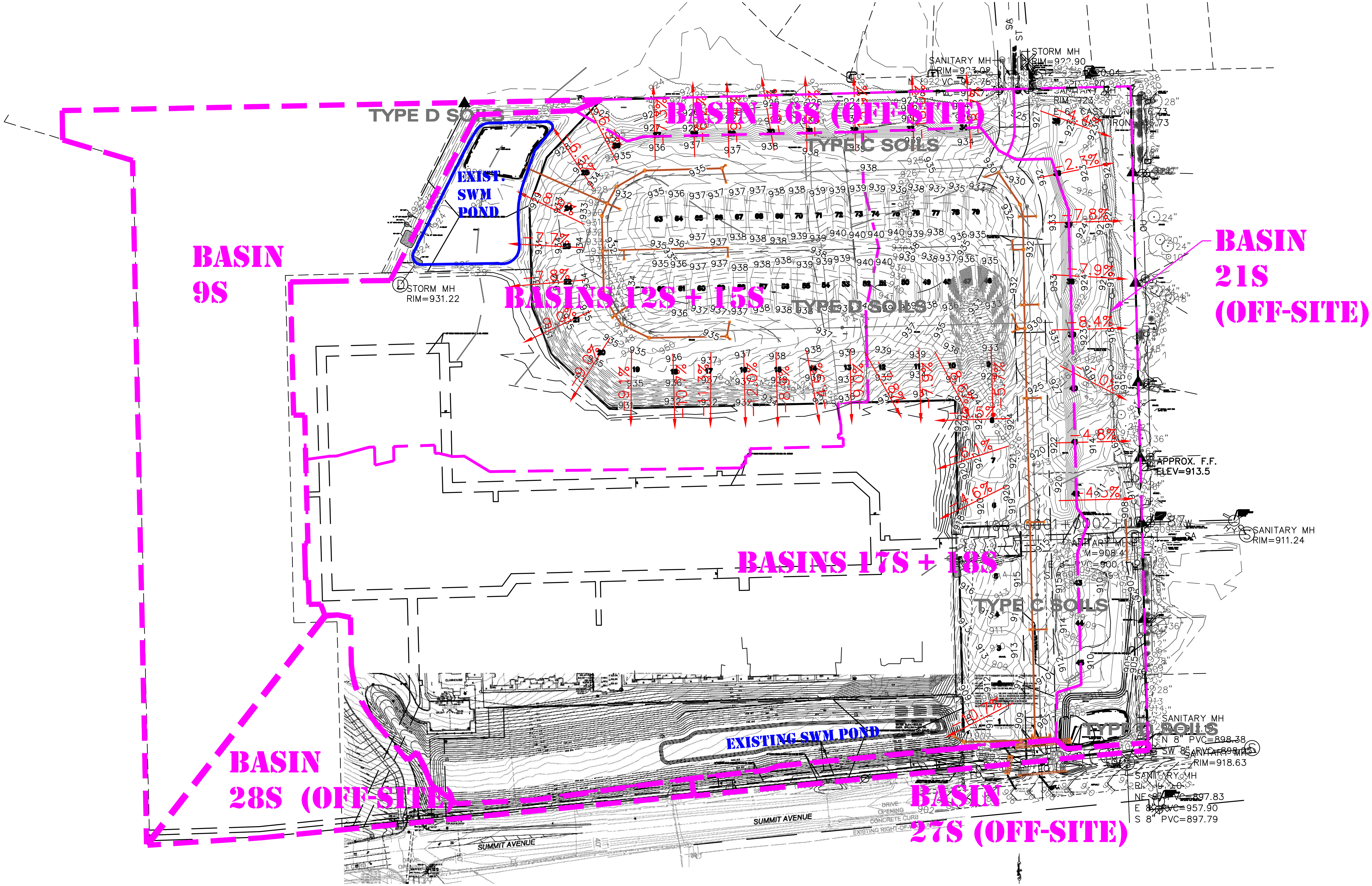
NORTH

1"= 200'

200' 0 200' 400'

SCALE 1"=200' (11X17) FEET

Appendix C: UPDATED Post-Development Basin Areas



UPDATED POST-DEVELOPMENT BASIN AREAS

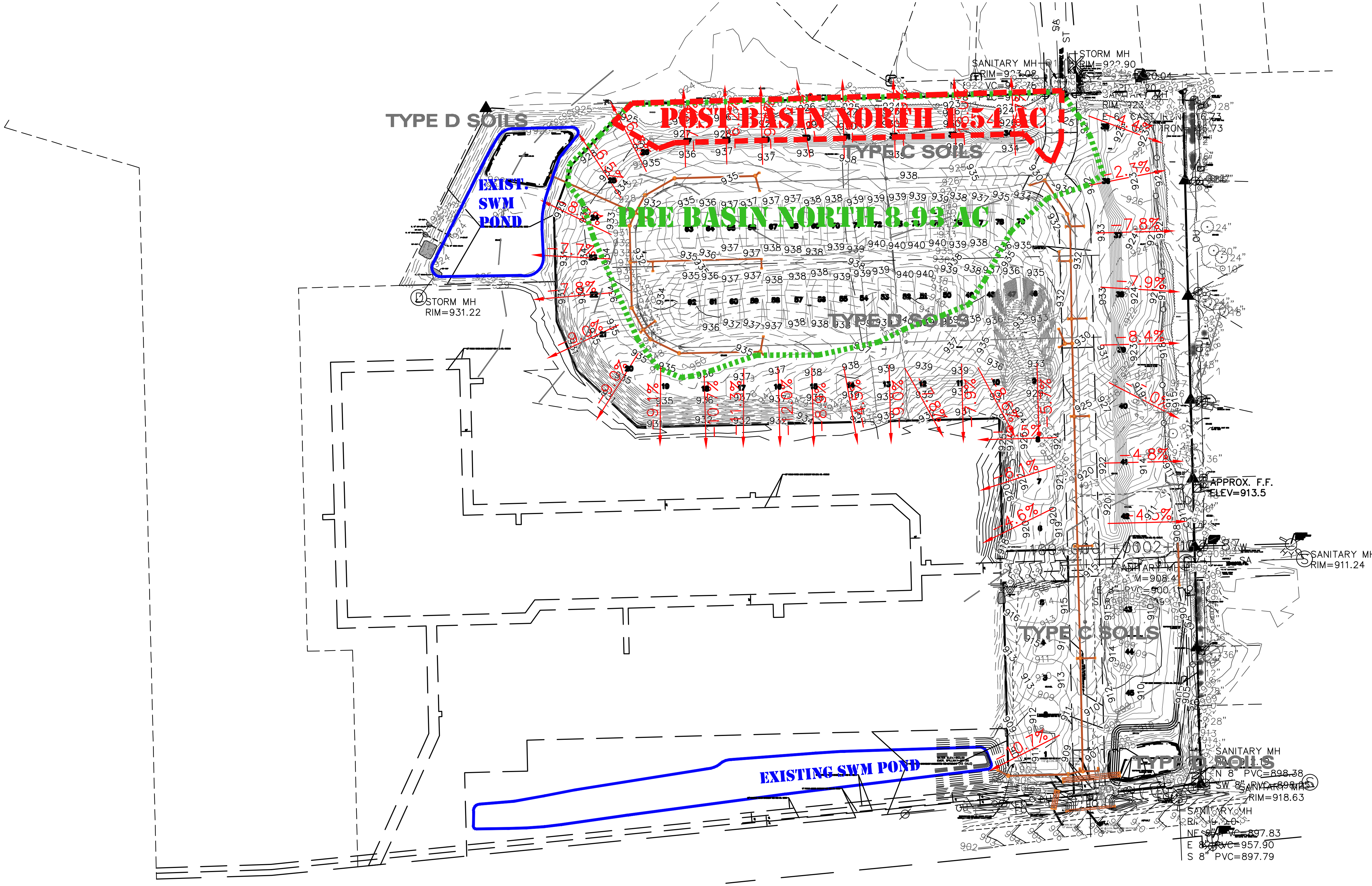
NORTH

1"= 200'

200' 0 200 400'

SCALE 1"=200' (11X17) FEET

Appendix D: OFF-SITE Pre & Post -Development NORTH Basin Areas



OFF-SITE PRE & POST NORTH BASIN AREAS

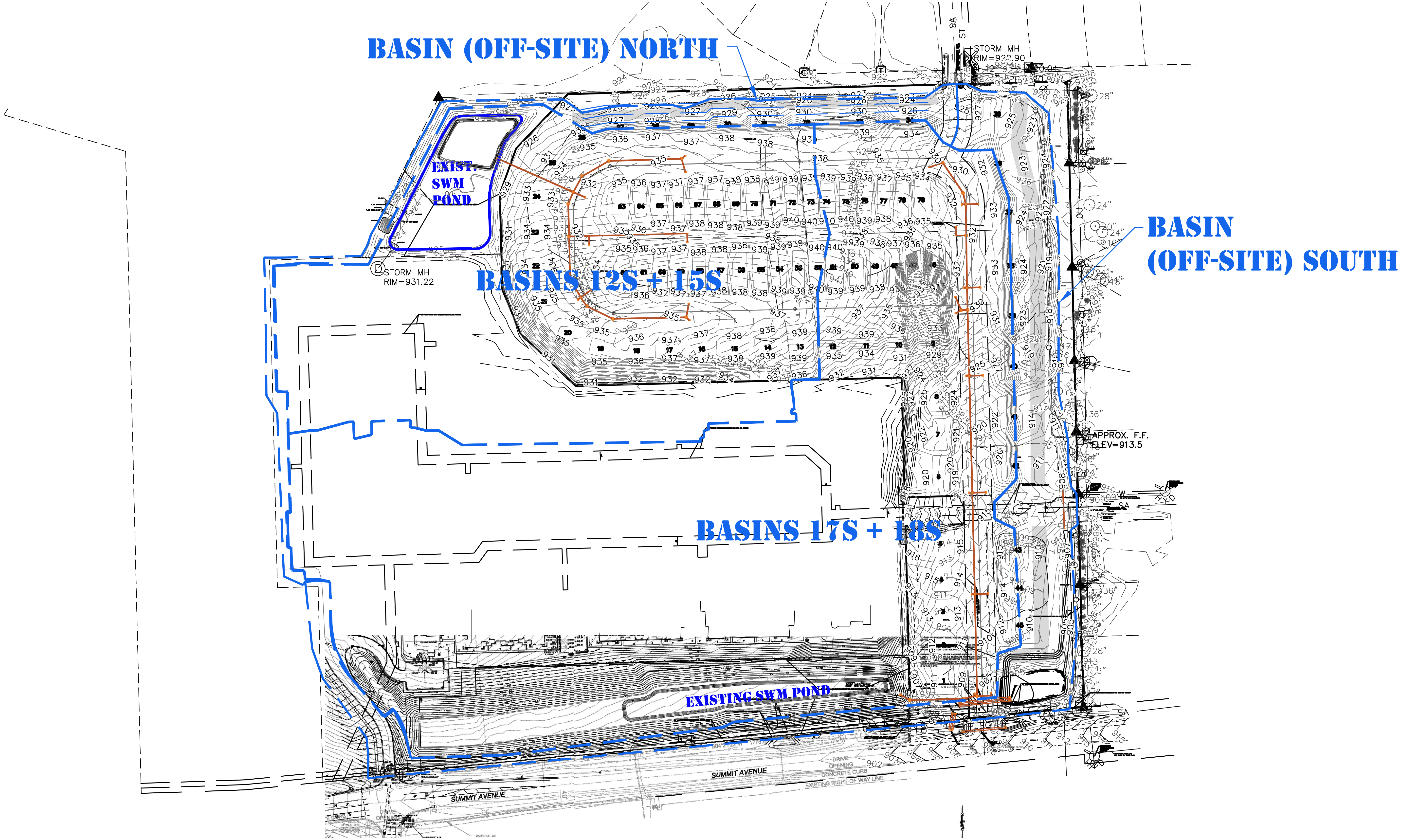
NORTH

1"= 200'

200' 0 200 400'

SCALE 1"=200' (11X17) FEET

Appendix E: SLAMM Basin Areas



NORTH

SLAMM BASIN AREA(S)

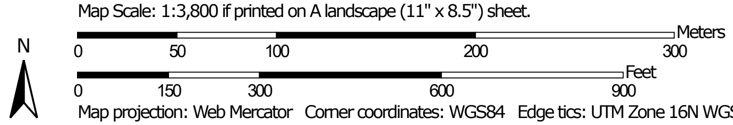
1"= 200'

200' 0 200 400'

SCALE 1"=200' (11X17) FEET

Appendix F: Web Soil Survey Map

Map Scale: 1:3,800 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Waukesha County, Wisconsin
Survey Area Data: Version 1, Sep 3, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Aug 4, 2022—Sep 13, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
HmB2	Hochheim loam, 2 to 6 percent slopes, eroded	D	12.4	40.4%
HmC2	Hochheim loam, 6 to 12 percent slopes, eroded	D	0.2	0.8%
KlA	Kendall silt loam, 1 to 3 percent slopes	C	1.6	5.1%
KwB	Knowles silt loam, 2 to 6 percent slopes	C	5.7	18.7%
PrA	Pistakee silt loam, 1 to 3 percent slopes	C	1.3	4.3%
RkE	Ritchey silt loam, 12 to 30 percent slopes	D	1.4	4.7%
ThB	Theresa silt loam, 2 to 6 percent slopes	C	8.0	26.0%
Totals for Area of Interest			**30.6**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix G: Geotechnical Report & Stormwater Soil Evaluation

Geotechnical Engineering Exploration and Analysis

Proposed Residential Development
Summit Avenue
Waukesha, Wisconsin

Prepared for:

Veridian Acquisitions, LLC
Menomonee Falls, Wisconsin

January 10, 2025
Project No. 1G-2410010

GILES
ENGINEERING ASSOCIATES, INC.

GILES
ENGINEERING ASSOCIATES, INC.
GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

• Dallas, TX
• Los Angeles, CA
• Manassas, VA
• Milwaukee, WI

January 10, 2025

Veridian Acquisitions, LLC
W199 N5539 Boxwood Boulevard
Menomonee Falls, WI 53051

Attention: Mr. Ben Lang
Acquisition and Entitlement Specialist

Subject: Geotechnical Engineering Exploration and Analysis
Proposed Residential Development
Summit Avenue
Waukesha, Wisconsin
Project No. 1G-2410010

Dear Mr. Lang:

As requested, Giles Engineering Associates, Inc. conducted a *Geotechnical Engineering Exploration and Analysis* for the proposed project. The accompanying report describes the services that were performed, and it provides geotechnical-related findings, conclusions, and recommendations that were derived from those services.

We sincerely appreciate the opportunity to provide geotechnical consulting services for the proposed project. Please contact the undersigned if there are questions about the report or if we may be of further service.

Very truly yours,

GILES ENGINEERING ASSOCIATES, INC.

Grace C. Hill
Staff Professional

Colleen M. Finley, P.E.
Geotechnical Department Manager

WISCONSIN
COLLEEN M. FINLEY
100150-6
OCONOMOWOC, WISCONSIN
PROFESSIONAL ENGINEER
1/10/25

Distribution: Veridian Acquisitions, LLC
Attn: Mr. Ben Lang (pdf via email: blang@veridianhomes.com)

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PROPOSED RESIDENTIAL DEVELOPMENT
SUMMIT AVENUE
WAUKESHA, WISCONSIN
PROJECT NO. 1G-2410010

Section No. Description Page No.

GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED RESIDENTIAL DEVELOPMENT
SUMMIT AVENUE
WAUKESHA, WISCONSIN
PROJECT NO. 1G-2410010

EXECUTIVE SUMMARY

This Executive Summary provides limited geotechnical information regarding the proposed project. Because this Executive Summary is exceedingly abbreviated, it must be read in complete context with the following report ("Report").

Surface and Subsurface Conditions

- Fifteen test borings were conducted at the site to explore subsurface conditions. Additionally, 19 test borings from the Former geotechnical report were used to evaluate subsurface conditions.
- Topsoil was at the surface of the test borings and was between ±2 and ±13 inches thick, except at Test Borings 2, 13, 14, and 15, which had fill at the surface.
- Fill material was at the surface of Test Borings 2, 13, 14, and 15 and below the topsoil at Test Borings 1, 3, 4, 5, 6, 9, 11, and 12 and extended to depths between 2 and 13 feet below ground. Additionally, it is understood that fill material has been placed since the time of Test Borings B74 through B77. The fill material was variable and consisted of sand (variable gradations), sandy gravel, silty sand, clayey sand, lean clay, silty clay, and crushed limestone. Cobbles and boulders were also encountered throughout the fill. Some of the fill material at the test borings and the material that has been placed in the south portion of the site since the time of the former test borings, is material generated from blasting operations at the neighboring construction site.
- Native soil was below the surface and fill materials, except at Test Borings 1, 3, 4, 5, and 13, where fill material extended to the weathered or unweathered bedrock. Native soil was variable and typically consisted of sandy clay, clayey sand, silty clay, gravelly sand, fine sand, sandy silt, and silty fine sand. Cobbles and boulders were encountered within the native soil and could be nested in areas.
- Weathered limestone bedrock was encountered at most borings below the topsoil, fill, or native soil. The weathered bedrock material typically consisted of sandy gravel with intact rock fragments. Most of the test borings were terminated due to auger refusal between depths of ±2 and ±18½ feet, which is generally interpreted to be due to competent bedrock and/or moderately weathered bedrock. The depths and elevations to weathered bedrock, along with the test boring and auger refusal depths at each test boring are provided in Table A, enclosed in Appendix A.
- It is estimated that the water table was below the maximum exploration depths at the test boring locations, when the test borings were conducted. Based moisture conditions of the retained soil samples, and the relatively shallow limestone bedrock, the site appears to be subject to perched groundwater, where groundwater collects/flows above the bedrock surface. This perched-groundwater condition could be significant at times, and likely fluctuates seasonally and with weather events. Groundwater could perch within several feet of the ground surface.

Foundations

- Spread-footing foundations are recommended for the proposed residences. Existing fill is unsuitable for direct or indirect support of foundations. Foundations are recommended to be directly supported by suitable-bearing native soil, weathered bedrock, or bedrock. Foundations could also be supported by new engineered fill or lean-concrete backfill placed on suitable native materials. If a foundation is supported by significantly dissimilar materials (such as soil and bedrock), a minimum 12-inch-thick layer of compacted aggregate is recommended to be installed beneath the foundation (in the area of the dissimilar materials) to help control differential settlement. The compacted aggregate would serve as a cushion layer to lessen the abrupt changes in foundation support. The foundations are recommended to be designed using a 3,000 pound per square foot (psf) maximum, net, allowable soil bearing capacity.
- Considering the existing fill and possible perched groundwater conditions, some over-excavation should be expected for footing construction. In some locations, over-excavation might be extensive in depth and area, depending on the conditions that are encountered. It is recommended that a geotechnical engineer provide recommendations pertaining to soil over-excavation and replacement at the time of construction.

At-Grade Garage Floor Slabs

- With proper subgrade preparation, it is expected that site soil will be suitable for support of at-grade floor slabs. Engineered fill that is selected, placed, and compacted according to the Report could also support concrete floor slabs.
- Assuming a maximum 100 psf floor load, and with regard to geotechnical considerations, at-grade floor slabs in garage areas are recommended to be at least 5 inches thick. A minimum 4-inch-thick base course is recommended to be below the floor slabs to serve as a capillary break and for support considerations.

Basement Recommendations

- Each basement is recommended to be equipped with a permanent drainage system, including footing drains and a layer of free-draining aggregate along basement walls.
- The basement floor slab is recommended to be at least 4 inches thick. For moisture control only, a minimum 10-mil vapor retarder is recommended to be directly below the basement floor slab throughout the entire floor area. A minimum 6-inch-thick base course is recommended to be directly below the vapor retarder to serve as a capillary break and for sub-slab drainage. Base-course material is recommended to consist of free-draining aggregate.

Pavement

- The use of hot-mix asphalt (HMA) pavement is acceptable from a geotechnical perspective for the proposed roadways.

Construction Considerations

- Because of the shallow bedrock, specialized excavation methods (possibly including blasting) are expected to be necessary, possibly even for shallow excavations.

GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED RESIDENTIAL DEVELOPMENT
SUMMIT AVENUE
WAUKESHA, WISCONSIN
PROJECT NO. 1G-2410010

1.0 SCOPE OF SERVICES

This report provides the results of the *Geotechnical Engineering Exploration and Analysis* that Giles Engineering Associates, Inc. ("Giles") conducted for the proposed development. The *Geotechnical Engineering Exploration and Analysis* included a geotechnical subsurface exploration program, geotechnical laboratory services, and geotechnical engineering. The scope of each service area was narrow and limited as directed by our client and based on our understanding and assumptions about the proposed project. Services are briefly described later. Environmental consulting services were beyond Giles' authorized scope for this project.

Geotechnical-related recommendations are provided in this report for design and construction of the foundations, basements, and at-grade floor slabs for the proposed residences. Recommendations are also provided for proposed roadway areas. Site preparation recommendations are also given but are only preliminary because the means and methods of site preparation will depend on factors that were unknown when this report was prepared. These factors include, but are not limited to, the weather before and during construction, the subsurface conditions that are exposed during construction, and the final details of the proposed project.

Giles previously prepared a *Geotechnical Engineering Exploration and Analysis* report ("Former Geotechnical Report") pertaining to the subject site. The Former Geotechnical Report is referenced by Giles Project No. 1G-2204016 and is dated June 24, 2022. Giles acquired permission from the client of the Former Geotechnical Report to use the test borings for this project. However, appreciable time has passed since the previous test borings were performed and it is possible that the subsurface conditions at the locations of the previous test borings might have changed.

2.0 SITE DESCRIPTION

The subject site is along the north side of Summit Avenue, about ½ mile east of Meadowbrook Road, in Waukesha, Wisconsin. The site area is shown on the *Test Boring Location Plan*, enclosed as Figure 1 in Appendix A. When the test borings (described later) were performed, the southern portion of the site undergoing grading operations in conjunction with the west neighboring construction, and the northern portion of the site was vacant. It is understood that the site was previously used for agricultural practices. Topographic contour lines shown on the *Overall Grading* plan– provided by the client, show that ground grades at the site are between El. 909 and El. 950. The date that the site was surveyed is unknown, therefore grading operations may have been performed since the site was surveyed.

3.0 WEB SOIL SURVEY REVIEW

The *Web Soil Survey*, operated by the USDA Natural Resources Conservation Service, identifies three predominant soil types at the site: Hochheim loam, Theresa silt loam, and Knowles silt loam. Additionally, Ritchey silt loam, Kendall silt loam, and Pistakee silt loam were also noted in the site area. The *Web Soil Survey* states that the depth to bedrock for the Knowles silt loam and Ritchey silt loam is 33 to 40 inches and 10 to 20 inches, respectively. Depth to bedrock was not indicated for the remaining soil types.

4.0 PROJECT DESCRIPTION

Proposed Residential Buildings

New one- to two-story residential buildings are planned to be constructed at the site. Proposed building locations are shown on the *Test Boring Location Plan*. It is assumed that each residential building will be a wood-frame structure that will have a basement. Details about the basements were not provided, therefore this report assumes that each basement floor will be about 9 to 10 feet below the first-floor elevation. Furthermore, it is assumed that bearing walls will support each building, possibly along with some columns. Maximum foundation loads were not provided but are assumed to be 4,000 pounds per lineal foot (plf) from bearing walls and 20,000 pounds per column. The at-grade floor of each residential building is planned to be a ground-bearing concrete slab with an assumed maximum live load of 100 pounds per square foot (psf).

Proposed Pavement Areas

The proposed development will include roadways as shown on the *Test Boring Location Plan*. It is assumed that these areas will be paved with asphalt-concrete, but Portland cement concrete pavement will be in areas of higher traffic stress. Because Giles was not provided with traffic information, the pavement recommendations provided later are based on arbitrarily assumed traffic conditions. Also, because proposed pavement grades were not provided, this report assumes that pavement will be at or above the current site grades.

Proposed Elevations

Based on the topographic contours shown on the *Overall Grading* plan, proposed ground grades at the site are planned to be between El. 909 and El. 938. Additionally, it is estimated that up to approximately 15 feet of cut and fill will be needed throughout the site to establish the proposed grounds grades throughout the residential and pavement areas, exclusive of any excavations. This report is based on the *Overall Grading* plan; if there are any changes to the plan, this report may need to be revised.

5.0 GEOTECHNICAL SUBSURFACE EXPLORATION PROGRAM

To explore subsurface conditions, fifteen geotechnical test borings (Test Borings 1 through 15) were conducted at the site on October 22, 23, and 31, 2024, using a mechanical drill-rig. Additionally, Test Borings B2-B6, B40-B43, B67-B71, B74-B78, and B86 were conducted in April and May of 2022 to prepare the Former Geotechnical Report, and were used for preparing this report. The test borings were terminated at depths between ±2 and ±21 feet below-ground. Most of the test borings were terminated shallower than the planned test boring depths due to auger refusal likely caused by weathered bedrock or bedrock. The auger refusal depths are further described later and are shown in Table A, enclosed in Appendix A. Test boring locations were positioned on-site relative to apparent property lines and existing site features and by GPS locations. Approximate locations of the test borings are shown on the *Test Boring Location Plan*.

Samples were collected from each test boring, at certain depths, using the Standard Penetration Test (SPT), conducted with the drill rig. A brief description of the SPT is given in Appendix B, along with descriptions of other field procedures. Immediately after sampling, select portions of SPT samples were placed in glass jars that were labeled at the site for identification. A Standard Penetration Resistance value (N-value) was determined from each SPT. N-values are reported on the *Test Boring Logs*, which are records of the test borings. N-values are used to estimate the in-place density of granular soil, such as the granular soil that was encountered at the test borings, as described below. However, it is important to note that at least some of the measured N-values are likely not representative of in-place density because gravel, cobbles, boulders, and weathered bedrock were encountered during testing.

The boreholes were backfilled upon completion; however, backfill materials will likely settle or heave, creating a hazard that can injure people and animals. Borehole areas should, therefore, be carefully and routinely monitored by the property owner or by others; settlement and heave of backfill materials should be repaired immediately. Giles will not monitor or repair boreholes.

Ground elevations at Test Borings 1 through 15 were determined by using a Trimble® R2 receiver. Test borings included from the Former Geotechnical Report were determined by topographic contour lines shown on the *Grading Plan* – Areas 1 through 9, prepared by V3 Companies. The test boring elevations are noted on the *Test Boring Logs*. Based on existing topographic contour lines shown on the *Overall Grading* plan– provided by the client, ground grades at the test borings appear unchanged except for the area of Test Borings B74, B75, and B76 where up about seven feet of fill has been placed, Test Boring B77 which has had minor filling (up to two feet), and Test Boring B78 which has had four feet of cut since the time the test borings were conducted.

6.0 GEOTECHNICAL LABORATORY SERVICES

The retained samples from the test borings were classified using the descriptive terms and particle-size criteria shown on the *General Notes* in Appendix D and by using the Unified Soil Classification System (ASTM D 2488) as a general guide. The classifications are shown on the *Test Boring Logs* along with horizontal lines that show estimated depths of material change. Field-related information pertaining to the test borings is also on the *Test Boring Logs*. For simplicity and abbreviation, terms and symbols are used on the *Test Boring Logs;* the terms and symbols are defined on the *General Notes*.

Unconfined compression (without measured strain), calibrated penetrometer resistance, and moisture content tests were performed on select soil samples to evaluate their general engineering properties. Results of the laboratory tests are on the *Test Boring Logs*, enclosed in Appendix A. However, because testing was conducted on SPT samples, which are categorized as disturbed samples, results of the unconfined compression and penetrometer resistance tests are approximate. Laboratory procedures are briefly described in Appendix C.

7.0 MATERIAL CONDITIONS

Because material sampling at the test borings was discontinuous, it was necessary to estimate conditions between sample intervals. Estimated conditions at the test borings are briefly discussed in this section and are described in more detail on the *Test Boring Logs*. The conclusions and recommendations in this report are based on the estimated conditions shown on the *Test Boring Logs*.

7.1. Surface Materials

Topsoil was at the surface of the test borings and was between ±2 and ±13 inches thick, depending on the test boring location (topsoil thickness is shown on the *Test Boring Logs*), except at Test Borings 2, 13, 14, and 15, which had fill at the surface. The topsoil predominantly consisted of lean clay and silty clay with up to estimated little amounts of sand and organic matter.

7.2. Fill Materials

Fill material was at the surface of Test Borings 2, 13, 14, and 15 and below the topsoil at Test Borings 1, 3, 4, 5, 6, 9, 11, and 12 and extended to depths between 2 and 13 feet below ground. Additionally, it is understood that fill material has been placed since the time of Test Borings B74 through B77. The fill material was variable and consisted of sand (variable gradations), sandy gravel, silty sand, clayey sand, lean clay, silty clay, and crushed limestone. Cobbles and boulders were also encountered throughout the fill. Some of the fill material at the test borings and the material that has been placed in the south portion of the site since the time of the former test borings, is material generated from blasting operations at the neighboring construction site. Based on field and laboratory testing, the fill material exhibited variable strength characteristics. At least some of the measured N-values are likely not representative of in-place density because gravel, cobbles, or boulders were encountered during testing.

7.3. Native Soil

Native soil was below the surface and fill materials, except at Test Borings 1, 3, 4, 5, and 13, where fill material extended to the weathered or unweathered bedrock. Native soil was variable and typically consisted of sandy clay, clayey sand, silty clay, gravelly sand, fine sand, sandy silt, and silty fine sand. Cobbles and boulders were encountered within the native soil and could be nested in areas. Based on laboratory testing, cohesive native soil exhibited stiff to hard comparative consistencies. SPT N-values within granular native soil are variable and correlate to relative densities between loose and very dense; however, at least some of the measured N-values are likely not representative of in-place density because gravel, cobbles, or boulders were encountered during testing.

7.4. Weathered Bedrock and Bedrock

Weathered limestone bedrock was encountered at Test Borings 4, 12, and 13 at a depth of ±6½ feet and at Test Borings B4, B67, B68, B69, B76, and B86 at depths of ±18, ±3, ±5, ±6½, ±6½, and ±2 feet, respectively. The weathered bedrock material typically consisted of sandy gravel with intact rock fragments. Additionally, most of the test borings were terminated due to auger refusal, which is interpreted to be due to competent bedrock and/or moderately weathered bedrock. The depths and elevations to weathered bedrock, along with the test boring and auger refusal depths at each test boring are provided in Table A, enclosed in Appendix A.

It is important to note that bedrock (including weathered bedrock) can be more easily penetrated with test-boring equipment than can be excavated with conventional earthwork equipment. Therefore, the auger-refusal depths discussed should not be relied upon as the depth where difficult excavation will be encountered. Special excavation and removal methods are expected to be necessary at depths shallower than the auger-refusal depths.

8.0 GROUNDWATER CONDITIONS

Free water was not encountered during drilling, and it is estimated that the water table was below the maximum exploration depths at the test boring locations, when the test borings were conducted. Based on moisture conditions of the retained soil samples, and the relatively shallow limestone bedrock, the site appears to be subject to perched groundwater, where groundwater collects/flows above the bedrock surface. This perched-groundwater condition could be significant at times, and likely fluctuates seasonally and with weather events. Groundwater could perch within several feet of the ground surface.

It is important to note that the groundwater conditions discussed above are only based on the conditions at the test borings. If a more detailed determination of the groundwater conditions is needed, groundwater observation wells are recommended to be installed and monitored at the site. Giles can install and monitor observation wells, if it is decided that a more detailed determination of the water table depth is needed.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1. Excavation Difficulties

Weathered bedrock was encountered in the test borings. Additionally, most of the test borings were terminated due to auger refusal, presumably caused by less weathered or un-weathered bedrock. The depths and elevations to weathered bedrock, along with the test boring and auger refusal depths at each test boring are provided in Table A, enclosed in Appendix A.

Depending on the location and floor elevations of the proposed residences, and considering the relatively shallow bedrock in some areas of the site, specialized excavation methods may be necessary for site development. The actual methods of excavation and removal of weathered and un-weathered bedrock are recommended to be determined by earthwork contractors based on their interpretation of the subsurface conditions at the site, and also based on the possibility of differing conditions away from the test borings. The degree of excavation difficulty will generally depend on the required excavation depth, the bedrock hardness, and the capabilities of the excavation equipment/methods chosen by the contractor. It is important to note that bedrock (including weathered bedrock) can be more easily penetrated with test-boring equipment than can be excavated with conventional earthwork equipment. Therefore, the auger-refusal depths discussed above should not be solely relied upon by contractors as the depth where difficult excavation will be encountered. Special excavation and removal methods may be necessary at depths shallower than the auger-refusal depths.

Blasting might be required for the project. If blasting is necessary, it should be done by a qualified specialty contractor and must be done carefully so as not to damage nearby structures, including buildings, utilities, roads, etc. A video survey of surrounding properties should be completed before and after blasting in the presence of the adjacent property owners to help reduce any potential liability claims. Blasting vibrations should be monitored and controlled. The maximum peak particle velocity should be determined based on the type, distance, condition, and historical significance of nearby structures. Hard-rock excavation methods may require special permits and should be performed in accordance with local, state, and federal regulations.

9.2. Seismic Design Considerations

A soil Site Class C is recommended for seismic design. By definition, Site Class is based on the average properties of subsurface materials to 100 feet below-ground. Because 100-foot test borings were not performed, it was necessary to estimate Site Class based on the test borings, presumed geology, and International Building Code.

9.3. Foundation Recommendations

A spread-footing foundation is recommended for the proposed residential buildings. Based on the assumed basement floor elevations, which will be 9 to 10 feet below the first floor elevation, and based on the conditions encountered at the test boring locations, it is anticipated that the foundations will bear on bedrock in some areas. However, existing fill is unsuitable for direct or indirect support of foundations. Each footing must bear on suitable native soil, weathered or competent bedrock, or on new engineered fill or lean-concrete backfill (both discussed below) placed on suitable native soil or bedrock. If a foundation is supported by significantly dissimilar materials (such as soil and bedrock), a minimum 12-inch-thick layer of compacted aggregate (approved by a geotechnical engineer) is recommended to be installed beneath the foundation in the area of the dissimilar materials to help control differential settlement. The compacted aggregate would serve as a cushion layer to lessen the abrupt changes in foundation support. The need for a cushion layer should be further evaluated by a geotechnical engineer during construction. The actual thickness, location, and extent of a cushion layer should also be determined by the geotechnical engineer.

The foundations are recommended to be designed using a 3,000 psf maximum, net, allowable soil bearing capacity. Although this bearing capacity is conservative for foundations that are directly supported by limestone bedrock, it is considered appropriate because the foundations are expected to be supported by native soil, weathered bedrock, or bedrock. For geotechnical considerations, strip footing pads are recommended to be at least 16 inches wide and isolated column pads (if any) are recommended to be at least 24 inches wide, regardless of the calculated foundation-bearing stress. From a geotechnical perspective, foundation walls are recommended to be constructed of cast-in-place concrete (rather than concrete masonry units) and the foundation system is recommended to be relatively rigid, considering that the foundations are expected to be supported by dissimilar native materials (soil and bedrock). It is recommended and assumed that a structural engineer will provide specific foundation details, including footing dimensions, reinforcing, etc.

A minimum 48-inch foundation-embedment depth is required by the building code. It is, therefore, recommended that footings for perimeter walls and other exterior elements of the residence bear at least 48 inches below the finished ground grade adjacent to the building. To satisfy the required embedment depth, perimeter footings in the basement area might need to step down to a lower elevation if the basement is partially or fully exposed. Interior footings within the basement can bear directly below a floor slab. Also, it is recommended that interior footings (if any) in the attached garages bear at least 48 inches below the surface of the garage floor.

The following Table 1 provides estimated depths and elevations of native soil that was suitable for foundation support (based on the recommended 3,000 psf bearing capacity) at Test Borings 1 through 15. In the areas of the Former test borings, depth to suitable soil was encountered within about two feet of the ground surface at the time the test borings were conducted. However, up to 7 feet of fill has been placed in the areas of Test Borings B74, B75, and B76. Based on Daily Field Reports from Intertek-PSI on March 20 and 21, 2024, this fill material consisted of a mix of sand, gravel, and boulders generated from the blasting operations from the adjacent construction.

TABLE 1 ESTIMATED DEPTH/ELEVATION OF SUITABLE NATIVE SOIL		
Test Boring Number	**Estimated Depth of Suitable Native Soil**	**Estimated Elevation of Suitable Native Soil**
1	±3.5 feet	El. 904.9
2	±9 feet	El. 904.4
3	>±6.5 feet	<El. 904.4
4	±6.5 feet	El. 905.9
5	>±9 feet	<El. 912.1
6	±6.5 feet	El. 918.1
7	±3 feet	El. 920.6
8	±4 feet	El. 920.8
9	±2 feet	El. 926
10	±3 feet	El. 929.1
11	±3 feet	El. 946.4
12	±2 feet	El. 913.1
13	±6.5 feet	El. 906.5
14	±9 feet	El. 902.5
15	±6.5 feet	El. 898.6

- For direct foundation support and for placement of engineered fill or lean-concrete backfill; based on a 3,000 psf maximum, net, allowable soil bearing capacity.
- Depths are referenced to the site grades when the test borings were performed.
- Elevations are referenced to the elevations on the *Test Boring Logs*.

Considering the existing fill materials and possible perched groundwater conditions, some over-excavation should be expected for footing construction. In some locations, over-excavation might be extensive in depth and area, depending on the conditions that are encountered. <u>Additionally, the soil conditions likely vary throughout the site away from the test borings. Therefore, evaluation and approval of foundation-support soil by a geotechnical engineer during construction is critical.</u> Without testing and approval by a geotechnical engineer, the proposed residences might be improperly supported, which could lead to excessive settlement and other structural problems.

A frictional coefficient of 0.35 is recommended to determine lateral resistance at the base of the foundation. The recommended frictional coefficient is only for concrete cast directly on suitable native soil or on new engineered fill or lean-concrete backfill used to replace unsuitable material. Lateral resistance due to friction should be determined based on dead load only. Also, the ultimate lateral resistance determined from the frictional coefficient is recommended to be factored to determine an allowable value. Passive resistance is recommended to be neglected to at least the recommended 48-inch foundation-embedment depth due to seasonal changes and due to the amount of lateral movement necessary to develop full passive pressure.

The foundation excavations are recommended to be dug with a smooth-edge bucket to develop a relatively undisturbed bearing grade. A toothed bucket will likely disturb foundation-bearing soil more than a smooth-edge bucket thereby making soil at the excavation base more susceptible to saturation and instability, especially during adverse weather. It is critical that contractors protect foundation-support soil and foundation construction materials (concrete and reinforcing). Furthermore, engineered fill is recommended to be placed and compacted in benched excavations along the foundation walls immediately after the foundation walls can properly support lateral pressures from backfill, compaction, and compaction equipment. Earth-formed footing construction techniques are expected to be feasible, but caving might be encountered in deeper excavations, especially due to existing fill, granular native soil, and perched groundwater.

Foundation Support Soil Requirements

All footings must bear on suitable native soil, weathered bedrock, or bedrock. Based on the recommended 3,000 psf maximum, net, allowable soil bearing capacity, the in-situ unconfined compressive strength of native cohesive soil (lean clay, sandy clay, and silty clay) within foundation influence zones is recommended to be at least 1.5 tons per square foot (tsf). Granular soil (sandy silt) within foundation influence zones is recommended to have a corrected N-value (determined from SPTs and correlated from other in-situ tests) of at least 10, based on the recommended bearing capacity. It is further recommended that the strength characteristics of soil within all foundation influence zones (determined by a geotechnical engineer during construction) meet or exceed the recommended values, unless Giles approves other values during construction. Also, it is recommended that a geotechnical engineer observe all foundation excavations prior to foundation construction to determine if an aggregate cushion layer (discussed above) is needed.

Due to the existing fill and bedrock conditions, evaluation of foundation-support materials by a geotechnical engineer during foundation excavation and foundation construction is critical. The purpose of the recommended evaluation is (1) to confirm that the foundations will be properly supported by suitable native materials, (2) to determine if over-excavation is needed, (3) to determine if a cushion layer is needed, and (4) to confirm that the foundation-support materials are similar to those described on the *Test Boring Logs*. If another firm performs the recommended support-soil evaluation, Giles must be notified if the composition and/or strength characteristics of foundation-support materials differ from those shown on the *Test Boring Logs*, thereby allowing us the opportunity to revise this report, if needed. All OSHA requirements must be strictly followed when evaluating foundation-support materials; excavations that do not meet OSHA safety guidelines must not be entered.

Unsuitable materials beneath foundation areas can likely be replaced with engineered fill consisting of dense-graded crushed stone that meets the gradation requirements of *dense-graded base* (1¼-inch) in Section 305 of the Wisconsin Department of Transportation Standard Specifications (2019). Granular material with other gradation characteristics could possibly be used but should be approved by a geotechnical engineer before the material is placed. If engineered fill is used as backfill beneath foundation areas, lateral over-excavation of unsuitable materials will also be required, in addition to the required vertical over-excavation. The overall width of lateral over-excavation will depend on the vertical over-excavation depth. For estimating purposes, the minimum lateral over-excavation could be determined by extending an imaginary line outward and downward at a ratio of 1(horizontal):2(vertical) from the bottom edges of a footing pad, but the actual lateral extents of over-excavation are recommended to be approved by a geotechnical engineer during construction.

Lean Portland cement concrete (minimum 28-day compressive strength of 500 psi) could also be used to replace unsuitable materials beneath foundation areas. Where lean concrete is used as backfill, footing construction must not begin until the lean concrete has gained sufficient strength. Also, over-excavations that are filled with lean concrete are recommended to be at least as wide (on all sides) as the footing pad that will be supported by the concrete, and excavation sidewalls are recommended to be plumb and parallel. To help control caving, lean-concrete backfill is recommended to be placed immediately after excavation. This trench-and-pour method requires close communication and scheduling between the general contractor, foundation contractor, concrete supply company, and geotechnical engineer. With a trench-and-pour method, a geotechnical engineer must observe excavations as they are made.

From a geotechnical perspective, footing pads can be stepped or thickened to extend through unsuitable materials, but stepped and thickened footings must be approved by the structural engineer. It is recommended that a geotechnical engineer provide specific recommendations pertaining to unsuitable materials within foundation areas at the time of construction.

Estimated Foundation Settlement

The post-construction total and differential settlements of a spread-footing foundation designed and constructed based on this report are estimated to be less than about 1 inch and ½ inch, respectively. Estimated settlements assume that the recommendations in this report will be followed and that foundation-support soil will be evaluated and approved by a geotechnical engineer during construction.

9.4. At-Grade (Garage) Floor Slab Recommendations

With proper subgrade preparation, native soil is expected to be suitable to support a ground-bearing concrete slab for each attached garage; new engineered fill that is placed on properly prepared native soil is also expected to be suitable. However, garage areas are recommended to be evaluated and approved by a geotechnical engineer immediately before fill placement and before floor construction. Without an evaluation of floor slab support materials, garage floor slabs could be improperly supported, which could lead to excessive settlement.

From a geotechnical perspective and based on a maximum 100 psf floor load, the floor slabs for the attached garages are recommended to be at least 5 inches thick; this thickness assumes that the 28-day compressive strength of the concrete will be at least 3,500 pounds per square inch (psi). However, it is recommended that a structural engineer specify the floor slab thickness, reinforcing, joint details, and other parameters.

A minimum 4-inch-thick base course is recommended to be below each garage slab to serve as a capillary break. It is recommended that the base course consist of compacted, free-draining crushed stone that meets the gradation requirements of ASTM No. 57 aggregate. Depending on the subgrade condition and materials, geotextile might need to be below the base course to serve as a separator. The need for geotextile should be determined during construction with the assistance of a geotechnical engineer.

Due to the frost-susceptible site soil and groundwater conditions, it is expected that the garage slab will be susceptible to freeze-thaw related movement. Installation of insulation or other protective measures against freeze-thaw movement should, therefore, be considered for this area. Pavement and ground grades are recommended to be sloped away from the residence and sidewalks to reduce water infiltration and potential freeze-thaw problems.

Estimated Floor Slab Settlement

The post-construction total and differential settlements of an at-grade floor slab constructed in accordance with this report are estimated to be less than about ½ inch and ⅜ inch, respectively, over about 20 feet. Estimated settlements assume that support soil will be evaluated and approved by a geotechnical engineer

9.5. Basement Recommendations

Geotechnical-related recommendations regarding basement construction are provided in this section. The recommendations assume that the proposed residences will have a full basement and that the basement floor will be approximately 9 to 10 feet below the first floor. Giles must be notified if each residence will not have a full basement or if the basement floor elevation will be different than assumed; revision of this report might be necessary. Hard rock excavation is expected to be necessary for basement construction in some areas.

Basement Floor Slab

Assuming a maximum 100 psf floor load and from a geotechnical perspective, the basement floor slab is recommended to be at least 4 inches thick; this thickness assumes that the 28-day compressive strength of concrete will be at least 3,500 pounds per square inch (psi). The basement floor slab can be designed based on a *Modulus of Subgrade Reaction* (K_{V1}) value of 150 pounds per square inch per inch (psi/in). It is recommended that a structural engineer specify the floor slab thickness, reinforcing, joint details, and other parameters.

For moisture control only, a minimum 10-mil vapor retarder is recommended to be directly below the floor slab throughout the entire basement area. It is recommended that the vapor retarder extend to all foundation walls. Vapor retarder sheets are recommended to be overlapped at least 6 inches, and the overlaps are recommended to be continuously taped. Vapor retarder is recommended to be in accordance with ASTM E 1745, entitled *Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs,* and other relevant documents.

A minimum 6-inch-thick base course is recommended to be directly below the minimum 10-mil vapor retarder to serve as a capillary break and for sub-slab drainage. Because the base course will be a component of the recommended drainage system (discussed below), it is recommended that the base material consist of crushed stone that meets the gradation requirements of ASTM No. 57 aggregate (washed). Base material is recommended to be properly compacted. Also, it is recommended that a geotechnical engineer approve base material before it is placed. Geotextile might need to be below the base material to serve as a separator. The need for geotextile should be determined during construction with the assistance of a geotechnical engineer.

The post-construction total and differential settlements of an isolated floor slab constructed in accordance with this report are estimated to be less than about ½ inch and ⅓ inch, respectively, over a distance of about 20 feet. Estimated settlements assume that support-soil will be thoroughly tested and approved by a geotechnical engineer.

Foundation Drainage System Recommendations

Continuous drainpipes are recommended to be along the interior and exterior sides of perimeter strip footings, thereby creating interior and exterior drainage loops around each basement. Drainpipes could consist of conduits specifically manufactured for foundation drainage applications, such as Form-A-Drain® conduits. Manufactured foundation drains are recommended to be installed per the manufacturer's recommendations. Circular drainpipes could also be used and are recommended to be minimum 4-inch-diameter perforated pipes suitable for foundation drainage. Circular drainpipes are recommended to be directly adjacent to the footing pads, not atop footing flanges. Interior drainpipes are to be properly situated within the base course layer below the floor slab. It is recommended that a minimum 12-inch-thick layer of free-draining crushed stone (ASTM No. 57 aggregate) surround exterior drainpipes, but the crushed stone must not extend below the foundations and into the foundation-influence zone. Bleeder pipes are recommended to be cast in the perimeter strip-footing pads to serve as water conduits between interior and exterior drainpipes. Bleeder pipes are recommended to be 3 inches in diameter and about 8 feet on-center, which is understood to be a State of Wisconsin building code.

It is recommended that the drainpipes discharge to a sump basin within each basement. The basin should be located based on construction details of the residence, and based on the planned discharge location. Also, the basin is recommended to have a sealed-and-bolted, airtight lid to prevent inflow of subsurface gases, such as radon. The basin must be equipped with a sump pump that has sufficient capacity. The sump pump could be equipped with a battery back-up to help prevent or reduce water problems in the event of a power failure. Piping for the sump pump should discharge a sufficient distance away from the proposed residence to a suitable location where the possibility of ponded water will not be a nuisance or hazard, especially during cold weather when ponded water could freeze.

Perimeter Aggregate Layer

Free-draining, washed aggregate is recommended to be along the exterior side of basement walls. The aggregate will serve as drainage media for the recommended drainage system. The aggregate layer is recommended to be at least 2 feet wide, measured from the outside face of the below-grade walls. Also, the aggregate layer is recommended to be continuous along the length and height of the walls, except that pavement or a ±6-inch-thick layer of relatively impervious material is recommended to be above the drainage aggregate to reduce surface-water intrusion. Furthermore, the aggregate layer must extend to the base of the perimeter strip-footing pads, thereby creating a continuous drainage path to the perimeter drainage conduits. However, drainage aggregate must not extend below the foundation-bearing grade and into the foundation-influence zone.

Drainage aggregate that is placed adjacent to basement walls is recommended to be compacted in relatively thin lifts, especially where drainage aggregate will support pavement or sidewalks. Use of manual compaction equipment must be in accordance with current OSHA excavation and trench safety standards, and other applicable requirements. Manual compaction equipment should not be used within spaces that do not meet OSHA requirements. Drainage aggregate should not be excessively compacted. Where necessary, excavations for basement walls must be properly shored, sloped, or restrained. Also, basement walls are recommended to be adequately braced before placing backfill to prevent the walls from moving or possibly even overturning during backfilling. Bracing must remain in-place until the top and bottom of the basement walls are structurally restrained.

Lateral Pressure Design Parameters

Below-grade walls must be designed to resist lateral pressures from drainage backfill, adjacent soil, and any surface and subsurface surcharges. An equivalent "at-rest" fluid pressure of 65 pounds per square foot per foot of depth (psf/ft) is recommended for design of below-grade walls. The recommended “at-rest” value is based on Giles’ assumption that drainage backfill will continuously abut the below-grade walls, and that the recommended drainage system will be installed and will remain functional. If drainage backfill and/or the drainage system are not installed, lateral pressures will likely exceed the recommended "at-rest" fluid pressure, possibly exceeding the lateral capacity of the walls.

Lateral pressures caused by surface and subsurface surcharge loads must be added to the "at-rest" fluid pressure. Giles could provide supplemental recommendations regarding surface and subsurface surcharge loads on a case-by-case basis but would require specific structural information. Below-grade walls that are not designed to resist actual pressures could move laterally and possibly fail. It is recommended and assumed that a structural engineer will design the below-grade walls.

9.6. Pavement Recommendations

Roadways will be constructed for the proposed development. It is assumed that the road is planned to be constructed of asphalt-concrete pavement with an aggregate base course. However, traffic-related information was not provided to us. Therefore, recommendations are provided herein based on an assumed traffic condition of fifteen 18-kip Equivalent Single Axle Loads (ESALs) per day. The recommended pavement section assumes no increase in traffic volume and no changes in vehicle type or traffic pattern. Also, it is assumed that the ESALs noted above will be in one direction for each lane.

It is important that the project owner, developer, civil engineer, and other design professionals involved with the project confirm that the ESALs noted above are appropriate for the expected traffic conditions, vehicle types, and axle loadings. If requested, Giles can provide supplemental pavement recommendations based upon other traffic conditions, vehicle types, and axle loads. The recommended pavement section could underperform or fail prematurely if the design ESALs are exceeded.

Based on the test borings, it is expected that pavement subgrade will mostly consist of sandy clay fill. Therefore, the recommended pavement sections shown below were developed based on an assumed field CBR value of 5 and a *Modulus of Subgrade Reaction* (K_{V1}) of 125 psi/in. Engineered fill that is placed in proposed pavement areas is recommended to have a field CBR value and a *Modulus of Subgrade Reaction* (K_{V1}) value at least equal to the design values. Also, the fill is recommended to be placed and compacted per this report.

Asphalt-Concrete Pavement

The following table shows the recommended thicknesses for HMA pavement with an aggregate base course. State specifications are also included in the table. The recommended HMA pavement section is based on the traffic conditions described above.

TABLE 2
RECOMMENDED ASPHALT-CONCRETE PAVEMENT

Materials	Thickness	Wisconsin DOT Standard Specifications
Hot Mix Asphalt Surface Course	1.5 inches	Section 460
Hot Mix Asphalt Binder Course	2.5 inches	Section 460
Dense-Graded Aggregate Base Course	9.0 inches	Section 305 1¼-inch Crushed Stone

General Pavement Considerations

The pavement recommendations assume that the pavement subgrade will be prepared in accordance with this report, the base course will be properly drained, and a geotechnical engineer will observe and test pavement construction. Pavement was designed based on AASHTO design parameters for a twenty-year design period, but the actual service life will likely be much less, especially considering the moisture-sensitive soil and perched groundwater. Pavement distress should be expected. Local codes may require specific testing to determine soil-support characteristics, and a minimum pavement section might be required.

9.7. Site Preparation Recommendations

This section provides recommendations for site preparation, including preparation of building, pavement, and engineered fill areas. The means and methods of site preparation will depend on the weather conditions before and during construction, the subsurface conditions that are exposed during earthwork operations, and the finalized details of the proposed development. Therefore, only generalized site preparation recommendations are given.

In addition to being general, the following site preparation recommendations are abbreviated; the *Guide Specifications* in Appendix D gives further recommendations. The *Guide Specifications* should be read along with this section. Also, the *Guide Specifications* are recommended to be used as an aid to develop the project specifications.

Clearing, Grubbing, and Stripping

Surface vegetation, trees and bushes (including root-balls), topsoil with adverse organic content, and otherwise unsuitable bearing materials are recommended to be removed from the proposed building area, pavement areas, and other structural areas. Clearing, grubbing and stripping should extend at least several feet beyond proposed development areas, where feasible.

Proof-Rolling and Fill Placement

After the recommended removal and stripping, and once the construction areas are cut (lowered) as needed, each subgrade is recommended to be proof-rolled with a fully-loaded, tandem-axle dump truck to locate unstable areas based on subgrade deflection caused by the wheel loads of the proof-roll equipment. For safety, proof-roll equipment must be kept a sufficient distance from excavations, such as the basement excavation. It is recommended that a geotechnical engineer observe proof-roll operations and evaluate subgrade stability based on those observations. Areas that cannot be proof-rolled (such as near excavations) are recommended to be evaluated and approved by a geotechnical engineer using appropriate means and methods.

Unstable granular soil that is identified during proof-rolling and testing can possibly be improved by scarification and moisture-conditioning (uniformly moistening or drying) followed by compaction using appropriate compaction equipment. Unsuitable soil can also be removed and replaced with engineered fill; however, engineered fill material is recommended to be approved by a geotechnical engineer before it is placed. Also, recommendations for subgrade improvement should be provided by a geotechnical engineer based on the site conditions during construction. Areas requiring subgrade improvement should be defined during construction with the assistance of a geotechnical engineer. Specific improvement methods should be determined during construction on an area-by-area basis. Where subgrade improvement is needed, it might be necessary to construct "test strips" to determine the most cost-effective and appropriate means of developing a suitable subgrade.

The proposed construction areas are recommended to be raised, where necessary, to the planned finished grades with engineered fill immediately after each subgrade is confirmed to be stable and suitable to support the proposed construction. Engineered fill is recommended to be placed in thin layers (lifts) that are uniform in elevation. Each layer of engineered fill is recommended to be compacted to at least 95 percent of the fill material's maximum dry density determined from the Standard Proctor compaction test (ASTM D 698). As an exception, the in-place dry density of engineered fill within one foot of a pavement subgrade is recommended to be compacted to at least 100 percent of the fill material's maximum dry density. The water content of fill material is recommended to be uniform and within a narrow range of the optimum moisture content, also determined from the Standard Proctor compaction test. Item Nos. 4 and 5 of the *Guide Specifications* give more information pertaining to selection and compaction of engineered fill.

Engineered fill that does not meet the density and water content requirements is recommended to be replaced, or it could be scarified to a sufficient depth (likely 6 to 12 inches, or more), moisture-conditioned, and compacted to the required density. A subsequent lift of fill should only be placed after a geotechnical engineer confirms that the previous lift was properly placed and compacted. Subgrade soil might need to be recompacted immediately before construction, since equipment traffic and adverse weather may reduce soil stability.

<u>Use of Site Soil as Engineered Fill</u>

Site soil that does not contain adverse organic content or other deleterious materials, as noted in the *Guide Specifications,* could be used as engineered fill. However, because granular site soil and weathered bedrock includes cobbles and boulders and rock slabs, extensive sorting or processing (crushing) to remove oversized materials is expected to be necessary for reuse of these materials as engineered fill, which might not be economically feasible for the project. Also, site soil (especially lean clay) that is used as engineered fill will likely need to be moisture conditioned (uniformly moistened or dried). If construction is during adverse weather, drying site soil will likely not be feasible. In that case, fill will likely need to be imported to the site. Additional recommendations regarding fill selection, placement, and compaction are given in the *Guide Specifications*.

9.8. Generalized Construction Considerations

<u>Adverse Weather</u>

Site soil is moisture sensitive and will become unstable when exposed to adverse weather, such as rain, snow, and freezing temperatures. Therefore, it might be necessary to remove or stabilize the upper 6 to 12 inches (or more) of soil due to adverse weather, which commonly occurs during late fall, winter, and early spring. At least some over-excavation or stabilization of unstable soil should be expected if construction is during or after adverse weather. Because site preparation is weather dependent, bids for site preparation and other earthwork activities should consider the time of year that construction will be conducted.

To protect soil from adverse weather, the site surface is recommended to be smoothly graded and contoured during construction to divert surface water from construction areas. Contoured subgrades are recommended to be rolled with a smooth-drum compactor before precipitation to "seal" the surface. Furthermore, construction traffic should be restricted to certain aggregate-covered areas to control traffic-related soil disturbance. Foundation, floor slab, and pavement construction should begin immediately after suitable support is confirmed.

<u>Dewatering</u>

Excavations are expected to be above the water table, but dewatering may be necessary due to precipitation or perched groundwater. Water that accumulates in construction areas is recommended to be removed along unsuitable soil as soon as possible. Filtered sump pumps, drawing water from sump pits excavated in the bottom of construction trenches, are expected to be adequate to remove water that collects in shallow excavations. Excavated sump pits should be fully lined with geotextile and filled with free-draining crushed stone, such as crushed stone that meets the gradation requirements of ASTM No. 57 aggregate.

<u>Excavations</u>

Excavations are recommended to be made in accordance with current OSHA excavation and trench safety standards and other applicable requirements. Sides of excavations might need to be benched, sloped, or braced to maintain or develop a safe work environment. Temporary shoring must be designed according to applicable regulatory requirements. Contractors are responsible for excavation safety. Due to the shallow weathered bedrock and bedrock, relatively extensive excavation difficulties are expected for site development, as discussed in Section 9.1.

<u>Existing Fill Considerations</u>

Questionable fill materials, where encountered, are recommended to be evaluated by a geotechnical engineer to determine if removal and replacement with engineered fill is necessary. Disposal of unsuitable material should be in accordance with local, state, and federal regulations for the material type. It is recommended that a soil management plan be developed prior to construction to address the handling and disposal of materials and groundwater. This report might need to be revised if the actual subsurface conditions differ from those noted on the *Test Boring Logs*.

Drain-Tile Considerations

The site has been used for agriculture. Therefore, considering the cohesive site soil and perched groundwater, drain-tile might exist at the site. Drain-tile that is encountered during construction should be rerouted around the proposed development, and be discharged to a suitable location on a permanent basis. Drain-tile should not be plugged, since it may drain large areas. Drain-tile that is damaged during construction should be repaired. It is recommended that a geotechnical engineer observe encountered drain-tile prior to repair and/or rerouting.

9.9. Recommended Construction Materials Testing

This report was prepared assuming that a geotechnical engineer will perform Construction Materials Testing ("CMT") services during construction of the proposed development. It might be necessary for Giles to provide supplemental geotechnical recommendations based on the results of CMT services and specific details of the project not known at this time.

10.0 BASIS OF REPORT

This report is strictly based on the project description given in Section 4.0. Giles must be notified if the project description or our assumptions are not accurate; revision of this report might be necessary. This report assumes that the proposed development will be designed and constructed according to the codes that govern construction at the site.

The conclusions and recommendations in this report are based on the estimated subsurface conditions shown on the *Test Boring Logs*. Giles must be notified if the subsurface conditions that are encountered during construction differ from those shown on the *Test Boring Logs*; revision of this report might be necessary. General comments and limitations of this report are given in the appendix.

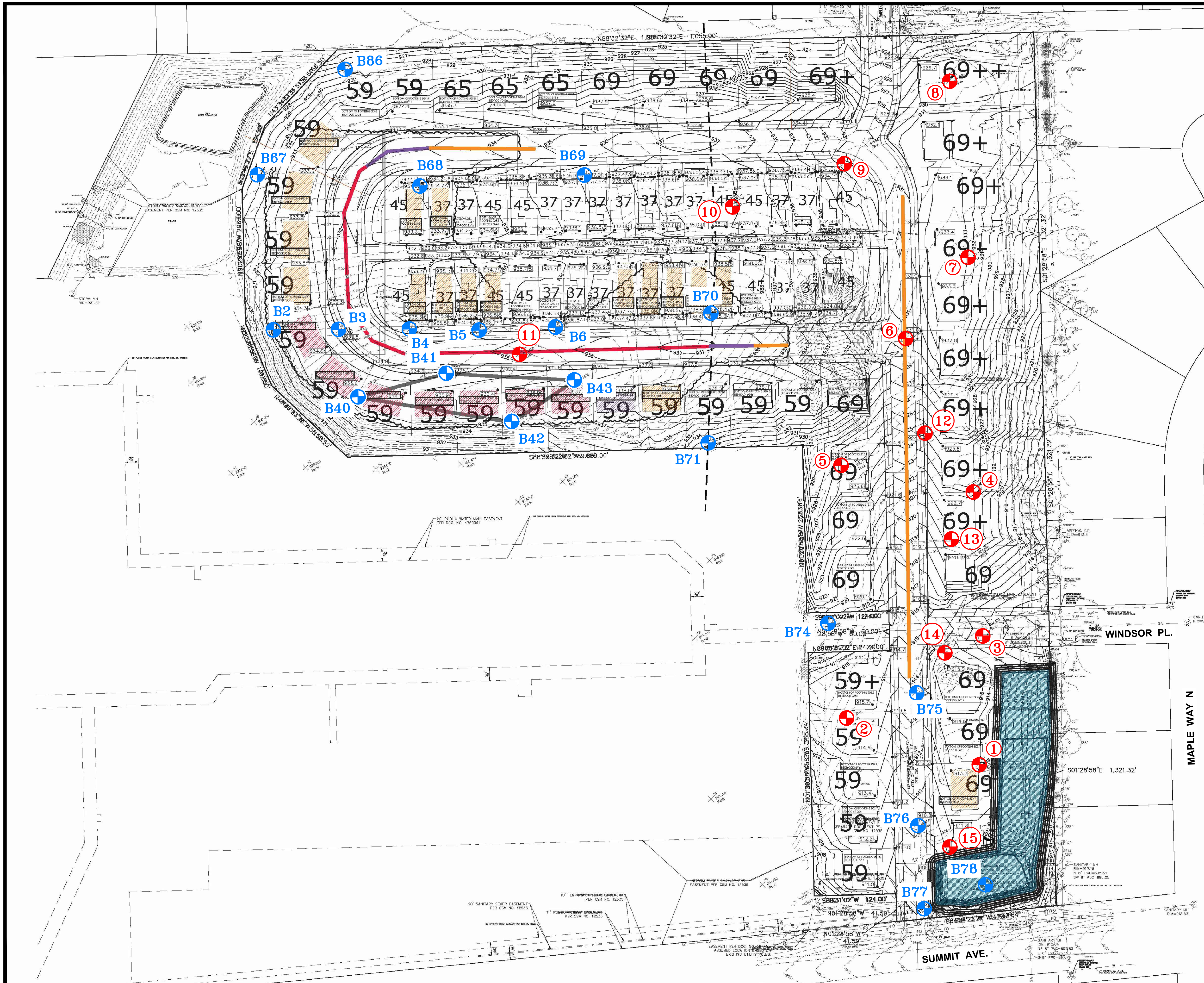
The conclusions and recommendations in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

APPENDIX A

FIGURES AND TEST BORING LOGS

The Test Boring Location Plan contained herein was prepared based upon information supplied by *Giles'* client, or others, along with *Giles'* field measurements and observations. The diagram is presented for conceptual purposes only and is intended to assist the reader in report interpretation.

The Test Boring Logs and related information enclosed herein depict the subsurface (soil and water) conditions encountered at the specific boring locations on the date that the exploration was performed. Subsurface conditions may differ between boring locations and within areas of the site that were not explored with test borings. The subsurface conditions may also change at the boring locations over the passage of time.



NOTES:

1.) TEST BORING LOCATIONS ARE APPROXIMATE.

2.) BASE MAP DEVELOPED FROM THE FILE (230103400c-overlay-C4.0-Overall Grading (002).pdf), PROVIDED BY THE CLIENT.

N
W E
S

0 75' 150'

APPROXIMATE SCALE

LEGEND:

1	GEOTECHNICAL TEST BORING
B40	PREVIOUS GEOTECHNICAL TEST BORING (PROJECT NO. 1G-2204016)

GILES ENGINEERING ASSOCIATES, INC.
N8 W22350 JOHNSON DRIVE, SUITE A1
WAUKESHA, WI 53186 (262)544-0118
www.gilesengr.com

FIGURE 1
TEST BORING LOCATION PLAN
PROPOSED RESIDENTIAL DEVELOPMENT
SUMMIT AVENUE
WAUKESHA, WISCONSIN

DESIGNED	DRAWN	SCALE	DATE	REVISED
GCH		approx. 1"=150'	01-09-25	--
PROJECT NO.: 1G-2410010			CAD No. 1g2410010-blp2	

GILES ENGINEERING ASSOCIATES, INC.

TABLE A
DEPTHS AND ELEVATIONS TO WEATHERED BEDROCK AND BEDROCK

Test Boring	Ground Surface Elevation	Depth of Weathered Rock/ Rock (2) (feet)	Elevation of Weathered Rock/ Rock (3)	Auger Refusal Depth (2) (feet)	Elevation of Auger Refusal (3)
1	908.4	--	--	±3.5	904.9
2	913.4	--	--	±14	899.4
3	910.9	--	--	±6.5	904.4
4	912.4	±6.5	905.9	±7.5	904.9
5	921.1	--	--	±9	912.1
6	924.6	--	--	±12.5	912.1
7	923.6	--	--	±12.5	911.1
8	924.8	--	--	>±16	<908.8
9	928.0	--	--	±12.5	915.5
10	932.1	--	--	±12	920.1
11	949.4	--	--	>±26	<923.4
12	915.1	±6.5	908.6	±12	903.1
13	913.0	±6.5	906.5	±12	901.0
14	911.5	--	--	±16	895.5
15	905.1	--	--	±17	888.1

1) Test Boring locations shown on the attached *Test Boring Location Plan* (Figure 1).
2) Depths are referenced to the surface grade at the test boring locations and are estimated based on conditions encountered during drilling.
3) Elevations are referenced to the test boring elevations, which were determined using a Trimble® R2 receiver.

GILES ENGINEERING ASSOCIATES, INC.

TABLE A (FORMER BORINGS)
DEPTHS AND ELEVATIONS TO WEATHERED BEDROCK AND BEDROCK

Test Boring	Ground Surface Elevation	Depth of Weathered Rock/ Rock (5) (feet)	Elevation of Weathered Rock/ Rock (6)	Auger Refusal Depth (5) (feet)	Elevation of Auger Refusal (6)
B2	941.1	--	--	±13.5	927.6
B3	943.6	--	--	±18.5	925.1
B4	945.8	±18	927.8	>±21	<924.8
B5	947.3	--	--	>±21	<926.3
B6	946.5	--	--	>±21	<925.5
B40	950.0	--	--	>±11	<939.0
B41	950.1	--	--	>±11	<939.1
B42	947.4	--	--	>±11	<936.4
B43	947.5	--	--	>±11	<936.5
B67	928.2	±2	926.2	±3	925.2
B68	930	±5	925	±5.5	924.5
B69	928.1	±6.5	921.6	±8.5	919.6
B70	941.2	--	--	>±11	<930.2
B71	932.5	--	--	>±11	<921.5
B74	913.1	--	--	±8	905.1
B75	906	--	--	±5.5	900.5
B76	903	±6.5	896.5	±8	895
B77	906.1	--	--	>±11	<895.1
B78	909	--	--	±13	896
B86	924.5	±2	922.5	±4.5	920

4) Test Boring locations shown on the attached *Test Boring Location Plan* (Figure 1).
5) Depths are referenced to the surface grade at the test boring locations and are estimated based on conditions encountered during drilling.
6) Elevations are referenced to topographic contours shown on the *Grading Plan* – Areas 1 through 9.

BORING NO. & LOCATION: 1	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 908.4 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/23/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil										
Fill: Gray fine to medium Sand, little Gravel and Silt (Includes Cobbles and Boulders)-Moist			1-SS	13						
		905	2-SS	60/2"						

Auger Refusal
Boring Terminated at about 3.5 feet (EL. 904.9')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
2		
SURFACE ELEVATION: 913.4 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/23/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
Fill: Brown Gravelly fine to medium Sand, little Silt-Moist			1-SS	19						
		910	2-SS	8						
Fill: Brown lean Clay, little Sand and Gravel-Moist	5		3-SS	10						
		905	4-SS	13						
Brown Sandy Clay, trace Gravel-Moist	10		5-SS	12				11		
Brown Clayey fine to medium Sand, little Gravel-Very Moist		900	6-SS	20						(a)

Auger Refusal
Boring Terminated at about 14 feet (EL. 899.4')

Water Observation Data	Remarks:
Water Encountered During Drilling:	(a) Poor Sample Recovery
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After Drilling:	
Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 3	TEST BORING LOG	
SURFACE ELEVATION: 910.9 feet	PROPOSED RESIDENTIAL DEVELOPMENT	GILES ENGINEERING ASSOCIATES, INC.
COMPLETION DATE: 10/23/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil: Dark Brown lean Clay, trace Organic Matter-Moist		910	1-SS	22						
Fill: Gray Sandy Gravel-Moist										
Fill: Dark Brown Clayey fine to medium Sand, little Gravel-Moist			2-SS	35						
Fill: Blasted Rock	5	905	3-SS	91						

Auger Refusal
Boring Terminated at about 6.5 feet (EL. 904.4')

Water Observation Data	Remarks:
Water Encountered During Drilling:	
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After Drilling:	
Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 4	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 912.4 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/23/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil: Dark Brown Silty Clay, trace Organic Matter-Moist			1-SS	8				23		
Fill: Brown Silty fine to medium Sand (Includes Wood Chips)-Moist		910	2-SS	7				13		
Fill: Brown Sandy Clay, little Gravel-Moist	5		3-SS	18						
Weathered Limestone Bedrock: Gray Sandy Gravel-Damp		905	4-SS	50/2"						

Auger Refusal
Boring Terminated at about 7.5 feet (EL. 904.9')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

TEST BORING LOG

BORING NO. & LOCATION: 5	PROPOSED RESIDENTIAL DEVELOPMENT SUMMIT AVENUE WAUKESHA, WISCONSIN PROJECT NO: 1G-2410010	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 921.1 feet		
COMPLETION DATE: 10/23/24		
FIELD REP: DAVIS LUCKETT		

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil: Brown Sandy Silt, trace Organic Matter-Moist		920	1-SS	8				21		
Fill: Brown Sandy Clay, trace Gravel-Moist										
Fill: Brown Clayey fine to medium Sand, little Gravel (Includes Blasted Rock)-Moist			2-SS	20						
	5		3-SS	18						
		915								
			4-SS	22						

Auger Refusal
Boring Terminated at about 9 feet (EL. 912.1')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 6	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 924.6 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/22/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±4" Topsoil: Brown Sandy Silt, trace Organic Matter-Moist			1-SS	8		4.0		18		
Fill: Brown Silty Clay, little Sand and Gravel-Moist			2-SS	14		2.0		21		
Fill: Brown Sandy Clay with Sand and Gravel-Moist	5	920	3-SS	23						
Brown Sandy Clay, trace Gravel (Includes Cobbles and Boulders)-Moist			4-SS	17				12		
	10	915	5-SS	67/2"						(a)

Auger Refusal
Boring Terminated at about 12.5 feet (EL. 912.1')

Water Observation Data	Remarks:
Water Encountered During Drilling:	(a) Poor Sample Recovery
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After Drilling:	
Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 7	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 923.6 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/22/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil: Dark Brown Sandy Silt, trace Organic Matter-Moist			1-SS	6				23		
Fill: Brown Silty Clay, trace Sand and Gravel-Moist			2-SS	16						(a)
Brown Gravelly fine to medium Sand (Includes Cobbles and Boulders)-Moist	5	920	3-SS	20						
Brown Sandy Clay, little Gravel (Includes Cobbles and Boulders)-Moist		915	4-SS	18				11		
	10		5-SS	86						

Auger Refusal
Boring Terminated at about 12.5 feet (EL. 911.1')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	(a) Poor Sample Recovery
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 8	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 924.8 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/22/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil: Dark Brown Silt, trace Organic Matter-Moist			1-SS	8		4.5+		21		
Dark Brown Sandy Clay, little Gravel-Moist			2-SS	24		3.3		24		(a)
Brown Sandy Silt, little Gravel (Includes Cobbles and Boulders)-Moist	5	920	3-SS	29						
Brown Silty Clay, little Sand and Gravel-Moist			4-SS	23						
Brown Sandy Silt, little Gravel (Includes Cobbles and Boulders)-Moist	10	915	5-SS	70						
Brown fine Sand, little Silt and Gravel (includes Cobbles and Boulders)-Moist			6-SS	66						
	15	910	7-SS	56/2"						

Boring Terminated at about 16 feet (EL. 908.8')

Water Observation Data	Remarks:
Water Encountered During Drilling:	(a) Poor Sample Recovery
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After Drilling:	
Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 9	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 928 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/22/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±3" Topsoil: Dark Brown Silty fine Sand, trace Organic Matter-Moist			1-SS	9		3.5		19		
Fill: Brown Sandy Clay, trace Gravel-Moist										
Dark Brown Silt, trace Sand-Moist		925	2-SS	21				19		
Brown Sandy Clay, little Gravel-Moist	5		3-SS	31				9		
Brown Silt, little Sand and Gravel (Includes Cobbles and Boulders)-Moist		920	4-SS	27				13		
	10		5-SS	76				7		

Auger Refusal
Boring Terminated at about 12.5 feet (EL. 915.5')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 10	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 932.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/22/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±6" Topsoil: Dark Brown Silty Clay, trace Sand and Organic Matter-Moist			1-SS	8		1.5		21		
Dark Brown Silty Clay, trace Sand and Organic Matter-Moist		930	2-SS	20		3.5		28		
Brown Sandy Clay, little Gravel (Includes Cobbles and Boulders)-Moist	5		3-SS	29						
		925	4-SS	40						
	10		5-SS	79						

Auger Refusal
Boring Terminated at about 12 feet (EL. 920.1')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	
11		GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 949.4 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/22/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±4" Topsoil: Brown Sandy Silt, trace Organic Matter-Moist			1-SS	5						
Fill: Brown Sandy Clay, trace Gravel-Moist			2-SS	24						
Brown Sandy Clay, little Gravel (Includes Cobbles and Boulders)-Moist	5	945	3-SS	23						
			4-SS	31						
	10	940	5-SS	28						
			6-SS	63						
	15	935	7-SS	25						
Brown Gravelly fine to medium Sand with Silt-Moist	20	930	8-SS	81						
Brown Sandy Clay, trace Gravel-Moist	25	925	9-SS	64						

Boring Terminated at about 26 feet (EL. 923.4')

Water Observation Data	Remarks:
Water Encountered During Drilling:	
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After Drilling:	
Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 12	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 915.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/31/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown Sandy Silt, trace Organic Matter-Moist										
Fill: Brown lean Clay, little Sand-Moist			1-SS	11		2.5		23		
Brown Gravelly fine to medium Sand-Moist			2-SS	18						
Brown Silty fine Sand, little Gravel (Includes Cobbles and Boulders)-Moist	5	910	3-SS	21						
Weathered Limestone Bedrock			4-SS	50/5"						(a)
	10	905	5-SS	50/0"						(a)

Auger Refusal
Boring Terminated at about 12 feet (EL. 903.1')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	(a) Poor Sample Recovery
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
13		
SURFACE ELEVATION: 913 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/31/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
Fill: Brown Sandy Gravel, little Silt-Moist			1-SS	18						
Fill: Crushed Limestone		910	2-SS	--						
Fill: Brown Sandy Clay, little Gravel-Moist	5		3-SS	6						
Weathered Limestone Bedrock		905	4-SS	50/5"						
	10		5-SS	50/2"						

Auger Refusal
Boring Terminated at about 12 feet (EL. 901')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 14	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 911.5 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 10/31/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
Fill: Brown Sandy Clay, little Gravel (includes Cobbles and Boulders)-Moist		910	1-SS	9		2.0		25		
			2-SS	50/0"						(a)
	5		3-SS	8						(b)
		905	4-SS	15						(b)
Brown Gravelly fine to medium Sand with Silt-Moist	10		5-SS	27						
		900								
Brown Silty fine Sand with Gravel-Moist	15		6-SS	20						

Auger Refusal
Boring Terminated at about 16 feet (EL. 895.5')

Water Observation Data	Remarks:
Water Encountered During Drilling:	(a) No SPT Sample Recovery - Auger Sample Obtained
Water Level At End of Drilling:	(b) Poor Sample Recovery
Cave Depth At End of Drilling:	
Water Level After Drilling:	
Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	
15		
SURFACE ELEVATION: 905.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	GILES ENGINEERING ASSOCIATES, INC.
COMPLETION DATE: 10/31/24	SUMMIT AVENUE WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2410010	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
Fill: Brown Sandy Silt with Gravel (includes Cobbles and Boulders)-Moist			1-SS	11				11		
			2-SS	50/4"						(a)
	5	900	3-SS	6						(a)
Brown Sandy Clay, little Gravel-Moist			4-SS	10		2.5		20		
Brown Silty fine Sand, little Gravel-Moist	10	895	5-SS	19						
Brown Sandy Clay, little Gravel-Moist	15	890	6-SS	16				13		(b)

Auger Refusal
Boring Terminated at about 17 feet (EL. 888.1')

Water Observation Data		Remarks:
▽	Water Encountered During Drilling:	(a) Poor Sample Recovery (b) No SPT Sample Recovery - Auger Sample Obtained
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After Drilling:	
	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 2	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 941.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±6" Topsoil: Dark Brown lean Clay, little Sand and Organic Matter-Moist		940	1-SS	5	1.7	2.0		25		
Brown Sandy Silt, little Gravel-Very Moist to Moist			2-SS	5				10		
	5	935	3-SS	17				8		
			4-SS	19				8		
	10	930	5-SS	28						

Auger Refusal
Boring Terminated at about 13.5 feet (EL. 927.6')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 3	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 943.6 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown lean Clay, trace Sand and Organic Matter-Moist			1-SS	6				22		
Brown Sandy Silt, little Gravel-Moist (Includes Cobbles and Boulders)			2-SS	7				8		
		940								
	5		3-SS	11				8		
			4-SS	24						
		935								
	10		5-SS	33						
		930								
	15		6-SS	63						

Auger Refusal
Boring Terminated at about 18.5 feet (EL. 925.1')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	
4		
SURFACE ELEVATION: 945.8 feet	PROPOSED RESIDENTIAL DEVELOPMENT	GILES ENGINEERING ASSOCIATES, INC.
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±6" Topsoil: Dark Brown lean Clay, trace Sand and Organic Matter-Moist		945	1-SS	5		2.0		21		
Brown lean Clay, little Sand-Moist										
Light Brown Sandy Silt, little Gravel-Moist (Includes Cobbles and Boulders)			2-SS	6				11		
	5	940	3-SS	7						(a)
			4-SS	19						
	10	935	5-SS	29						(a)
	15	930	6-SS	50						
Weathered Limestone Bedrock	20	925	7-SS	50/2"						(a)

Boring Terminated at about 21 feet (EL. 924.8')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	(a) Poor Sample Recovery
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 5	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 947.3 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±6" Topsoil: Dark Brown lean Clay, trace Sand and Organic Matter-Moist			1-SS	6	2.9	2.8		22		
Brown lean Clay, trace Sand-Moist		945								
Brown Sandy Silt, little Gravel-Moist (Includes Cobbles and Boulders)			2-SS	5				11		
	5		3-SS	23						
		940	4-SS	25				13		
	10		5-SS	16				9		
		935								
	15		6-SS	42						
		930								
	20		7-SS	59						

Boring Terminated at about 21 feet (EL. 926.3')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 6	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 946.5 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown lean Clay, trace Sand and Organic Matter-Moist										
Brown lean Clay, little Sand-Moist		945	1-SS	7				17		
Brown Sandy Silt, little Gravel-Moist (Includes Cobbles and Boulders)			2-SS	9				9		
	5		3-SS	19				10		
		940	4-SS	28						
	10		5-SS	30						
		935								
	15		6-SS	41						
		930								
	20		7-SS	50/3"`						

Boring Terminated at about 21 feet (EL. 925.5')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 40	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 950 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/28/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown Sandy Clay, little Sand and Organic Matter-Moist			1-SS	5				17		
Brown Sandy Silt, little Gravel-Moist			2-SS	8						
	5	945	3-SS	14						(a)
			4-SS	16						
	10	940	5-SS	18						

Boring Terminated at about 11 feet (EL. 939')

Water Observation Data	Remarks:
Water Encountered During Drilling:	(a) No Recovery - Auger Sample at 3-SS
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After __ Hours: __ ft.	
Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 41	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 950.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/28/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown lean Clay, little Sand and Organic Matter-Moist										
Brown Sandy Silt, little Gravel-Moist			1-SS	6				17		
			2-SS	7				11		
	5	945	3-SS	8				10		
			4-SS	23						
	10	940	5-SS	24						

Boring Terminated at about 11 feet (EL. 939.1')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
42		
SURFACE ELEVATION: 947.4 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown Silty Clay, little Sand and Organic Matter-Moist			1-SS	6				15		
Brown Sandy Silt, little Gravel-Moist		945	2-SS	10				9		
	5		3-SS	10				9		
		940	4-SS	15						
	10		5-SS	22						

Boring Terminated at about 11 feet (EL. 936.4')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	
43		
SURFACE ELEVATION: 947.5 feet	PROPOSED RESIDENTIAL DEVELOPMENT	GILES ENGINEERING ASSOCIATES, INC.
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±6" Topsoil: Dark Brown lean Clay, little Sand and Organic Matter-Moist			1-SS	6						
Brown Sandy Silt, little Gravel-Moist		945	2-SS	7				10		
	5		3-SS	35						
		940	4-SS	22				8		
	10		5-SS	23						
Boring Terminated at about 11 feet (EL. 936.5')										

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 67	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 928.2 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±10" Topsoil: Dark Brown lean Clay, little Sand and Organic Matter-Moist			1-SS	12		1.5		28		
Brown lean Clay, little Sand-Moist										
Weathered Limestone Bedrock										

Auger Refusal
Boring Terminated at about 3 feet (EL. 925.2')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 68	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 930 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown lean Clay, little Sand and Organic Matter-Moist			1-SS	6	1.6	1.8		28		
Brown lean Clay, little Sand-Moist			2-SS	8				24		
Brown Sandy Silt, little Gravel-Moist	5	925	3-SS	50/4"				9		
Weathered Limestone Bedrock										

Auger Refusal
Boring Terminated at about 5.5 feet (EL. 924.5')

Water Observation Data	Remarks:
Water Encountered During Drilling:	
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After __ Hours: __ ft.	
Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 69

SURFACE ELEVATION: 928.1 feet

COMPLETION DATE: 04/26/22

FIELD REP: JAMES BLAIR

TEST BORING LOG

PROPOSED RESIDENTIAL DEVELOPMENT

SUMMIT AVENUE AND MEADOWBROOK ROAD
WAUKESHA, WISCONSIN

PROJECT NO: 1G-2204016

GILES ENGINEERING ASSOCIATES, INC.

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown lean Clay, little Sand and Gravel-Moist			1-SS	5	1.7	2.3		21		
Brown Sandy Silt, little Gravel-Very Moist to Moist		925	2-SS	6		1.3		22		
	5		3-SS	6				11		
Weathered Limestone Bedrock		920	4-SS	50/1"						

Auger Refusal
Boring Terminated at about 8.5 feet (EL. 919.6')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 71	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 932.5 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 05/04/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±10" Topsoil: Dark Brown lean Clay, trace Organic Matter-Moist			1-SS	3		2.0		24		
Brown lean Clay, little Sand-Moist										
Light Brown Sandy Silt, little Gravel-Very Moist		930	2-SS	7				12		
	5		3-SS	11				10		
Light Brown Sandy Silt, little Gravel-Moist (Includes Cobbles and Boulders)		925	4-SS	19						
	10		5-SS	45						

Boring Terminated at about 11 feet (EL. 921.5')

Water Observation Data	Remarks:
Water Encountered During Drilling:	
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After __ Hours: __ ft.	
Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 74	TEST BORING LOG	
SURFACE ELEVATION: 913.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	GILES ENGINEERING ASSOCIATES, INC.
COMPLETION DATE: 05/04/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown Silty Clay, trace Sand and Organic Matter-Moist			1-SS	5				25		
Brown Sandy Clay, trace Gravel-Moist		910	2-SS	7		1.0		29		
Brown Silty fine to medium Sand with Gravel-Moist	5		3-SS	30						

Auger Refusal
Boring Terminated at about 8 feet (EL. 905.1')

	Water Observation Data	Remarks:
∇	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 75	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 906 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 05/04/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Dark Brown Silty Clay, trace Sand and Organic Matter-Moist		905	1-SS	5		1.8		23		
Dark Brown lean Clay, trace Sand and Gravel-Moist			2-SS	9				33		
Brown Sandy Silt with Gravel-Moist (Includes Cobbles and Boulders)	5		3-SS	62						

Auger Refusal
Boring Terminated at about 5.5 feet (EL. 900.5')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
▬	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 76	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 903 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 05/04/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: DAVIS LUCKETT	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±5" Topsoil: Brown lean Clay, little Organic Matter-Moist			1-SS	3				31		
Brown lean Clay, trace Sand-Moist										
Brown Sandy Silt, little Gravel-Moist		900	2-SS	11						
	5		3-SS	7				15		
Weathered Limestone Bedrock			4-SS	50/5"						
		895								

Auger Refusal
Boring Terminated at about 8 feet (EL. 895')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
77		
SURFACE ELEVATION: 906.1 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 05/05/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±6" Topsoil: Dark Brown Sandy lean Clay, trace Organic Matter and Gravel-Moist		905	1-SS	8				17		
Brown Sandy Silt, little Gravel-Moist			2-SS	19						
	5	900	3-SS	11						
			4-SS	43						
	10		5-SS	43				10		

Boring Terminated at about 11 feet (EL. 895.1')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
78		
SURFACE ELEVATION: 909 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 05/05/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±8" Topsoil: Very Dark Brown Silty Clay, trace Sand and Organic Matter-Moist										
Dark Brown Sandy Clay, trace Gravel-Moist			1-SS	6		1.3		27		
Brown Sandy Silt, little Gravel-Very Moist to Wet			2-SS	7				11		
		905								
	5		3-SS	7						
			4-SS	13						
Brown Sandy Silt, little Gravel-Most		900								
	10		5-SS	39						
			6-SS	50/5"						

Auger Refusal
Boring Terminated at about 13 feet (EL. 896')

Water Observation Data	Remarks:
Water Encountered During Drilling:	
Water Level At End of Drilling:	
Cave Depth At End of Drilling:	
Water Level After __ Hours: __ ft.	
Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: 86	TEST BORING LOG	GILES ENGINEERING ASSOCIATES, INC.
SURFACE ELEVATION: 924.5 feet	PROPOSED RESIDENTIAL DEVELOPMENT	
COMPLETION DATE: 04/26/22	SUMMIT AVENUE AND MEADOWBROOK ROAD WAUKESHA, WISCONSIN	
FIELD REP: JAMES BLAIR	PROJECT NO: 1G-2204016	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
±10" Topsoil: Dark Brown lean Clay, little Sand and Organic Matter-Moist			1-SS	6		2.5		21		
Dark Brown lean Clay, little Sand-Moist										
Weathered Limestone Bedrock			2-SS	50/3"		1.8		32		
		920	3-SS	50/0"						

Auger Refusal
Boring Terminated at about 4.5 feet (EL. 920')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling:	
▼	Water Level At End of Drilling:	
	Cave Depth At End of Drilling:	
▼	Water Level After __ Hours: __ ft.	
	Cave Depth After __ Hours: __ ft.	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

APPENDIX B

FIELD PROCEDURES

The field operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) designation D

420 entitled “Standard Guide for Sampling Rock and Rock” and/or other relevant specifications. Soil samples were preserved and transported to *Giles’* laboratory in general accordance with the procedures recommended by ASTM designation D 4220 entitled “Standard Practice for Preserving and Transporting Soil Samples.” Brief descriptions of the sampling, testing and field procedures commonly performed by *Giles* are provided herein.

GENERAL FIELD PROCEDURES

Test Boring Elevations

The ground surface elevations reported on the Test Boring Logs are referenced to the assumed benchmark shown on the Boring Location Plan (Figure 1). Unless otherwise noted, the elevations were determined with a conventional hand-level and are accurate to within about 1 foot.

Test Boring Locations

The test borings were located on-site based on the existing site features and/or apparent property lines. Dimensions illustrating the approximate boring locations are reported on the Boring Location Plan (Figure 1).

Water Level Measurement

The water levels reported on the Test Boring Logs represent the depth of “free” water encountered during drilling and/or after the drilling tools were removed from the borehole. Water levels measured within a granular (sand and gravel) soil profile are typically indicative of the water table elevation. It is usually not possible to accurately identify the water table elevation with cohesive (clayey) soils, since the rate of seepage is slow. The water table elevation within cohesive soils must therefore be determined over a period of time with groundwater observation wells.

It must be recognized that the water table may fluctuate seasonally and during periods of heavy precipitation. Depending on the subsurface conditions, water may also become perched above the water table, especially during wet periods.

Borehole Backfilling Procedures

Each borehole was backfilled upon completion of the field operations. If potential contamination was encountered, and/or if required by state or local regulations, boreholes were backfilled with an “impervious” material (such as bentonite slurry). Borings that penetrated pavements, sidewalks, etc. were “capped” with Portland Cement concrete, asphaltic concrete, or a similar surface material. It must, however, be recognized that the backfill material may settle, and the surface cap may subside, over a period of time. Further backfilling and/or re-surfacing by *Giles’* client or the property owner may be required.

FIELD SAMPLING AND TESTING PROCEDURES

Auger Sampling (AU)

Soil samples are removed from the auger flights as an auger is withdrawn above the ground surface. Such samples are used to determine general soil types and identify approximate soil stratifications. Auger samples are highly disturbed and are therefore not typically used for geotechnical strength testing.

Split-Barrel Sampling (SS) – (ASTM D-1586)

A split-barrel sampler with a 2-inch outside diameter is driven into the subsoil with a 140-pound hammer free-falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the "Standard Penetration Resistance" or N-value is an index of the relative density of granular soils and the comparative consistency of cohesive soils. A soil sample is collected from each SPT interval.

Shelby Tube Sampling (ST) – (ASTM D-1587)

A relatively undisturbed soil sample is collected by hydraulically advancing a thin-walled Shelby Tube sampler into a soil mass. Shelby Tubes have a sharp cutting edge and are commonly 2 to 5 inches in diameter.

Bulk Sample (BS)

A relatively large volume of soils is collected with a shovel or other manually-operated tool. The sample is typically transported to *Giles'* materials laboratory in a sealed bag or bucket.

Dynamic Cone Penetration Test (DC) – (ASTM STP 399)

This test is conducted by driving a 1.5-inch-diameter cone into the subsoil using a 15-pound steel ring (hammer), free-falling a vertical distance of 20 inches. The number of hammer-blows required to drive the cone 1¾ inches is an indication of the soil strength and density, and is defined as "N". The Dynamic Cone Penetration test is commonly conducted in hand auger borings, test pits and within excavated trenches.

- Continued -

Ring-Lined Barrel Sampling – (ASTM D 3550)

In this procedure, a ring-lined barrel sampler is used to collect soil samples for classification and laboratory testing. This method provides samples that fit directly into laboratory test instruments without additional handling/disturbance.

Sampling and Testing Procedures

The field testing and sampling operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the field testing (i.e. N-values) are reported on the Test Boring Logs. Explanations of the terms and symbols shown on the logs are provided on the appendix enclosure entitled “General Notes”.

APPENDIX C

LABORATORY TESTING AND CLASSIFICATION

The laboratory testing was conducted under the supervision of a geotechnical engineer in accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Brief descriptions of laboratory tests commonly performed by *Giles* are provided herein.

LABORATORY TESTING AND CLASSIFICATION

Photoionization Detector (PID)

In this procedure, soil samples are "scanned" in *Giles'* analytical laboratory using a Photoionization Detector (PID). The instrument is equipped with an 11.7 eV lamp calibrated to a Benzene Standard and is capable of detecting a minute concentration of **certain** Volatile Organic Compound (VOC) vapors, such as those commonly associated with petroleum products and some solvents. Results of the PID analysis are expressed in HNu (manufacturer's) units rather than actual concentration.

Moisture Content (w) (ASTM D 2216)

Moisture content is defined as the ratio of the weight of water contained within a soil sample to the weight of the dry solids within the sample. Moisture content is expressed as a percentage.

Unconfined Compressive Strength (qu) (ASTM D 2166)

An axial load is applied at a uniform rate to a cylindrical soil sample. The unconfined compressive strength is the maximum stress obtained or the stress when 15% axial strain is reached, whichever occurs first.

Calibrated Penetrometer Resistance (qp)

The small, cylindrical tip of a hand-held penetrometer is pressed into a soil sample to a prescribed depth to measure the soils capacity to resist penetration. This test is used to evaluate unconfined compressive strength.

Vane-Shear Strength (qs)

The blades of a vane are inserted into the flat surface of a soil sample and the vane is rotated until failure occurs. The maximum shear resistance measured immediately prior to failure is taken as the vane-shear strength.

Loss-on-Ignition (ASTM D 2974; Method C)

The Loss-on-Ignition (L.O.I.) test is used to determine the organic content of a soil sample. The procedure is conducted by heating a dry soil sample to 440°C in order to burn-off or "ash" organic matter present within the sample. The L.O.I. value is the ratio of the weight loss due to ignition compared to the initial weight of the dry sample. L.O.I. is expressed as a percentage.

Particle Size Distribution (ASTB D 421, D 422, and D 1140)

This test is performed to determine the distribution of specific particle sizes (diameters) within a soil sample. The distribution of coarse-grained soil particles (sand and gravel) is determined from a "sieve analysis," which is conducted by passing the sample through a series of nested sieves. The distribution of fine-grained soil particles (silt and clay) is determined from a "hydrometer analysis" which is based on the sedimentation of particles suspended in water.

Consolidation Test (ASTM D 2435)

In this procedure, a series of cumulative vertical loads are applied to a small, laterally confined soil sample. During each load increment, vertical compression (consolidation) of the sample is measured over a period of time. Results of this test are used to estimate settlement and time rate of settlement.

Classification of Samples

Each soil sample was visually-manually classified, based on texture and plasticity, in general accordance with the Unified Soil Classification System (ASTM D-2488-75). The classifications are reported on the Test Boring Logs.

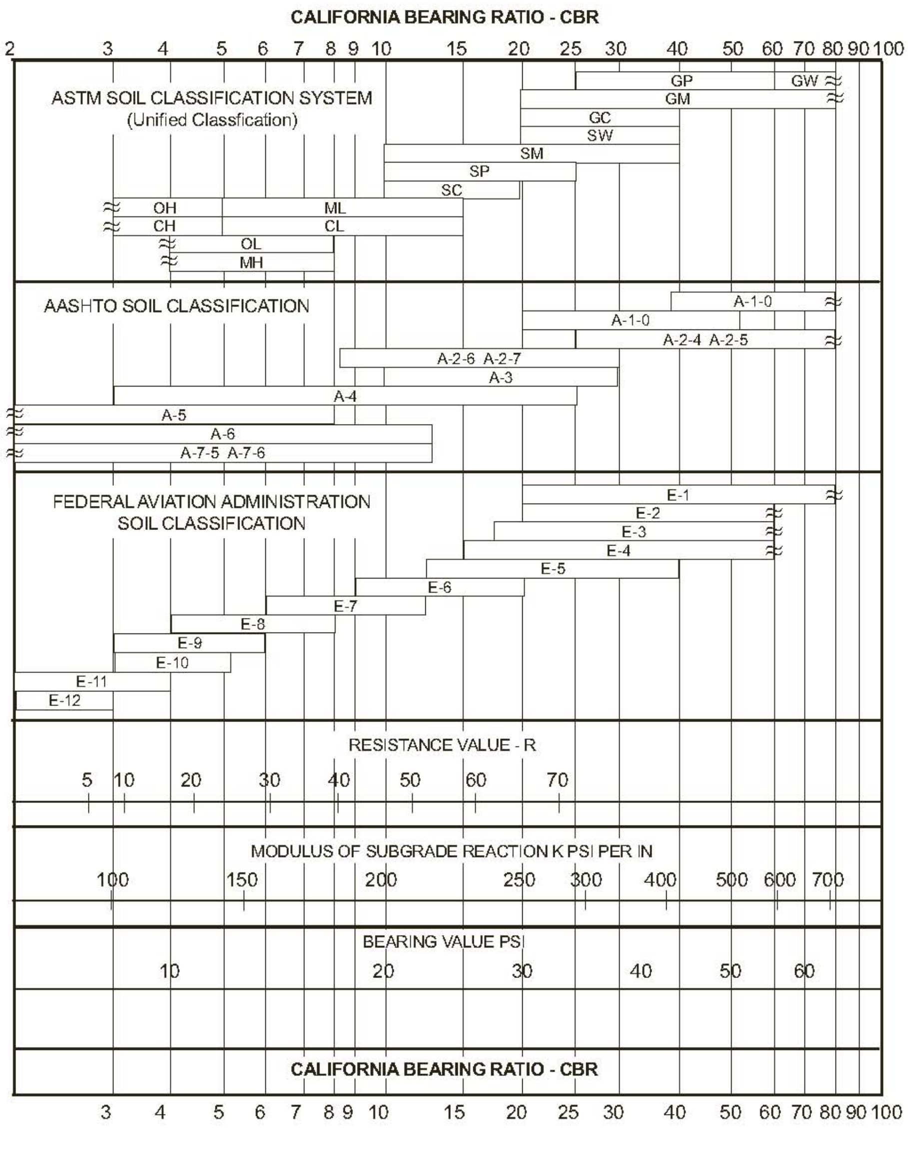
Laboratory Testing

The laboratory testing operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the laboratory tests are provided on the Test Boring Logs or other appendix enclosures. Explanation of the terms and symbols used on the logs is provided on the appendix enclosure entitled "General Notes."

California Bearing Ratio (CBR) Test ASTM D-1833

The CBR test is used for evaluation of a soil subgrade for pavement design. The test consists of measuring the force required for a 3-square-inch cylindrical piston to penetrate 0.1 or 0.2 inch into a compacted soil sample. The result is expressed as a percent of force required to penetrate a standard compacted crushed stone.

Unless a CBR test has been specifically requested by the client, the CBR is estimated from published charts, based on soil classification and strength characteristics. A typical correlation chart is below.



APPENDIX D

GENERAL INFORMATION

AND
IMPORTANT INFORMATION ABOUT
THIS GEOTECHNICAL REPORT

<u>GENERAL COMMENTS</u>

The soil samples obtained during the subsurface exploration will be retained for a period of thirty days. If no instructions are received, they will be disposed of at that time.

This report has been prepared exclusively for the client in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. Copies of this report may be provided to contractor(s), with contract documents, to disclose information relative to this project. The report, however, has not been prepared to serve as the plans and specifications for actual construction without the appropriate interpretation by the project architect, structural engineer, and/or civil engineer. Reproduction and distribution of this report must be authorized by the client and *Giles*.

This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. The project plans and specifications may also be submitted to *Giles* for review to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted.

The analysis of this site was based on a subsoil profile interpolated from a limited subsurface exploration. If the actual conditions encountered during construction vary from those indicated by the borings, *Giles* must be contacted immediately to determine if the conditions alter the recommendations contained herein.

The conclusions and recommendations presented in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

GUIDE SPECIFICATIONS FOR SUBGRADE AND GRADE PREPARATION FOR FILL, FOUNDATION, FLOOR SLAB AND PAVEMENT SUPPORT; AND SELECTION, PLACEMENT AND COMPACTION OF FILL SOILS USING STANDARD PROCTOR PROCEDURES

1. Construction monitoring and testing of subgrades and grades for fill, foundation, floor slab and pavement; and fill selection, placement and compaction shall be performed by an experienced soils engineer and/or his representatives.

2. All compaction fill, subgrades and grades shall be (a) underlain by suitable bearing material; (b) free of all organic, frozen, or other deleterious material, and (c) observed, tested and approved by qualified engineering personnel representing an experienced soils engineer. Preparation of subgrades after stripping vegetation, organic or other unsuitable materials shall consist of (a) proof-rolling to detect soil, wet yielding soils or other unstable materials that must be undercut, (b) scarifying top 6 to 8 inches, (c) moisture conditioning the soils as required, and (d) recompaction to same minimum in-situ density required for similar materials indicated under Item 5. Note: compaction requirements for pavement subgrade are higher than other areas. Weather and construction equipment may damage compacted fill surface and reworking and retesting may be necessary to assure proper performance.

3. In overexcavation and fill areas, the compacted fill must extend (a) a minimum 1 foot lateral distance beyond the exterior edge of the foundation at bearing grade or pavement subgrade and down to compacted fill subgrade on a maximum 0.5(H):1(V) slope, (b) 1 foot above footing grade outside the building, and (c) to floor subgrade inside the building. Fill shall be placed and compacted on a 5(H):1(V) slope or must be stepped or benched as required to flatten if not specifically approved by qualified personnel under the direction of an experienced soil engineer.

4. The compacted fill materials shall be free of deleterious, organic, or frozen matter, shall contain no chemicals that may result in the material being classified as “contaminated”, and shall be low-expansive with a maximum Liquid Limit (ASTM D-423) and Plasticity Index (ASTM D-424) of 30 and 15, respectively, unless specifically tested and found to have low expansive properties and approved by an experienced soils engineer. The top 12 inches of compacted fill should have a maximum 3-inch-particle diameter and all underlying compacted fill a maximum 6-inch-diameter unless specifically approved by an experienced soils engineer. All fill materials must be tested and approved under the direction of an experienced soils engineer prior to placement. If the fill is to provide non-frost susceptible characteristics, it must be classified as a clean GW, GP, SW or SP per the Unified Soil Classification System (ASTM D-2487).

5. For structural fill depths less than 20 feet, the density of the structural compacted fill and scarified subgrade and grades shall not be less than 95 percent of the maximum dry density as determined by Standard Proctor (ASTM-698) with the exception of the top 12 inches of pavement subgrade which shall have a minimum in-situ density of 100 percent of maximum dry density, or 5 percent higher than underlying fill materials. Where the structural fill depth is greater than 20 feet, the portions below 20 feet should have a minimum in-place density of 100 percent of its maximum dry density of 5 percent greater than the top 20 feet. The moisture content of cohesive soil shall not vary by more than -1 to +3 percent and granular soil ±3 percent of the optimum when placed and compacted or recompacted, unless specifically recommended/approved by the soils engineer monitoring the placement and compaction. Cohesive soils with moderate to high expansion potentials (PI>15) should, however, be placed, compacted and maintained prior to construction at a moisture content 3±1 percent above optimum moisture content to limit further heave. The fill shall be placed in layers with a maximum loose thickness of 8 inches for foundations and 10 inches for floor slabs and pavement, unless specifically approved by the soils engineer taking into consideration the type of materials and compaction equipment being used. The compaction equipment should consist of suitable mechanical equipment specifically designed for soil compaction. Bulldozers or similar tracked vehicles are typically not suitable for compaction.

6. Excavation, filling, subgrade and grade preparation shall be performed in a manner and sequence that will provide drainage at all times and proper control of erosion. Precipitation, springs and seepage water encountered shall be pumped or drained to provide a suitable working platform. Springs or water seepage encountered during grading/foundation construction must be called to the soil engineer’s attention immediately for possible construction procedure revision or inclusion of an underdrain system.

7. Non-structural fill adjacent to structural fill should typically be placed in unison to provide lateral support. Backfill along walls must be placed and compacted with care to ensure excessive unbalanced lateral pressures do not develop. The type of fill material placed adjacent to below-grade walls (i.e. basement walls and retaining walls) must be properly tested and approved by an experienced soils engineer with consideration for the lateral pressure used in the wall design.

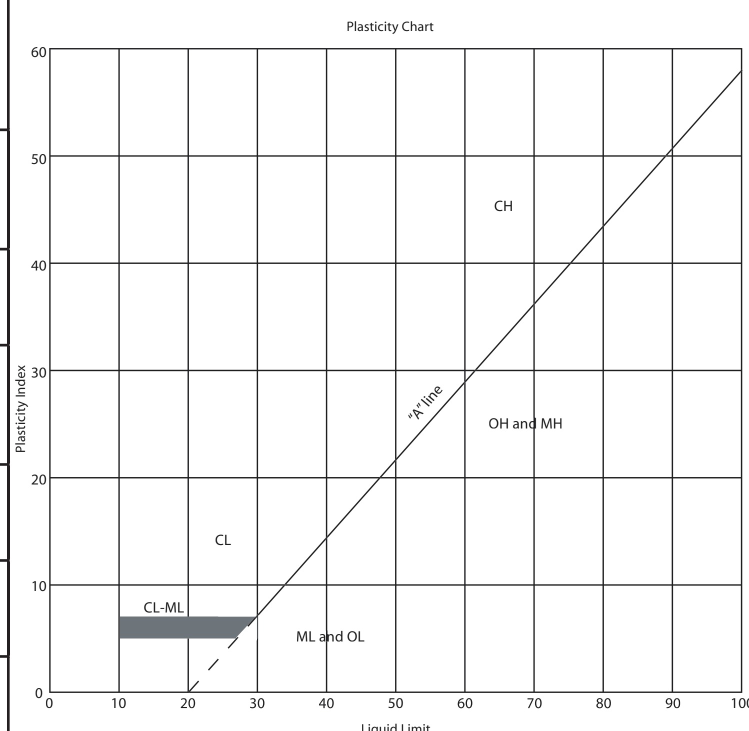
8. Whenever, in the opinion of the soils engineer or the Owner’s Representatives, an unstable condition is being created either by cutting or filling, the work shall not proceed into that area until an appropriate geotechnical exploration and analysis has been performed and the grading plan revised, if found necessary.

CHARACTERISTICS AND RATINGS OF UNIFIED SOIL SYSTEM CLASSES FOR SOIL CONSTRUCTION *									
Class	**Compaction Characteristics**	**Max. Dry Density Standard Proctor (pcf)**	**Compressibility and Expansion**	**Drainage and Permeability**	**Value as an Embankment Material**	**Value as Subgrade When Not Subject to Frost**	**Value as Base Course**	**Value as Temporary Pavement**	
								With Dust Palliative	**With Bituminous Treatment**
GW	Good: tractor, rubber-tired, steel wheel or vibratory roller	125-135	Almost none	Good drainage, pervious	Very stable	Excellent	Good	Fair to poor	Excellent
GP	Good: tractor, rubber-tired, steel wheel or vibratory roller	115-125	Almost none	Good drainage, pervious	Reasonably stable	Excellent to good	Poor to fair	Poor	
GM	Good: rubber-tired or light sheepsfoot roller	120-135	Slight	Poor drainage, semipervious	Reasonably stable	Excellent to good	Fair to poor	Poor	Poor to fair
GC	Good to fair: rubber-tired or sheepsfoot roller	115-130	Slight	Poor drainage, impervious	Reasonably stable	Good	Good to fair **	Excellent	Excellent
SW	Good: tractor, rubber-tired or vibratory roller	110-130	Almost none	Good drainage, pervious	Very stable	Good	Fair to poor	Fair to poor	Good
SP	Good: tractor, rubber-tired or vibratory roller	100-120	Almost none	Good drainage, pervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SM	Good: rubber-tired or sheepsfoot roller	110-125	Slight	Poor drainage, impervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SC	Good to fair: rubber-tired or sheepsfoot roller	105-125	Slight to medium	Poor drainage, impervious	Reasonably stable	Good to fair	Fair to poor	Excellent	Excellent
ML	Good to poor: rubber-tired or sheepsfoot roller	95-120	Slight to medium	Poor drainage, impervious	Poor stability, high density required	Fair to poor	Not suitable	Poor	Poor
CL	Good to fair: sheepsfoot or rubber-tired roller	95-120	Medium	No drainage, impervious	Good stability	Fair to poor	Not suitable	Poor	Poor
OL	Fair to poor: sheepsfoot or rubber-tired roller	80-100	Medium to high	Poor drainage, impervious	Unstable, should not be used	Poor	Not suitable	Not suitable	Not suitable
MH	Fair to poor: sheepsfoot or rubber-tired roller	70-95	High	Poor drainage, impervious	Poor stability, should not be used	Poor	Not suitable	Very poor	Not suitable
CH	Fair to poor: sheepsfoot roller	80-105	Very high	No drainage, impervious	Fair stability, may soften on expansion	Poor to very poor	Not suitable	Very poor	Not suitable
OH	Fair to poor: sheepsfoot roller	65-100	High	No drainage, impervious	Unstable, should not be used	Very poor	Not suitable	Not suitable	Not suitable
Pt	Not suitable		Very high	Fair to poor drainage	Should not be used	Not suitable	Not suitable	Not suitable	Not suitable

* "The Unified Classification: Appendix A - Characteristics of Soil, Groups Pertaining to Roads and Airfields, and Appendix B - Characteristics of Soil Groups Pertaining to Embankments and Foundations," Technical Memorandum 357, U.S. Waterways Ixperiment Station, Vicksburg, 1953.

** Not suitable if subject to frost.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			*Group Symbols*	*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (more than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent: GW, GP, SW, SP; More than 12 percent: GM, GC, SM, SC; 5 to 12 percent: *Borderline* cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtrues, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (appreciable amount of fines)	GM[a] d / u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a] d / u	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve size)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt	Peat and other highly organic soils			

[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits, suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u is used when L.L. is greater than 28.
[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group sympols. For example GW-GC, well-graded gravel-sand mixture with clay binder.

GENERAL NOTES

SAMPLE IDENTIFICATION

All samples are visually classified in general accordance with the Unified Soil Classification System (ASTM D-2487-75 or D-2488-75)

DESCRIPTIVE TERM (% BY DRY WEIGHT)

Trace:	1-10%
Little:	11-20%
Some:	21-35%
And/Adjective	36-50%

PARTICLE SIZE (DIAMETER)

Boulders:	8 inch and larger
Cobbles:	3 inch to 8 inch
Gravel:	coarse - ¾ to 3 inch
	fine – No. 4 (4.76 mm) to ¾ inch
Sand:	coarse – No. 4 (4.76 mm) to No. 10 (2.0 mm)
	medium – No. 10 (2.0 mm) to No. 40 (0.42 mm)
	fine – No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt:	No. 200 (0.074 mm) and smaller (non-plastic)
Clay:	No 200 (0.074 mm) and smaller (plastic)

SOIL PROPERTY SYMBOLS

Dd:	Dry Density (pcf)
LL:	Liquid Limit, percent
PL:	Plastic Limit, percent
PI:	Plasticity Index (LL-PL)
LOI:	Loss on Ignition, percent
Gs:	Specific Gravity
K:	Coefficient of Permeability
w:	Moisture content, percent
qp:	Calibrated Penetrometer Resistance, tsf
qs:	Vane-Shear Strength, tsf
qu:	Unconfined Compressive Strength, tsf
qc:	Static Cone Penetrometer Resistance (correlated to Unconfined Compressive Strength, tsf)
PID:	Results of vapor analysis conducted on representative samples utilizing a Photoionization Detector calibrated to a benzene standard. Results expressed in HNU-Units. (BDL=Below Detection Limit)
N:	Penetration Resistance per 12 inch interval, or fraction thereof, for a standard 2 inch O.D. (1⅜ inch I.D.) split spoon sampler driven with a 140 pound weight free-falling 30 inches. Performed in general accordance with Standard Penetration Test Specifications (ASTM D-1586). N in blows per foot equals sum of N-Values where plus sign (+) is shown.
Nc:	Penetration Resistance per 1¾ inches of Dynamic Cone Penetrometer. Approximately equivalent to Standard Penetration Test N-Value in blows per foot.
Nr:	Penetration Resistance per 12 inch interval, or fraction thereof, for California Ring Sampler driven with a 140 pound weight free-falling 30 inches per ASTM D-3550. Not equivalent to Standard Penetration Test N-Value.

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon
ST:	Shelby Tube – 3 inch O.D. (except where noted)
CS:	3 inch O.D. California Ring Sampler
DC:	Dynamic Cone Penetrometer per ASTM Special Technical Publication No. 399
AU:	Auger Sample
DB:	Diamond Bit
CB:	Carbide Bit
WS:	Wash Sample
RB:	Rock-Roller Bit
BS:	Bulk Sample
Note:	Depth intervals for sampling shown on Record of Subsurface Exploration are not indicative of sample recovery, but position where sampling initiated

SOIL STRENGTH CHARACTERISTICS

COHESIVE (CLAYEY) SOILS

COMPARATIVE CONSISTENCY	BLOWS PER FOOT (N)	UNCONFINED COMPRESSIVE STRENGTH (TSF)
Very Soft	0 - 2	0 - 0.25
Soft	3 - 4	0.25 - 0.50
Medium Stiff	5 – 8	0.50 - 1.00
Stiff	9 – 15	1.00 - 2.00
Very Stiff	16 – 30	2.00 - 4.00
Hard	31+	4.00+

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	BLOWS PER FOOT (N)
Very Loose	0 - 4
Loose	5 - 10
Firm	11 - 30
Dense	31 - 50
Very Dense	51+

DEGREE OF PLASTICITY	PI
None to Slight	0 - 4
Slight	5 - 10
Medium	11 - 30
High to Very High	31+

DEGREE OF EXPANSIVE POTENTIAL	PI
Low	0 - 15
Medium	15 - 25
High	25+

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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