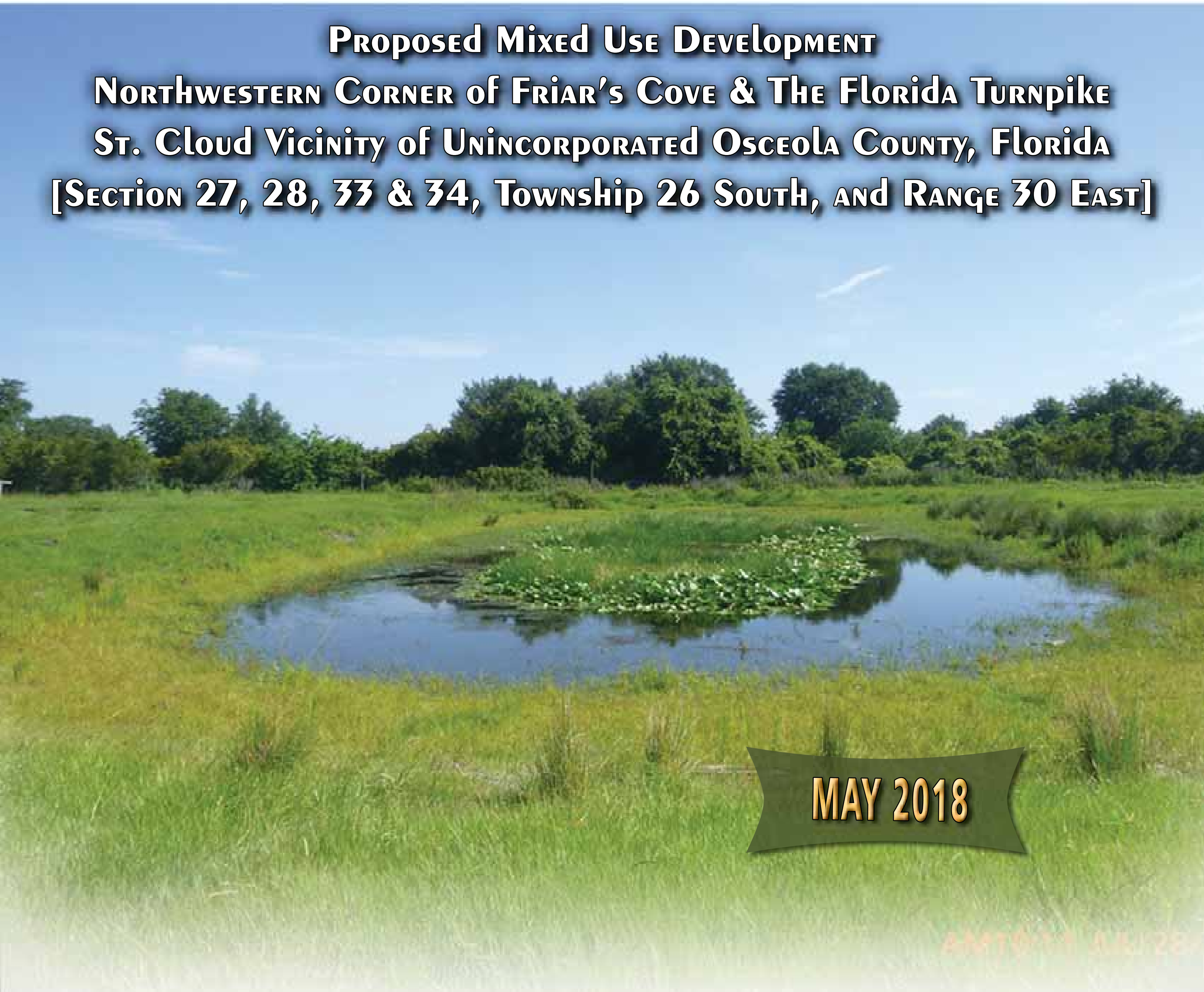
DESIGN-LEVEL GEOTECHNICAL ENGINEERING REPORT

FONTANA



Proposed Mixed Use Development
Northwestern Corner of Friar's Cove & The Florida Turnpike
St. Cloud Vicinity of Unincorporated Osceola County, Florida
[Section 27, 28, 33 & 34, Township 26 South, and Range 30 East]

MAY 2018

Prepared by

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Date: May 4, 2018

Devo's Project No: 17-585.16

To:

AMICK CONSTRUCTION
401 Ferguson Drive
Orlando, FL 32805
phone: 407-293-6562

attention: Jeff Fuqua, President

Re:

DESIGN-LEVEL GEOTECHNICAL ENGINEERING REPORT
FONTANA
Proposed Mixed Use Development
Northwestern Corner of Friar's Cove Road & The Florida Turnpike
St. Cloud Vicinity of Unincorporated Osceola County, Florida
[Section 27, 28, 33 &34, Township 26 South, and Range 30 East]

Dear Mr. Fuqua:

Attached is our design level geotechnical engineering report for the proposed Fontana Development.

Also included in our report are estimates of the seasonal high water table, recommendations for pond control elevations, borrow suitability assessment, recommendations for demucking/backfill of areas containing surficial organic soils, recommendation for mass grading, roadway pavement sections, sewer and other utility trenches and testing, and foundation recommendations for typical single-family residential structures.

We trust that the geotechnical data, assessment and recommendations in this report are responsive to the needs of Amick Construction, the design engineer, and the reviewing/permitting agencies.

Feel free to contact us if there are any questions regarding this report.

Sincerely,

Devo Seereeram

Devo Seereeram, Ph.D., P.E.
Florida Registration No. 48303
Date: May 4, 2018

TABLE OF CONTENTS

Page No

TABLE OF CONTENTS (CONTINUED)

Page No

List of Exhibits

List of Tables

TABLE OF CONTENTS (CONTINUED)

List of Attached Figures

General Figures

Soil Profiles - SPT Pond Borings (30 ft deep)

Soil Profiles - Site-Wide Borings (up to 10 ft deep)

TABLE OF CONTENTS (CONTINUED)

List of Attached Figures (continued)

Soil Profiles - Site-Wide Borings (up to 10 ft deep) (continued)

Muck Probe Data

1.0 BACKGROUND

The proposed Fontana Development is a mixed use development consisting of a number of single and multifamily units, a school, commercial areas, several stormwater ponds, roadways and associated infrastructure. Fontana's proposed location is at the northwestern corner of Friar's Cove Road and The Florida Turnpike. The site is within the St. Cloud vicinity of unincorporated Osceola County, Florida [Sections 27, 28, 33 &34, Township 26 South, Range 30 East]. Figures 1.1 to 1.5 (attached) are a series of project base maps with the following content:

Figure 1.1a	Site Boundary on USGS Quadrangle Map
Figure 1.1b	Zoom In View - Site Boundary on USGS Quadrangle Map
Figure 1.2	2016 Aerial Map with Test Locations
Figure 1.3	1944 Aerial Map with Test Locations
Figure 1.4	NRCS Soil Map
Figure 1.5	Pond Borrow Suitability Indexes
Figure 1.6	Seasonal High Water Table Contours

The land cover currently consists of pasture, scattered trees and some abandoned citrus groves. The 1944 land cover is shown in Figure 1.3, and the wetlands appear mostly unchanged. Based on information shown on the topographical map provided the eastern portion of the site is nearly level and western portion gently slopes towards the west and southwest. Ground elevations range generally from +55 to +70 ft NAVD.

2.0 OBJECTIVES

The objectives of this investigation are to provide the following data and parameters for design and permitting:

Site-Wide

- Seasonal high water table contour map.
- Mass grading recommendations for the residential development {to prevent perched water conditions and other types of yard wetness}.
- Foundation recommendations for the proposed single-family residential structures.

Roadways

- Soil stratigraphy (and muck thickness, if any) along the roadway alignment in accordance with typical Osceola County requirements, together with measured water table depths and seasonal high water table estimates.
- Assessment of roadway stations requiring underdrains which will be performed when the profile grade lines are provided by the project civil engineer.
- Pavement thickness design

Ponds, Drainage

- Borrow suitability assessment.
- Seasonal high, seasonal low, and average wet season water table elevations for each pond.
- Berm stability analyses as necessary.
- Storm Sewer & Structure Earthwork Recommendations.

A SFWMD construction dewatering plan is not included at this stage but can be provided upon request.

3.0 NRCS SOIL MAP UNITS

The United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) has mapped and published descriptions of the shallow soils (i.e., soils within 80 inches of land surface) in Osceola County (Fl). In undeveloped areas without established drainage systems and impervious cover, the NRCS soil mapping is usually fairly reliable and it is prudent practice to compare the site-specific soil and ground water data with the corresponding NRCS soil/water table characterization profiles. Figure 1.4 shows the NRCS soil map units within the overall site and the Fontana site boundaries. As noted in this figure, there are ten (10) NRCS soil map units within the site and these are grouped according to their drainage characteristics as follows:

Moderately Well Drained Soils

- ❏ Narcoossee fine sand (#24)

Poorly Drained Soils

- ❏ Basinger fine sand, 0 to 2% slopes (#5)
- ❏ Basinger fine sand, depressional, 0 to 1% slopes (#6)
- ❏ Immokalee fine sand, 0 to 2% slopes (#16)
- ❏ Myakka fine sand, 0 to 2% slopes (#22)
- ❏ Ona fine sand, 0 to 2% slopes (#27)
- ❏ Smyrna fine sand, 0 to 2% slopes (#42)

Very Poorly Drained Soils

- ❏ Delray loamy fine sand, depressional (#10)
- ❏ Placid fine sand, frequently ponded, 0 to 1% slopes (#32)
- ❏ Samsula muck, frequently flooded, 0 to 1% slopes (#40)

Key characteristics of these NRCS soil map units are summarized for each soil type in Tables 1 through 10.

Table 1. Key NRCS Data for Narcoossee fine sand (#24)

<table>
<tr><td colspan="3">This is a moderately well drained, nearly level soil on low ridges and knolls in the flatwoods. This soil has a water table at a depth of 24 to 40 inches for 4 to 6 months in most years. It recedes to a depth of more than 60 inches in extended dry periods.</td></tr>
<tr><td colspan="2">Hydrologic Soil Group</td><td>C</td></tr>
<tr><td colspan="3">Typical Soil Profile</td></tr>
<tr><td>Depth</td><td>Soil Color & Texture</td><td>Permeability</td></tr>
<tr><td>0 - 5 in</td><td>very dark gray fine sand</td><td rowspan="3">12 to 40 ft/day</td></tr>
<tr><td>5 - 9 in</td><td>gray fine sand</td></tr>
<tr><td>9 - 22 in</td><td>light gray fine sand</td></tr>
<tr><td>22 - 26 in</td><td>dark reddish brown and dark brown fine sand weakly cemented with organic matter</td><td>4 to 12 ft/day</td></tr>
<tr><td>26 - 36 in</td><td>yellowish brown fine sand with dark yellowish brown mottles</td><td rowspan="3">12 to 40 ft/day</td></tr>
<tr><td>36 - 62 in</td><td>light gray fine sand with yellowish brown mottles</td></tr>
<tr><td>62 - 80 in</td><td>pale brown fine sand</td></tr>
</table>

Table 2. Key NRCS Data for Basinger fine sand, 0 to 2% slopes (#5)

<table>
<tr><td colspan="3">This is a poorly drained, nearly level soil in low, broad flats and sloughs in the flatwoods. Areas of this soil are elongated in most places and range from about 4 to 300 acres. Slopes are smooth to concave and range from 0 to 2 percent. The soil has a water table at a depth of less than 10 inches for 2 to 6 months during most years and at a depth of 10 to 30 inches during the dry season in most years. In extended dry periods, the water table drops below a depth of 40 inches.</td></tr>
<tr><td colspan="2">Hydrologic Soil Group</td><td>A/D</td></tr>
<tr><td colspan="3">Typical Soil Profile</td></tr>
<tr><td>Depth</td><td>Soil Color & Texture</td><td>Permeability</td></tr>
<tr><td>0 - 4 in</td><td>black fine sand</td><td rowspan="6">> 40.0 ft/day</td></tr>
<tr><td>4 -7 in</td><td>dark gray fine sand</td></tr>
<tr><td>7 - 19 in</td><td>light gray fine sand</td></tr>
<tr><td>19 - 35 in</td><td>dark brown fine sand</td></tr>
<tr><td>35 - 58 in</td><td>light gray fine sand</td></tr>
<tr><td>58 - 80 in</td><td>brown fine sand</td></tr>
</table>

Table 3. Key NRCS Data for Basinger fine sand, depressional, 0 to 1% slopes (#6)

This is a poorly drained, nearly level soil in shallow depressions and poorly defined drainageways in the flatwoods. Areas of this soil are circular or elongated in most places and generally range from about 4 to 190 acres. Slopes are flat to concave and range from 0 to 2 percent. Water stands on the surface for 6 to 12 months during most years.		
Hydrologic Soil Group		A/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 4 in	black fine sand	> 40 ft/day
4 - 7 in	dark gray fine sand	
7 - 19 in	light gray fine sand	
19 - 35 in	dark brown fine sand	
35 - 58 in	light gray fine sand	
58 - 80 in	brown fine sand	

Table 4. Key NRCS Data for Immokalee fine sand, 0 to 2% slopes (#16)

This is a poorly drained nearly level soil in broad flatwoods areas. The water table is at a depth of less than 10 inches for 2 months in most years and within a depth of 10 to 40 inches for 8 months or more in most years. It is a depth of more than 40 inches during dry periods.		
Hydrologic Soil Group		A/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 7 in	very dark gray fine sand	12 to 40 ft/day
7 - 13 in	light gray fine sand	
13 - 37 in	white fine sand with faint brown mottles	
37 - 41 in	black fine sand weakly cemented by organic matter	1.2 to 12 ft/day
41 - 47 in	dark reddish brown with reddish yellow and black mottles	
47 - 65 in	dark brown fine sand with reddish yellow and dark brown mottles	12 to 40 ft/day
65 - 80 in	dark grayish brown fine sand	

Table 5. Key NRCS Data for Myakka fine sand, 0 to 2% slopes (#22)

This is a poorly drained, nearly level soil in broad areas in the flatwoods. The water table is at a depth of less than 10 inches for 1 to 4 months in most years and a depth of more than 40 inches during very dry seasons.		
Hydrologic Soil Group		A/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 7 in	very dark gray fine sand	12 to 40 ft/day
7 - 27 in	light gray fine sand	
27 - 33 in	black fine sand weakly cemented with organic matter	1.2 to 12 ft/day
33 - 37 in	dark reddish brown and very dark gray fine sand weakly cemented with organic matter	
37 - 43 in	dark yellowish brown fine	12 to 40 ft/day
43 - 70 in	light yellowish brown fine sand	
70 - 80 in	dark reddish brown fine sand	

Table 6. Key NRCS Data for Ona fine sand, 0 to 2% slopes (#27)

This soil is nearly level and poorly drained. It is in broad flat areas in the flatwoods between swamps and marshes or in long, narrow bands bordering depressions ans drainageways. In most years, a seasonal high water table is within 10 inches of the surface for 1 month to 2 months. It recedes to a depth of 10 to 40 inches for periods of 6 months or more.		
Hydrologic Soil Group		B/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 6 in	Black fine sand	12 to 40 ft/day
6 - 15 in	Dark reddish brown fine sand	1.2 to 4 ft/day
15 - 18 in	Dark brown fine sand	12 to 40 ft/day
18 - 27 in	Pale brown mottled fine sand	
27 - 42 in	Gray mottled fine sand	
42 - 80 in	Very pale brown fine sand	

Table 7. Key NRCS Data for Delray loamy fine sand, depressional (#10)

This is a very poorly drained nearly level soil in depressions in the flatwoods and at the edges of large lakes that have fluctuating water levels. Water stands on the surface for 2 to 6 months in most years and is within a depth of 10 inches for 6 to 9 months in most years.		
Hydrologic Soil Group		A/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 14 in	black loamy fine sand	12 to 40 ft/day
14 - 44 in	gray fine sand	
44 - 50 in	dark gray fine sandy loam mottled with pale brown	1.2 to 12 ft/day
50 - 62 in	dark grayish brown sandy clay loam that has yellowish brown mottles	
62 - 80 in	grayish brown loamy fine sand mottled with brownish yellow	4 to 12 ft/day

Table 8. Key NRCS Data for Placid fine sand, frequently ponded, 0 to 1% slopes (#32)

This is a very poorly drained, nearly level soil in low, wet depressions and swamps in the flatwoods. Water stands on the surface for 6 to 9 months or more in most years.		
Hydrologic Soil Group		C
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 14 in	black fine sand with pockets of light gray fine sand	12 to 40 ft/day
14 - 24 in	very dark gray fine sand with pockets of light fine gray	
24 - 36 in	light brownish gray fine sand with mottles and stains of dark grayish brown	
36 - 80 in	light gray fine sand with mottles of gray and brown	

Table 9. Key NRCS Data for Samsula muck, frequently flooded, 0 to 1% slopes (#40)

This is a nearly level, very poorly drained, organic soil in freshwater marshes and swamps. The soil has a water table at or above the surface except during extended dry periods.		
Hydrologic Soil Group		B/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 8 in	Dard reddish brown muck.	12 to 40 ft/day
8 - 14 in	Black muck.	
14 - 31 in	Black fine sand with lenses of light gray fine sand.	
31 - 80 in	Grayish brown fine sand mottled with dark grayish brown fine sand to a depth of 65 inches or more.	

Table 10. Key NRCS Characterization Data for Smyrna fine sand (#42)

This is a nearly level, poorly drained soil in broad flat areas in the flatwoods. The water table is at a depth of less than 10 inches for 1 to 4 months and between depths of 10 and 40 inches for more than 6 months in most years. In rainy seasons the water table rises above the surface briefly.		
Hydrologic Soil Group		A/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 4 in	black fine sand	12 to 40 ft/day
4 - 7 in	dark gray fine sand	
7 - 14 in	light gray fine sand	
14 - 17 in	black fine sand weakly cemented with organic matter	1.2 to 12 ft/day
17 - 20 in	dark reddish brown fine sand weakly cemented with organic matter	
20 - 25 in	brown fine sand	
25 - 43 in	light gray fine sand	12 to 40 ft/day
43 - 56 in	grayish brown fine sand	
56 - 69 in	dark reddish brown fine sand	1.2 to 12 ft/day
69 - 80 in	dark reddish brown and black fine sand	

4.0 GEOTECHNICAL INVESTIGATION

The scope of our field and laboratory testing included the following:

❶ Site reconnaissance by our site geotechnical engineer and senior engineering technician.

❷ Fifty-eight (58) power auger borings to depth of 30 ft within the footprint of the proposed ponds to assess the suitability of the soils for use as fill. The locations of these borings are shown in attached Figure 1.2, labeled PB-1 through PB-58.

❸ One hundred and three (103) hand auger borings to depths of up to 10 ft at site-wide locations. The locations of these borings are shown in attached Figure 1.2, labeled HA-1 through HA-103.

❹ Muck probing in seven (7) areas suspected of containing surficial organics. These areas are labeled Muck Probe Area 1 through Muck Probe Area 7, as shown in the key sheets in Figures 4.1 to 4.7. The methology and limitations of the muck probe procedure is presented Exhibit 1.

❺ Installation of piezometers and measurements of the depth to stabilized ground water table in each of the boreholes.

❻ Visual & tactile examination and classification of soil samples.

❼ Numerous fines fraction tests on selected soil samples from the fifty-eight (58) pond borings. These tests are used to assess the suitability of the soils for use as fill material.

The field work was undertaken over the period May 22 to July 24, 2017, with frequent interruptions due to rain. The stabilized water table was measured in the piezometers over the period, July 21 to 22, 2017. Borings were staked out in the field and the elevations surveyed by Donald W McIntosh Associates, Inc.

NOTE:
The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.

Exhibit 1. Limitations of muck probe procedure

5.0 GEOTECHNICAL DATA

5.1 Presentation of Data

The data obtained from our field investigation is presented on the attached figures, including:

① Boring locations are shown in Figure 1.2 (and also in Figure 1.3).

② Graphic soil profiles for the deep pond borings (PB series) are presented in Figures 2.1 to 2.17. {Figure 2.18 contains additional deep borings which are no longer within the pond footprints due to changes in the proposed pond configurations.}

③ Graphic soil profiles for the shallow site-wide borings (HA series) are presented in Figures 3.1 to 3.21.

④ Muck probe data for Muck Probe Areas 1 to 7 are presented in Figures 4.1 to 4.7.

⑤ Water table depth measurements and laboratory test data are annotated adjacent to the soil profiles (in Figures 2.1 to 2.17 and Figures 3.1 to 3.21). Contours of the estimated seasonal high groundwater water table (in feet NAVD) are shown in Figures 1.6.

5.2 Surficial and Buried Organics

Surficial organics were disclosed at four (4) of the fifty-eight (58) pond boring locations, PB-23 and P4-24 (see Figure 2.4), PB-55 and PB-58 (see Figure 2.18). The surficial organics were in the form of muck and organic sand, 0.5 to 2 ft thick.

Of the one hundred and three (103) hand auger borings drilled, surficial muck was disclosed at three (3) locations, HA-48, HA-59 and HA-65. The muck thickness ranged from 0.5 ft to 1.5 ft. In addition, boring HA-78 disclosed 0.5 ft of surficial organic sand.

No buried layers of organics were disclosed at any of the boring locations drilled in this investigation.

Muck Probe Data - Area #1
Nine (9) probes were made within Muck probe Area #1, located in the southeast quadrant of the site, as shown in Figure 4.1. No surficial organics were disclosed, and standing water was not present at any of the probe locations at Area #1 on the date of probing, August 4, 2017.

Muck Probe Data - Area #2
A total of eighteen (18) probes were made within Muck probe Area #2, located in the southwest quadrant of the site, as shown in Figure 4.2. No surficial organics were disclosed at any of the probe locations. Standing water, 2" to 6" deep, was present at six (6) of the probe locations on the date of probing, August 4, 2017.

Muck Probe Data - Area #3
Eleven (11) probes were made within Muck probe Area #3, located in the west central west sector of the site, as shown in Figure 4.3. No surficial organics were disclosed at any of the probe locations. Standing water, 2" to 6" deep, was present at eight (8) of the probe locations on the date of probing, August 4, 2017.

Muck Probe Data - Area #4
Fifteen (15) probes were made within Muck probe Area #4, located in the northeast quadrant of the site, as shown in Figure 4.4. No surficial organics were disclosed at any of the probe locations. Standing water, 2" to 3" deep, was present at four (4) of the probe locations on the date of probing, August 4, 2017.

Muck Probe Data - Area #5
A total of sixty-six (66) probes were made within Muck probe Area #5, located in the east central sector of the site, as shown in Figure 4.5. Surficial organics were disclosed at forty-seven (47) of the probe locations, in the form of muck 5" to 60" thick. Standing water, 2" to 12" deep, was present at twenty-seven (27) of the probe locations on the date of probing, August 14, 2017.

Muck Probe Data - Area #6
Seven (7) probes were made within Muck probe Area #6, located in the northwest quadrant of the site, as shown in Figure 4.6. No surficial organics or standing water were disclosed at any of the probe locations on the date of probing, August 14, 2017.

Muck Probe Data - Area #7
Six (6) probes were made at selected spot location in the western portion of the site, as shown in Figure 4.7. Surficial organics were disclosed at all six (6) of the probe locations, in the form of muck 6" to 24" thick. No standing water was present at any of the probe locations on the date of probing, August 14, 2017.

5.3 Soil Stratigraphy

Site-Wide Hand Auger Borings
The shallow site-wide hand auger borings (Figures 3.1 to 3.21) generally disclosed various shades of brown and gray fine sand to slightly silty fine sand through to the depth of exploration (10 feet deep maximum), with occasional silty sands and some thin buried layers of cemented sand and clayey fine sands at a few boring locations.

Surficial muck deposits were encountered at HA-48 (Figure 3.10), HA-59 (Figure 3.12) and HA-65 (Figure 3.13) ranging from 0.5 to 1.5 ft thick.

Pond Borings
The deeper boring performed in the proposed pond footprints are shown in attached Figures 2.1 to 2.18. The borings on these figures are arranged by individual pond locations, and Table 11 provides a reference between boring numbers and figure numbers. In general, the soils disclosed at these boring locations ranged from sands to slightly silty sands to silty fine sand to clayey fine sand. The suitability of the soils for use as site fill is indicated on the boring profiles, adjacent to each boring (as indicated by a colored index scale).

The general suitability of the soils at each individual boring locations for use as site fill is also shown in attached Figure 1.5. In this figure, each boring is assigned an index value which is based on the quantity and quality of the excavated material at that location. As seen in Figure 1.5, the areas which should provide the greatest quantities of useable fill are located on the eastern and north-central portions of the site.

Table 11. Pond Boring Index Table

Pond Number	Figure Number	Boring Numbers
SMA-1	Figure 2.1	PB-49, PB-50, PB-51
	Figure 2.2	PB-52, PB-53, PB-54
SMA-2	Figure 2.3	PB-15, PB-16, PB-17
SMA-3	Figure 2.4	PB-18, PB-19, PB-23, PB-24, PB-25
SMA-4	Figure 2.5	PB-3, PB-7, PB-8
SMA-5	Figure 2.6	PB-12, PB-13, PB-14
SMA-6	Figures 2.7 & 2.18	PB-4, PB-20, PB-21, PB-22
SMA-7	Figure 2.8	PB-1
SMA-8	Figure 2.9 & 2.5	PB-8, PB-9, PB-10, PB-11
SMA-9	Figure 2.10	PB-2
SMA-10	Figure 2.11	PB-28, PB-29, PB-30, PB-31
SMA-11	Figure 2.12	PB-5, PB-6
SMA-12	Figure 2.13	PB-41, PB-42, PB-43, PB-44
SMA-13	Figure 2.14	PB-45, PB-46, PB-47, PB-48
SMA-14	Figure 2.15	PB-32, PB-33, PB-34, PB-35
SMA-15	Figure 2.16	PB-36, PB-37, PB-38, PB-39, PB-40
SMA-16	Figure 2.17	PB-26, PB-27
N.A. [1]	Figure 2.18	PB-20, PB-55, PB-56, PB-57, PB-58

Notes:

1. May not be within a pond footprint due to changes in layout

5.4 Water Table

The measured depths to the stabilized ground water table, measured on July 22 and July 24, 2017, ranged from above surface (1.0 ft of standing water) to a depth of about 6.1 ft below ground surface. Water table depth and elevation measurements are summarized in Table 12, and are also annotated adjacent to the soil profiles in Figures 2.1 to 2.18 and 3.1 to 3.21.

A contour map of the estimated elevation of the seasonal high ground water table is presented in Figure 1.6.

Table 12. Measured Water Table Elevations and Seasonal High Estimates

Boring No.	Ground Surface Elevation (ft NAVD)	Measured Water Table {July 24, 2017}		Estimated SHWT Elevation (ft NAVD)
		Depth Below Ground (ft)	Elevation (ft NAVD)	
SITE-WIDE HAND AUGER BORINGS				
HA-1	55.7	0.1	55.6	55.6
HA-2	56.1	0.2	55.9	55.9
HA-3	62.0	4.0	58.0	58.0
HA-4	62.0	3.2	58.8	58.8
HA-5	65.4	5.6	59.8	59.8
HA-6	63.5	3.8	59.7	59.7
HA-7	61.8	1.3	60.5	60.5
HA-8	56.2	0.0	56.2	56.2
HA-9	58.9	1.8	57.1	57.1
HA-10	62.2	3.8	58.4	58.4
HA-11	63.9	4.6	59.3	59.3
HA-12	65.3	5.3	60.0	60.0
HA-13	65.8	5.1	60.7	60.7
HA-14	64.8	4.7	60.1	60.1
HA-15	63.7	3.1	60.6	60.6
HA-16	62.5	2.3	60.2	60.2
HA-17	63.0	0.7	62.3	62.3
HA-18	57.3	1.1	56.2	56.2
HA-19	58.4	0.0	58.4	58.4
HA-20	62.4	3.3	59.1	59.1
HA-21	64.6	4.8	59.8	59.8
HA-22	66.1	5.5	60.6	60.6
HA-23	66.8	5.7	61.1	61.1
HA-24	66.0	4.1	61.9	61.9
HA-25	64.5	3.7	60.8	60.8
HA-26	63.4	0.0	63.4	63.4
HA-27	57.6	0.2	57.4	57.4
HA-28	58.6	0.0	58.6	58.6
HA-29	61.3	2.1	59.2	59.2
HA-30	64.9	4.9	60.0	60.0
HA-31	65.6	5.0	60.6	60.6
HA-32	67.8	6.1	61.7	61.7
HA-33	67.7	5.3	62.4	62.4
HA-34	67.9	5.6	62.3	62.3
HA-35	66.2	4.7	61.5	61.5
HA-36	62.1	0.4	61.7	61.7

Table 12. Measured Water Table Elevations and Seasonal High Estimates

Boring No.	Ground Surface Elevation (ft NAVD)	Measured Water Table {July 24, 2017}		Estimated SHWT Elevation (ft NAVD)
		Depth Below Ground (ft)	Elevation (ft NAVD)	
HA-37	56.1	0.0	56.1	56.1
HA-38	59.8	1.6	58.2	58.2
HA-39	59.4	0.5	58.9	58.9
HA-40	62.3	2.8	59.5	59.5
HA-41	63.5	3.6	59.9	59.9
HA-42	65.2	4.4	60.8	60.8
HA-43	67.8	6.0	61.8	61.8
HA-44	68.6	5.8	62.8	62.8
HA-45	67.6	5.2	62.4	62.4
HA-46	66.8	4.8	62.0	62.0
HA-47	61.3	0.2	61.1	61.1
HA-48	60.4	0.0	60.4	60.4
HA-49	55.7	1.2	54.5	54.5
HA-50	58.5	1.8	56.7	56.7
HA-51	59.5	1.8	57.7	57.7
HA-52	60.3	2.0	58.3	58.3
HA-53	62.0	2.1	59.9	59.9
HA-54	64.9	4.1	60.8	60.8
HA-55	65.5	5.0	60.5	60.5
HA-56	68.1	5.6	62.5	62.5
HA-57	67.2	4.3	62.9	62.9
HA-58	63.2	1.2	62.0	62.0
HA-59	60.5	0.2	60.3	60.3
HA-60	57.9	1.7	56.2	56.2
HA-61	67.5	3.8	63.7	63.7
HA-62	66.8	2.5	64.3	64.3
HA-63	65.2	2.1	63.1	63.1
HA-64	65.7	3.2	62.5	62.5
HA-65	56.1	0.9	55.2	55.2
HA-66	61.5	2.3	59.2	59.2
HA-67	57.5	1.0	56.5	56.5
HA-68	60.8	1.6	59.2	59.2
HA-69	61.5	1.4	60.1	60.1
HA-70	66.2	4.7	61.5	61.5
HA-71	67.5	4.9	62.6	62.6
HA-72	68.0	4.0	64.0	64.0
HA-73	68.7	4.1	64.6	64.6

Table 12. Measured Water Table Elevations and Seasonal High Estimates

Boring No.	Ground Surface Elevation (ft NAVD)	Measured Water Table {July 24, 2017}		Estimated SHWT Elevation (ft NAVD)
		Depth Below Ground (ft)	Elevation (ft NAVD)	
HA-74	67.5	4.6	62.9	62.9
HA-75	64.5	4.8	59.7	59.7
HA-76	66.8	5.6	61.2	61.2
HA-77	64.0	4.9	59.1	59.1
HA-78	55.6	1.3	54.3	54.3
HA-79	57.6	1.7	55.9	55.9
HA-80	60.1	1.7	58.4	58.4
HA-81	63.6	3.9	59.7	59.7
HA-82	65.5	3.9	61.6	61.6
HA-83	67.8	5.6	62.2	62.2
HA-84	68.8	4.6	64.2	64.2
HA-85	69.1	5.0	64.1	64.1
HA-86	69.0	4.9	64.1	64.1
HA-87	68.2	4.9	63.3	63.3
HA-88	57.6	2.4	55.2	55.2
HA-89	59.3	2.6	56.7	56.7
HA-90	60.4	2.4	58.0	58.0
HA-91	63.8	4.1	59.7	59.7
HA-92	67.4	6.1	61.3	61.3
HA-93	67.1	3.8	63.3	63.3
HA-94	68.0	5.0	63.0	63.0
HA-95	68.7	5.1	63.6	63.6
HA-96	68.9	5.3	63.6	63.6
HA-97	68.7	5.9	62.8	62.8
HA-98	67.9	4.4	63.5	63.5
HA-99	67.7	4.4	63.3	63.3
HA-100	67.6	4.5	63.1	63.1
HA-101	66.2	3.2	63.0	63.0
HA-102	66.7	3.5	63.2	63.2
HA-103	57.3	0.0	57.3	57.3
POND BORINGS				
PB-1	64.8	6.0	58.8	58.8
PB-2	64.0	6.1	57.9	57.9
PB-3	61.3	2.1	59.2	59.2
PB-4	62.9	3.0	59.9	59.9
PB-5	56.7	0.9	55.8	55.8
PB-6	56.5	0.0 [1]	56.5	56.5

Table 12. Measured Water Table Elevations and Seasonal High Estimates

Boring No.	Ground Surface Elevation (ft NAVD)	Measured Water Table {July 24, 2017}		Estimated SHWT Elevation (ft NAVD)
		Depth Below Ground (ft)	Elevation (ft NAVD)	
PB-7	60.6	1.7	58.9	58.9
PB-8	60.5	1.5	59.0	59.0
PB-9	66.6	5.0	61.6	61.6
PB-10	67.6	5.2	62.4	62.4
PB-11	67.7	5.7	62.0	62.0
PB-12	60.0	2.4	57.6	57.6
PB-13	60.0	1.9	58.1	58.1
PB-14	60.9	2.1	58.8	58.8
PB-15	56.0	0.4	55.6	55.6
PB-16	55.8	0.0 [1]	55.8	55.8
PB-17	55.9	0.0	55.9	55.9
PB-18	58.3	0.7	57.6	57.6
PB-19	57.9	0.0	57.9	57.9
PB-20	61.9	2.5	59.4	59.4
PB-21	61.6	2.2	59.4	59.4
PB-22	62.0	2.4	59.6	59.6
PB-23	55.5	0.0 [1]	55.5	55.5
PB-24	54.6	0.0 [1]	54.6	54.6
PB-25	58.3	1.3	57.0	57.0
PB-26	66.3	3.2	63.1	63.1
PB-27	66.1	3.2	62.9	62.9
PB-28	62.7	1.6	61.1	61.1
PB-29	63.3	1.7	61.6	61.6
PB-30	63.8	2.2	61.6	61.6
PB-31	62.4	0.8	61.6	61.6
PB-32	67.8	5.9	61.9	61.9
PB-33	64.6	1.9	62.7	62.7
PB-34	64.9	1.7	63.2	63.2
PB-35	64.9	0.7	64.3	64.3
PB-36	66.6	3.1	63.5	63.5
PB-37	68.1	3.7	64.4	64.4
PB-38	68.5	4.6	63.9	63.9
PB-39	68.5	1.1	67.4	67.4
PB-40	69.0	5.4	63.6	63.6
PB-41	58.2	1.4	56.8	56.8
PB-42	60.0	2.2	57.8	57.8
PB-43	62.9	3.4	59.5	59.5

Table 12. Measured Water Table Elevations and Seasonal High Estimates

Boring No.	Ground Surface Elevation (ft NAVD)	Measured Water Table {July 24, 2017}		Estimated SHWT Elevation (ft NAVD)
		Depth Below Ground (ft)	Elevation (ft NAVD)	
PB-44	64.3	3.8	60.5	60.5
PB-45	65.0	4.2	60.8	60.8
PB-46	66.9	5.3	61.6	61.6
PB-47	67.2	5.6	61.6	61.6
PB-48	68.1	4.7	63.4	63.4
PB-49	55.6	0.0	55.6	55.6
PB-50	55.2	0.2	55.0	55.0
PB-51	56.6	0.0 [1]	56.6	56.6
PB-52	55.1	0.0 [1]	55.1	55.1
PB-53	53.7	0.0	53.7	53.7
PB-54	55.2	0.0	55.2	55.2
PB-55	54.0	0.0 [1]	54.0	54.0
PB-56	53.3	0.0 [1]	53.3	53.3
PB-57	53.7	0.7	53.0	53.0
PB-58	52.8	0.0 [1]	52.8	52.8

Notes:

1. Standing water encountered above ground surface.

6.0 ASSESSMENT AND RECOMMENDATIONS

6.1 General

Apart from thin layers of surficial organics at a few locations, the roadway and site-wide borings generally disclosed an upper mantle of fine sands underlain mostly by fine sands and slightly silty fine sands. Seasonal high water table contours are in Figure 1.6.

These soil and ground water conditions pose no major geotechnical constraints to the development of typical 1 to 2 story single family residential units and the associated roadway, parking, and drainage infrastructure. However, there are some considerations which need to be highlighted:

❶ Areas which may be found to contain surficial or buried organics within development footprints will have to be made suitable for development by demucking and backfilling per our recommendations presented in Table 13.

❷ The site grading and any ground water control mechanisms (i.e., underdrains) will have to be carefully designed to take into account the shallow seasonal high water table (Figure 1.6). Grading and ground water control guidelines are summarized below:

- ❑ A minimum vertical distance of 2.5 ft, and preferably 3.0 ft, should be provided between:
  ① the centerline of the pavement at the lowest inlet which goes into the pond, and
  ② the pond control level

- ❑ Roadway underdrains should be used where the vertical separation between the bottom of the base course and the seasonal high water table is less than 18 inches. Once the final roadway profile grades are plotted and transmitted to our office, we will perform a supplemental review to assess the extent of each road which requires underdrains. These recommendations will be included in a separate report. Additional design recommendations are in Table 13.

Table 13. Recommendations for Site Preparation & Demucking/Backfill

ITEM	DISCUSSION & RECOMMENDATIONS
A.1 GENERAL	Soils-related aspects of development will be typical for this area. In the areas where only a thin layer of topsoil or organic soil is present, normal site preparation will include removing the existing topsoil and vegetation followed by compaction of the subgrade soils and any fill soils required to achieve final grades within the roadway and building pad areas. Development areas containing thicker deposits of surficial organics will require demucking and backfilling as described in Section A.2 of this table. To prevent ponded conditions and "wet yards" and to promote subsurface runoff, the uppermost 2 feet of fill within the residential lots should comprise relatively free-draining sand (< 7% passing the U.S. No. 200 Sieve). Additional guidelines related to separation of the seasonal high water table and ground water control are listed below: ❒ Underdrains should not be relied upon to lower the water table more than 12 inches below the seasonal high water table elevations in Figure 5.1. ❒ A minimum separation of 18 inches should be maintained between the bottom of the pavement base course and the seasonal high water table. The invert of the underdrain pipe should be at least 30 inches below the bottom of the pavement base course. ❒ Ideally, underdrain runs should be parallel to the ground water/land surface contours.

Table 13. Recommendations for Site Preparation & Demucking/Backfill

ITEM	DISCUSSION & RECOMMENDATIONS
A.2 DEMUCKING ALONG ROADWAYS AND BUILDING LOTS	It is recommended that the portions of the road alignment and the footprint of any development element plus a distance of 5 ft on the sides, which contain surficial and/or buried organics below the excavation lines, be completely demucked and backfilled with clean sand. The demucking excavation should have a 2H:1V transition slope adjacent to organic deposits which are to remain. Demucking and backfilling should be performed as follows: 1. The areas which contains organic deposits should be demucked and backfilled with clean fine sand or slightly silty fine sand relatively free of organics and debris. The surficial organic material shall be excavated to expose the underlying mineral soil. 2. Dewatering during excavating and backfilling shall be anticipated and may be accomplished by ditching and the use of sump pumps and/or other methods such as sanded well points, and vertical or horizontal suction wells. The water table shall be maintained a minimum of 2 feet below the excavated surface. The method of dewatering is the sole responsibility of the contractor. 3. Upon approval of the project geotechnical engineer, the excavated area may be backfilled with clean fine sand free of unsuitable or deleterious material. The fill should not be placed in standing water. 4. The backfill material shall consist of relatively clean fine sand with less than 10 percent passing the U.S. No. 200 sieve and shall be free of roots and/or other deleterious material. The material shall be compacted to a minimum density equal to at least 95 percent of the soil's Modified Proctor Density value (AASHTO T-180). The fill shall be placed in loose lift thicknesses not exceeding 12 inches. 5. A representative of the project geotechnical engineer should be retained to provide onsite inspection during the demucking operation and testing of the compacted fill to ensure compliance with the recommendations above.

6.2 Stormwater Ponds Control Elevations

South Florida Water Management District (SFWMD) requires that the control elevation of dry-bottom or wet-bottom ponds be established at the average wet season water table elevation, provided such an elevation does not cause adverse dehydration impacts to adjacent wetlands or results in significant permanent dewatering of the surficial aquifer.

For this particular site, the average wet season water table is estimated to be 12 inches below the seasonal high water table in Figure 1.6. Spot estimates of the seasonal high water table elevations are also presented in Figure 1.6. Our recommended pond control elevations are shown in Exhibit 2 in ft NAVD.

Exhibit 2. Recommended Pond Control Elevations (ft NAVD)

6.3 Mass Grading

Materials to be used for filling shall be fine sands, slightly silty fine sands, and silty fine sands. The distinction between the soil textural classifications is based on the percent by weight passing the U.S. No. 200 sieve (i.e., the *fines fraction*). This distinction and the engineering uses of the various soils are generally articulated in Table 14.

These are our recommendations for general mass grading operations:

❶ Ensure that the site is properly cleared and grubbed.

❷ Strip the topsoil to a depth of at least 6 inches, root rake to a depth of 12 inches and then compact to 95% Modified Proctor Density.

❸ Cut and fill the areas identified for re-profiling and compact the fill material and resulting subgrade to 95% Modified Proctor Density.

❹ For compaction of the sand, we recommend a large self-propelled vibratory roller which has a minimum static weight of 12,000 pounds and is capable of exerting a minimum impact energy of 20,000 pounds (i.e., DYNAPAC CA-152 or equivalent). Compact in lift thicknesses necessary to achieve 95% density. The maximum lift thickness shall not exceed 1 ft.

❺ One (1) compaction test is recommended for every 15,000 square feet of fill for each 1 ft vertical interval. This recommendation works out to be one (1) compaction test per 550 cubic yards of in-place fill material. Compaction tests shall be performed at 1 ft vertical intervals.

6.4 Engineering Suitability of Fill from Stormwater Ponds

The deep borings drilled in the pond footprints generally disclosed both areas where significant amounts of soils that are suitable for use for mass grading the site can be obtained as well as areas where quantities of suitable fill material will be more limited. The area where significant amounts of fill can be obtained are indicated in attached Figure 1.4

The lighter and darker colored fine sands are preferred for the veneer fill and these are identified by the color bands in the boring profiles in Figures 2.1 to 2.18. The sands with higher silt content will tend to become hydraulically restrictive once compacted, creating lot drainage and wetness issues. Table 14 provides a description of the uses of the different types of soils.

Table 14. Engineering Suitability of Soils

TEXTURAL DESCRIPTION	ENGINEERING USES
fine sand with roots (topsoil) fines fraction < 5%	Suitable as non-structural landscape and bulk fill outside structural areas
fine sand fines fraction: ≤ 5%	Suitable for use as structural backfill, pavement subgrade, or general purpose fill. This material is easy to work in the wet season as it is free-draining and dries fairly rapidly. When compacted, its permeability is not reduced to a degree which causes ponding.
slightly silty fine sand fines fraction: > 5%, ≤ 12%	Suitable for use as structural backfill or general purpose fill. This material can be difficult to work if its fines fraction exceeds 10%. At the higher fines fractions (>7%), it tends to become hydraulically restrictive when compacted resulting in slow subsurface drainage and "wetness" during periods of heavy rainfall.
silty fine sands fines fraction: > 12%	Suitable for use as structural backfill or general purpose fill. However, it will be excavated from below water table and may be difficult to handle and compact for the following reason: *The moisture content of the silty sands below the water table is generally 19 to 25% and its optimum moisture content for compaction is generally in the range of 10 to 14%. Since the material is not free-draining, the drying process can be protracted and involve spreading of the material in thin lifts during dry spells, etc.* The material is not free-draining when compacted and can cause a perched water table. Within lots and roads, it is better to place this material 2 ft below the final grade and not in the uppermost zone of fill.
clayey sands	Marginally suitable for structural or general purpose fill. May be difficult to compact. Should be capped with a minimum of 24 inches of fine sand. Home builders also generally have problems excavating shallow footings in compacted fill material comprising stiff clayey sands.

6.5 Pavement Recommendations

Table 15 and Table 16 present the recommendations for the pavement section and preparation of the subgrade.

Table 15. Bituminous/Concrete Pavement Design & Earthwork Recommendations

Item No.	**Item Description**	**Discussion & Recommendations**
		A. Design Recommendations
A.1	General	The shallow subsurface soils are suitable for the construction and support of either a flexible (limerock) or semi-flexible (soil-cement) pavement base. However, a minimum separation of 24 inches should be maintained between the bottom of the base course and the seasonal high water table.
A.2	Recommended Pavement Section	see Table 16
A.3	Resilient Modulus	Based on the type of soils encountered, the anticipated quality of any fill material placed and the method of preparation, a roadbed LBR value of 14 with a corresponding resilient modulus of 5,500 psi may be used as a conservative estimate. The actual resilient modulus is likely closer to 8,000 psi.
A.4	Subgrade Compaction & Stabilization	The subgrade soils shall be compacted to a minimum of 98% of the soil's maximum Modified Proctor Density value (AASHTO T-180) to a depth of 1 foot below the base course. The top 6 or 12 inches of the subgrade (depending on wheel load) shall be stabilized to a minimum Florida Bearing Value (FBV) of 75 psi under curb areas and the limerock base course. Alternatively, the subgrade should be stabilized to a minimum Limerock Bearing Ratio (LBR) of 40. References: Sections 160 and 914 of the *FDOT Standard Specifications for Road and Bridge Construction*
A.5	Limerock Base Course	The limerock base should meet FDOT standards, including a minimum Limerock Bearing Ratio (LBR) of 100. The base material shall be compacted to at least 98 percent of the FM 1 - T 180 Maximum Density. References: Sections 200 and 911 of the *FDOT Standard Specifications for Road and Bridge Construction*
A.6	Soil-Cement Base Course Alternative	The soil-cement base should be compacted to at least 95 percent of AASHTO T-134. The soil cement shall have a 7-day design strength of at least 450 psi. *On this particular site, the City of Orlando strength and compaction requirements in Section 6.7 shall govern.* Reference: Section 270 of the *FDOT Standard Specifications for Road and Bridge Construction*

Table 15. Bituminous/Concrete Pavement Design & Earthwork Recommendations

Item No.	**Item Description**	**Discussion & Recommendations**
A.7	Graded Crushed Concrete Aggregate Base Alternative	The graded crushed concrete aggregate base should be from City of Orlando/Orange County/Osceola County approved sources, which yield a satisfactory mixture with a minimum LBR of 120 and otherwise meeting all the requirements of Section 6.06 of the City of Orlando Engineering Standards Manual 5th Edition
A.8	Bituminous Concrete Surface Course	see Table 16
A.9	Bituminous Concrete Base Course	
A.10	Separation of base course from water table	A minimum separation of 24 inches should be maintained between the bottom of the base course and the seasonal high water table. Road/pavement underdrains are recommended where the separation of the bottom of the base course and the seasonal high water table is less than 24 inches.
A.11	Modulus of Subgrade Reaction	Based on the type of soils encountered, the anticipated quality of any fill material that may be placed and the method of preparation, a modulus of subgrade reaction of 200 pci may be used for slab design.

Table 15. Bituminous/Concrete Pavement Design & Earthwork Recommendations

Item No.	Item Description	Discussion & Recommendations
B. Earthwork Recommendations		
B.1	Clearing & grubbing	Paved areas plus a minimum margin of 5 feet and all areas requiring fill should be cleared, stripped and grubbed to remove all surface vegetation, roots, topsoil and other deleterious materials. Materials generated during this process should be removed from the site and disposed of as directed by the owner/engineer. Reference: Section 110 of the *FDOT Standard Specifications for Road and Bridge Construction*
B.2	Proof-rolling	Within the pavement area, plus a minimum margin of 5 feet on either side, the resulting cleared surface (& where undercut), the exposed natural soils should be proof rolled to detect unstable conditions such as yielding or pumping soils. Soft areas or excessively wet soils should be excavated, removed, dried and/or replaced with suitable compacted fill, as described in item B.6 below.
B.3	Dewatering	Depending on the final design grades and depth of filling performed dewatering for pavement construction is not anticipated for this project if the subgrade preparation is done in the dry season.
B.4	Compaction method	The resulting cleared surface should be leveled and then compacted by means of a large self propelled vibratory roller which has a minimum static weight of 12,000 pounds and is capable of exerting a minimum impact energy of 20,000 pounds (i.e., DYNAPAC CA-15 or equivalent) in areas more than 75 feet away from existing structure(s). Within 75 feet of an existing structure(s) and areas where the groundwater table is within 2 feet of the ground surface, compaction should be achieved with a vibratory roller in the static mode or the use of non-vibratory compaction equipment, such as a heavy rubber tired front end loader. The front end loader should have a minimum bucket size of 3 cubic yards which should remain full during the compaction process.
B.5	Density Requirements	The compaction efforts should continue until the subsoils within the proposed roadway are compacted to a minimum density equivalent to 95 percent of the soils' Maximum Modified Proctor Density value (AASHTO T-180), as tested to a minimum depth of 1 foot below the bottom of the pavement base course and/or exposed subgrade.
B.6	Fill	Any fill material required to attain finished grade should consist fine sand with less than 7 percent passing the U.S. No. 200 Sieve. All sources of structural fill should be approved by the geotechnical engineer prior to their placement. The fill soils should be placed in level lifts not exceeding 12 inches loose thickness and compacted to the minimum density specified in item B.5 above.

Table 15. Bituminous/Concrete Pavement Design & Earthwork Recommendations		
Item No.	**Item Description**	**Discussion & Recommendations**
B.7	Quality Control	A representative of the project geotechnical engineer should be retained to provide on-site inspection and testing during the site preparation activities so that proper documentation and compliance of the recommendations outlined above can be provided.

Table 16. Flexible Pavement Thickness Recommendations

Pavement layer component	Layer Thickness (in)	Layer Coefficient	Layer SN
ARTERIAL {LESS THAN 45 MPH} - OPTION 1			
FC-9.5 (friction course with PG 76-22 binder)	1.00	0.44	0.44
Superpave SP-12.5 asphalt (PG 76-22 binder)	2.00	0.44	0.88
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	10.00	0.18	1.80
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**3.84**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	2,700,000
		minimum (5 ksi)	950,000
ARTERIAL {LESS THAN 45 MPH} - OPTION 2			
FC-9.5 (friction course with PG 76-22 binder)	1.00	0.44	0.44
Superpave SP-12.5 asphalt	1.50	0.44	0.66
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	10.00	0.18	1.80
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**3.62**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	1,900,000
		minimum (5 ksi)	650,000
MAIN COLLECTORS - OPTION 1			
Superpave SP-9.5 asphalt (PG 76-22 binder)	1.25	0.44	0.55
Superpave SP-12.5 asphalt	1.50	0.44	0.66
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	10.00	0.18	1.80
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**3.73**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	2,200,000
		minimum (5 ksi)	750,000

Table 16. Flexible Pavement Thickness Recommendations

Pavement layer component	Layer Thickness (in)	Layer Coefficient	Layer SN
MAIN COLLECTORS - OPTION 2			
Superpave SP-9.5 asphalt (PG 76-22 binder)	1.25	0.44	0.55
Superpave SP-12.5 asphalt	1.50	0.44	0.66
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	8.00	0.18	1.44
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**3.37**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	1,400,000
		minimum (5 ksi)	425,000
COMMERCIAL LOCAL {HEAVY}			
Superpave SP-9.5 asphalt	0.00	0.44	0.00
Superpave SP-12.5 asphalt	2.50	0.44	1.10
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	8.00	0.18	1.44
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**3.26**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	1,000,000
		minimum (5 ksi)	350,000
COMMERCIAL LOCAL {MEDIUM}			
Superpave SP-9.5 asphalt	0.00	0.44	0.00
Superpave SP-12.5 asphalt	2.00	0.44	0.88
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	8.00	0.18	1.44
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**3.04**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	700,000
		minimum (5 ksi)	225,000

Table 16. Flexible Pavement Thickness Recommendations

Pavement layer component	Layer Thickness (in)	Layer Coefficient	Layer SN
Residential Local (Heavy Traffic)			
Superpave SP-9.5 asphalt	1.50	0.44	0.66
Superpave SP-12.5 asphalt	0.00	0.44	0.00
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	8.00	0.18	1.44
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**2.82**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	425,000
		minimum (5 ksi)	150,000
Residential Local (Light Traffic)			
Superpave SP-9.5 asphalt	1.50	0.44	0.66
Superpave SP-12.5 asphalt	0.00	0.44	0.00
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	6.00	0.18	1.08
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**2.46**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	200,000
		minimum (5 ksi)	100,000
Residential Alleys			
Superpave SP-9.5 asphalt	1.50	0.44	0.66
Superpave SP-12.5 asphalt	0.00	0.44	0.00
Limerock Base (LBR 100) or Crushed Concrete (LBR 150)	6.00	0.18	1.08
Stabilized Sub Base - LBR 40 reduce to LBR 30 (9000 psi resilient modulus) due to 2 ft clearance to water table	12.00	0.06	0.72
Pavement SN {Structural #}			**2.46**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	200,000
		minimum (5 ksi)	100,000

Table 16. Flexible Pavement Thickness Recommendations

Pavement layer component	Layer Thickness (in)	Layer Coefficient	Layer SN
TYPICAL PATHWAY PAVEMENT STRUCTURES			
Type S-1 Asphaltic Concrete Surface Course	1.25	0.44?	0.55
Limerock Base (LBR 100) compacted to 98% of AASHTO T-180 modified proctor maximum dry density or Soil Cement (350 PSI) compacted to 98% of AASHTO T-134 standard proctor maximum dry density	4.00	0.18?	0.72
Stabilized Subgrade - LBR 40 compacted to 98% of AASHTO T-180 modified proctor maximum dry density (stabilization not required for soil cement base.)	10.00	0.06?	0.60
Pavement SN {Structural #}			**1.87**
Design Equivalent 18 kip Single Axle Loads for 20 years @85% reliability . . .		maximum (8 ksi)	200,000
		minimum (5 ksi)	100,000

Notes:

❶ Stabilized subgrade: compacted to a minimum density equivalent to 98 percent of the soil's Modified Proctor Density Value (AASHTO T-180 test method). The stabilized subgrade is per FDOT Type B stabilization material or equivalent (minimum LBR=40).

❷ Limerock base (meeting the Florida DOT requirements for limerock base) or crushed aggregate (meeting City of Orlando ESM, LBR > 120) and compacted to a density of not less than 98 percent of the material's Modified Proctor Density Value (AASHTO T-180).

❸ Superpave mixes (SP-9.5 and SP-12.5) shall be per FDOT specs and be compacted to the density range specified by FDOT.

❹ SP-9.5 lift thickness range: 1 to 1½ inches; SP-12.5 lift thickness range: 1½ to 2½ inches {per FDOT 2016}

❺ Pavement construction shall include the application of a tack coat between successive base and asphaltic concrete layers and in accordance with FDOT Section 300.

❻ The equivalent AASHTO nominal maximum aggregate size Superpave mixes are as follows:
SP-9.5 .... 9.5 mm {3/8"}
SP-12.5...12.5 mm {½"}

❼ Friction course FC-9.5 layer thickness = 1 inch (approx). Friction course FC-12.5 layer thickness = 1.5 inch (approx). A friction course will be placed on all roads with a design speed of 35 to 45 mph for multi-lane roads.

❽ Resilient modulus of subgrade soil assumed to be in the range 5 ksi to 8 ksi

6.6 Pipe Trench & Manhole Structure Recommendations

Table 17 presents the recommendations for sewer pipe an other utility trenches within the roadway and other paved areas.

Table 17. Earthwork Recommendations for Pipe Trench

ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
		A. PIPE TRENCH EXCAVATION
A.1	General	Excavate trenches for pipe culverts and storm sewers to the elevation of the bottom of the pipe and to a width sufficient to provide adequate working room. Where the soils permit, ensure that the trench sides are vertical up to at least the mid-point of the pipe. Remove soil not meeting the classification specified as suitable backfill material in Section B-1, to a depth of 4 inches below the bottom of the pipe elevation. References: Section 125-4.4 of the *FDOT Standard Specifications for Road and Bridge Construction* pg. 739, Soil Engineering by Handy & Spangler
A.2	Trenches in Fill	For pipes placed above the natural ground line, the embankment shall be placed and compacted prior to excavation of the trench to an elevation at least 24 inches above the top of the pipe and to a width equal to four (4) pipe diameters, and the trench then excavated to the required grade. However, this is not applicable in this particular project. Reference: Section 125-4.4 of the *FDOT Standard Specifications for Road and Bridge Construction*

Table 17. Earthwork Recommendations for Pipe Trench

ITEM NO.	ITEM DESCRIPTION	DISCUSSION & RECOMMENDATIONS
A.3	Undercutting (where necessary)	When rock, boulders, or other hard, lumpy or unyielding materials are encountered in the trench bottom they shall be removed to a depth of at least 12 inches below the pipe. Muck or other soft material considered by the Engineer to be unsuitable as foundation for the pipe shall be removed to a depth required for obtaining a firm foundation, and as directed by the Engineer. When undercutting is required in order to remove unsuitable material (either hard or soft), the trench shall be backfilled to a point 6 inches above the bottom of the pipe, with suitable granular material which will form a firm bed for the pipe, and the bottom shall be shaped to fit the pipe, to a point 6 inches above the bottom of the pipe. Such bedding material shall be fine sand or other suitable granular material, obtained from the grading operations on the project, or a commercial material if no suitable material is thus available. When a pipe trench is undercut in order to remove unsuitable materials or for other reasons, it shall be brought to the required grade using materials as specified above, after which the bottom shall be compacted to match approximately the density of the soil in which the trench was cut. References: Section 125-4.4 of the *FDOT Standard Specifications for Road and Bridge Construction*
A.4	Dewatering	Dewatering is likely to be required for construction of the stormwater conveyance pipes, culvert crossing and at the outfalls. Dewatering, where required, may be achieved by well points or pumping from interior sumps. The design of the dewatering system is the responsibility of the Contractor. The water table, if present, should be lowered to a level 2 ft below the base of the trench during excavation and backfilling.

Table 17. Earthwork Recommendations for Pipe Trench		
ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
A.5	Safety	The Contractor(s) performing trench excavation on this Contract, in excess of 5 feet in depth, shall comply with the Occupational Safety and Health Administration's (OSHA) trench excavation safety standards, 29 C.F.R., s. 1926.650, Subpart P, including all subsequent revisions or updates to these standards as adopted by the Department of Labor and Employment Security (DLES). The Contractor shall consider all available geotechnical information in his design of the trench excavation safety system. No material or excessive loads shall be applied at the surface within a distance from the edge of the trench equal to the depth of the trench. Reference: Section 125-1.1 of the *FDOT Standard Specifications for Road and Bridge Construction.*

Table 17. Earthwork Recommendations for Pipe Trench

ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
		B. TRENCH BACKFILLING
B.1	Backfill Materials	All material used for backfill shall be of a quality acceptable to the Engineer and shall be free from large lumps, wood, or other extraneous material. Fine sands and slightly silty fine sands such as those disclosed in the roadway borings, are generally suitable as backfill and granular bedding provided they are not overly cemented. Slightly clayey fine sands, if present, are also suitable but can present problems with moisture control to achieve compaction, especially during the rainy season. Clayey sands will be difficult to compact since they usually come out in lumps when excavated and the soil moisture is difficult to control. In general, materials that conform to AASHTO Soil Classification A-1, A-2 or A-3 are acceptable for use as trench backfill. Reference: Section 125-8.1.3 of the *FDOT Standard Specifications for Road and Bridge Construction*.

Table 17. Earthwork Recommendations for Pipe Trench

ITEM NO.	ITEM DESCRIPTION	DISCUSSION & RECOMMENDATIONS
B.2	General	Backfill in dry conditions whenever normal dewatering equipment can accomplish the needed dewatering. A “LOT”, as defined by FDOT, is one lift of backfill material placement, not to exceed 500 ft in length or a single run of pipe connecting two successive structures, whichever is less. Backfill on each side of the pipe for the first lift will be considered a separate LOT. Backfill on opposite sides of the pipe for the remaining lifts will be considered separate LOTs, unless the same compactive effort is applied. For multiple phase backfill, a LOT shall not extend beyond the limits of the phase. Place the material in horizontal layers not exceeding 6 inches in compacted thickness. Backfill around culverts and pipes simultaneously to approximately the same elevation. For pipes 15 inches inside diameter, or greater, trenches may have up to four zones that must be backfilled as follows: [a] Lowest Zone: The Lowest Zone is backfilled for deep undercuts up to within 4 inches of the bottom of the pipe. This zone is backfilled with coarse sand, or other suitable granular material, obtained from the grading operations on the project, or a commercial material, if no suitable material is available. [b] Bedding Zone: The zone above the Lowest Zone is the Bedding Zone. Usually it will be the backfill which is 4 inches of soil below the bottom of the pipe. When rock or hard material has been removed to place the pipe, the Bedding Zone will be 12 inches of soil below the bottom of the pipe. Backfill with materials classified as A-1, A-2 or A-3. Material classified as A-4 may be used if the pipe is concrete. [c] Cover Zone: The Cover Zone is the next zone of backfill that is placed after the pipe has been laid. This zone extends to 12 inches above the top of the pipe. The Cover Zone and Bedding Zone are considered the Soil Envelope for the pipe. Backfill materials specified for the Bedding Zone in (b) above may also be used in the Cover Zone. [d] Top Zone: The Top Zone extends from 12 inches above the top of the pipe to the base or final grade. Backfill the area of the trench above the soil envelope with materials allowed in FDOT Design Standard, Index 505 or other approved materials.

Table 17. Earthwork Recommendations for Pipe Trench

ITEM NO.	ITEM DESCRIPTION	DISCUSSION & RECOMMENDATIONS
B.3	Backfill Zones for Pipes	[a] Lowest Zone: Compact the soil in the lowest zone to approximately match the density of the soil in which the trench was cut. [b] Bedding Zone: If the trench was not undercut below the bottom of the pipe, loosen the soil in the bottom of the trench immediately below the approximate middle third of the outside diameter of the pipe. If the trench was undercut, place the bedding material and leave it in a loose condition below the middle third of the outside diameter of the pipe. Compact the outer portions to meet the density requirements of the Acceptance Criteria. Place the material in lifts no greater than 6 inches in compacted thickness. [c] Cover Zone: Before placing the Cover zone material, lay pipe, excavating for bells where required. Place the material in 6-inch layers (compacted thickness), evenly deposited on both sides of the pipe, and compact with mechanical tampers suitable for this purpose. Hand tamp material below the pipe haunch that cannot be reached by mechanical tampers. Meet the requirements of the density Acceptance Criteria in Section B4. [d] Top Zone: Place the material in layers not to exceed 12 inches in compacted thickness. Meet the requirements of the Accepted Criteria in Section B4. Reference: Section 125-8.3.1 and 125.8.3.2 of the *FDOT Standard Specifications for Road and Bridge Construction*.

Table 17. Earthwork Recommendations for Pipe Trench

<table>
<tr><th>ITEM NO.</th><th>ITEM DESCRIPTION</th><th colspan="3">DISCUSSION & RECOMMENDATIONS</th></tr>
<tr><td rowspan="4">B.4</td><td rowspan="4">Acceptance Criteria</td><td colspan="3">Obtain a minimum Quality Control (QC) density in any LOT of 100% of the maximum density as determined by AASHTO T99, Method C, or in the case of the Lowest Zone, to a density to approximately match the existing soil. Note that the applicable County or City requirements shall apply where these are more restrictive than FDOT requirements.
Exceptions to Pipe Density Requirements: Compact the backfill to a firmness approximately equal to that of the soil next to the pipe trench in locations outside the plane described by a two (horizontal) to one (vertical) slope downward from the roadway shoulder line of the back of curb as applicable.
Frequency: Conduct QC maximum density sampling and testing at a minimum frequency of one test per soil type. The verification test will be at a minimum of one per soil type.
Reference:
Section 125-9.2 of the *FDOT Standard Specifications for Road and Bridge Construction*</td></tr>
<tr><td>Test Name</td><td>Quality Control</td><td>Verification</td></tr>
<tr><td>Maximum Density</td><td>One per soil type</td><td>One per soil type</td></tr>
<tr><td>Density</td><td>One per LOT</td><td>One per four LOTs and the first lift not affected by water</td></tr>
<tr><td>B.5</td><td>Backfill under wet conditions</td><td colspan="3">Where wet conditions are such that dewatering by normal pumping methods would not be effective, the procedure outlined below may be used when specifically authorized by the Engineer in writing. In such specifically authorized cases the backfill material used below the elevation at which mechanical tampers would be effective shall be of the AASHTO A-3 soil classification. After the pipe is bedded properly, the A-3 material shall be placed, and rammed and compacted under the pipe haunches by the use of timbers or hand tampers, and hand-tamping continued during the placing of the backfill until the backfill reaches an elevation such that its moisture content will permit the use of mechanical tampers. When the backfill has reached such elevation, normally acceptable backfill material may be used and compaction shall be obtained by the use of mechanical tampers. The mechanical tamping shall be done in such a manner and to such extent as to transfer the compacting force into the previously hand-tamped fill.
Reference:
Section 125-8.3.4 of the *FDOT Standard Specifications for Road and Bridge Construction*</td></tr>
</table>

Table 17. Earthwork Recommendations for Pipe Trench

ITEM NO.	ITEM DESCRIPTION	DISCUSSION & RECOMMENDATIONS
B.6	Precautions	Heavy construction equipment shall not be permitted to cross over culverts or storm sewer pipes until backfill material has been placed and compacted to the finished earthwork grade or to an elevation at least 4 ft above the crown of the pipe.
B.7	Minimum cover requirements	The minimum cover over the top of the pipe shall be as per Index 205 of the FDOT Roadway and Traffic Design Standards (Jan. 2006).
B.8	Quality Control	per Osceola County requirements

6.7 Foundation Recommendations for Single-Family Residential Structures

Tables 18, 19, and 20 contain the foundation and testing recommendations for the single-family residential structures and this information will be required by the structural engineer.

Table 18. Foundation Recommendations for Single-Family Residential Structures

Description	**Column Footing**	**Wall Footing**	**Monolithic Slab Foundation** [4]
Net allowable bearing pressure [1]	2,500 psf	2,500 psf	2,000 psf
Minimum width	24 inches	16 inches	12 inches
Minimum embedment below finished grade [2]	12 inches	12 inches	12 inches
Compaction requirements	95 percent of the materials maximum Modified Proctor dry density for a depth of 24 inches below footing and on the sides of the footing up to finished grade over a width of at least 1.5 × footing width		
Minimum Testing Frequency	see testing requirements after Table 20		
Approximate total settlement [3]	< 1 inch	< 1 inch	< 1 inch
Estimated differential settlement [3]	< ¾ inch between columns	< ¾ inch over 40 ft	< ¾ inch over 40 ft

Notes:

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Assumes any unsuitable fill or soft soils, if encountered, will be undercut and replaced with compacted engineered fill.
2. For erosion protection and to reduce effects of seasonal moisture variations in subgrade soils.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. The above settlement estimates have assumed that the maximum footing width is 4¼ feet for column footings and 1 b feet (20 inches) for continuous footings.
4. Turned-down portion of slab.

Table 19. Detailed Foundation Design & Earthwork Recommendations

ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
		A. DESIGN RECOMMENDATIONS
A.1	General	Based on the soil conditions disclosed by the borings, no major geotechnical constraints are anticipated for the planned construction. Once prepared as specified hereunder, the foundation soils are capable of satisfactorily supporting the proposed 1-story and 2-story single family residential structures on conventionally designed shallow foundations.
A.2	Allowable bearing pressure and settlement	For a maximum total settlement of 1 inch or less, footings should be designed for a **net allowable soil contact pressure of....** **2,500 psf or less.** The net bearing pressure is equal to the gross bearing pressure minus the weight of the soil between the elevation of the bottom of the footing and the finished grade alongside. When the soil surcharge above the bottom of a footing is at different elevations on the two sides, the shallower surcharge is used to determine the net bearing pressure. When a concrete floor or pavement rests on a soil surcharge, it is appropriate to compute an equivalent surcharge which is the height of a column of soil equal in weight to that of the actual soil and pavement above the bottom of the footing. Foundation elements that must resist overturning or are subject to eccentric loads should be designed for **a maximum edge pressure of...** **3,000 psf or less for the other structures.**
A.3	Settlement Rate	Settlements are expected to occur rapidly, primarily as a result of elastic compression of the supporting sands, and should be complete shortly after application of the load.
A.4	Continuous wall footings	① Minimum confinement of 12 inches as measured from the bottom of the footing to the lowest adjacent finished grade. The lowest adjacent finished grade is defined as the lower elevation of either the outside ground surface or the top of slab alongside. ② Minimum width of 16 inches ③ Maximum wall load of 3 kips per lineal foot

Table 19. Detailed Foundation Design & Earthwork Recommendations

ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
A.5	Isolated square footings	① Minimum confinement of 12 inches as measured from the bottom of the footing to the lowest adjacent finished grade ② Minimum plan dimensions of 24 inches by 24 inches ③ Maximum column load of 15 kips
A.6	Thickened Edge of Monolithic Slab	① Minimum confinement of 12 inches as measured from the bottom of the footing to the lowest adjacent finished grade ② Minimum width of 12 inches
A.7	Modulus of subgrade reaction	For design of slabs and estimating slab deflections, a modulus of subgrade reaction (k) of 200 lb/in³ (lb/in² per inch of deflection) may be used.
A.8	Separation of slabs from water table	A minimum separation of 36 inches should be maintained between the seasonal high water table and the bottom of the building slabs. A moisture barrier should be used to separate the slab from the underlying soils. A 6-mil thick plastic or vinyl membrane may be used as a moisture barrier and it should be protected from damage during construction. Special drainage material is not required beneath the floor slab.
A.9	Corrosion classification	Corrosion series test parameters (i.e., pH, chlorides, resistivity, and chlorides) were not performed on selected soil samples. Based on our experience with similar light colored fine sands, the classification of the soil should be “slightly aggressive” according to the environmental classification ranges published in the *FDOT Structures Design Guidelines*. Reference: Chapter 7 of the *FDOT Structures Design Guidelines* titled “Florida- Concrete Design, Environmental Classification and Construction Criteria”.
A.10	Sinkhole Potential	This site has a very low potential for the development of sinkholes and a site-specific assessment of sinkhole potential is not required in our opinion.
A.11	Seismic Considerations	The 1991 Uniform Building Code indicates on Figure 1206.1 (page 305) that the Seismic Zone for Florida is “0". A seismic impact zone is an area that has a 10% or greater probability that the horizontal ground level acceleration of the rock in the area exceeds 0.01g once in 250 years. The horizontal ground level acceleration for the seismic zone which encompasses the site and vicinity is less than 0.05g. Therefore, the site is not located in a seismic impact zone and the design of the structure does not need to consider a seismic event.

Table 19. Detailed Foundation Design & Earthwork Recommendations		
ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
A.12	Frost Penetration	Frost heave and rapid settlement following thaw is not a concern at this site. The maximum depth of frost penetration is less than 5 inches. However, the Standard Building Code requires the bottom of footings be not less than 12 inches below the finished grade.

Table 19. Detailed Foundation Design & Earthwork Recommendations

ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
B. EARTHWORK RECOMMENDATIONS		
B.1	General	The preparation of the foundation soils shall proceed in a conventional manner. The foundation soils should be firm and unyielding. If any soft or unstable areas are identified during preparation of foundation soils, the deficient soil will have to be replaced with suitable compacted fill as described below.
B.2	Clearing & grubbing	Surface vegetation, topsoil, roots, and other organic debris or deleterious materials shall be cleared and grubbed within the building area plus a minimum margin of 5 feet beyond the perimeter of the foundation lines. Topsoil and/or other organic soils suitable for landscaping purposes shall be stockpiled onsite for reuse or disposed of as directed by the owner. Clearing and grubbing is followed by excavating or filling to the foundation elevation. References: Section 110-2 of the *FDOT Standard Specifications for Road and Bridge Construction* Section 110-7 of the FDOT Standard Specifications for Road and Bridge Construction

Table 19. Detailed Foundation Design & Earthwork Recommendations

ITEM NO.	ITEM DESCRIPTION	DISCUSSION & RECOMMENDATIONS
B.3	Fill or Backfilling of Over-excavation Beneath the Footings	The following is recommended for the additional embankment required to raise the building areas to finished grade: ① **Compaction of cleared surface**: The resulting cleared surface should be compacted before fill is placed over any natural in-place soils. Compaction of the natural soil shall be as specified below. ② **Fill material quality**: sands which have less than **7 percent** of fines passing a U.S. No. 200 Sieve will be acceptable provided the moisture content is controlled to ensure that the materials can be compacted to the required density. All proposed sources of structural fill shall be approved by the project geotechnical engineer prior to their placement within the proposed building areas. The 7% fines criterion may be relaxed upon review and approval by the geotechnical engineer. Reference: Section 455-29 of the *FDOT Index To Section 455 - Structures Foundations* ③ **Compaction & density requirement**: Compact to 95 percent of the soils' Modified Proctor Maximum Density (ASTM D-1557) as tested to a minimum depth of one (1) foot below the footing and floor slab base elevations. For compaction, the contractor shall use an approved heavy vibratory roller with a static drum weight of at least 8,000 lb. Each lift shall be thoroughly compacted in 12-inch maximum loose lift thicknesses to the required density. The final lift below the footing shall also be compacted with a suitable sled vibratory compactor to remove any upper disturbance caused by the drum roller. When conditions require the use of a smaller compactor, the lift thickness shall be reduced to achieve the required density. Prior to beginning the compaction process, moisture contents within the foundation or fill soils should be controlled so that they will approach the optimum required for maximum compactibility. Reference: Section 455-30 of the *FDOT Index To Section 455 - Structures Foundations*

Table 19. Detailed Foundation Design & Earthwork Recommendations

ITEM NO.	ITEM DESCRIPTION	DISCUSSION & RECOMMENDATIONS
B.4	Excavation	① Dry excavations are excavations that can be completed without the need to lower the water table. Dry excavations shall be used when the water table at the time of construction (in the opinion of the geotechnical engineer) will remain two (2) feet or more below the bottom of the excavation or over-excavation. The footing excavation shall be to the bottom of the footing, or over-excavation limit. Any suitable material shall be saved for backfill. The seasonal high water table is greater than 6 ft below land surface. ② The foundation soils below the footing shall be compacted to obtain a minimum density equivalent to 95 percent of the Modified Proctor Maximum Density (ASTM D-1557) as tested to a minimum depth of one (1) foot below the footing and floor slab base elevations. ③ The contractor shall make adequate provisions to divert surface runoff and to collect and remove any water entering the excavation. References: Section 125-4 of the *FDOT Standard Specifications for Road and Bridge Construction* Section 455-28 of the *FDOT Index To Section 455 - Structures Foundations*
B.5	Temporary side slopes	Slopes for temporary excavations less than 4 feet deep shall be sloped at 1.5 Horizontal to 1 Vertical (1.5H:1V) or flatter. The slopes must be protected from erosion. Temporary excavations greater than 10 ft deep shall have side slopes of 2.0H:1V or flatter, or shall be braced using a plan certified by a professional engineer registered in the state of Florida. Excavated materials shall not be placed at top of slopes within a horizontal distance equal to the depth of excavation. The design and construction of temporary slopes must be in accordance with current OSHA standards.

Table 19. Detailed Foundation Design & Earthwork Recommendations

ITEM NO.	**ITEM DESCRIPTION**	**DISCUSSION & RECOMMENDATIONS**
B.6	Dewatering	All concrete for the shallow footings must be placed in the dry. Construction dewatering is not anticipated for construction of the building foundations for this project. The following recommendations apply if dewatering is required: ① Non-vibratory equipment should be used when compacting close to the groundwater table. ② The contractor may excavate within 2 feet of the water table before dewatering begins. ③ The dewatered water table should be maintained at least 2 feet below the excavation. ④ The contractor shall make adequate provisions to divert surface runoff from the excavation. Reference: Section 455-26 of the *FDOT Index To Section 455 - Structures Foundations*
B.7	Protection of existing structures	Non-vibratory equipment is recommended when compacting within 75 feet of existing structures. Soil placed adjacent to footing or walls shall be carefully compacted with light rubber tired or vibratory plate compactors (weighing less than 1000 lb) to avoid damage to the footings or walls. This material shall be placed in level lifts not exceeding 6 inches loose thickness and be compacted to a minimum of 95 percent of its Modified Proctor Density. A vibratory roller shall not be used to compact soils adjacent to any completed portions of the structure. No backfill shall be placed on the footing until the concrete is at least 7 days old. Reference: Section 455-25 of the *FDOT Index To Section 455 - Structures Foundations*
B.8	Quality Control	A representative of the project geotechnical engineer should be retained to provide on-site inspections and testing of the compaction and filling operations so that proper documentation of the required minimum compaction and compliance with the recommendations above can be provided. Refer to Table 20 for additional recommendations. Reference: Section 455-30 of the *FDOT Index To Section 455 - Structures Foundations*

Table 20. Density Testing Recommendations - Single Family Residential Structures

The following recommended sampling and testing procedures are to be performed at the time of foundation construction. These testing procedures are in addition to any test borings and fill certifications normally performed as part of the mass grading operations of developed lots.

The scope of the foundation soil compaction testing procedures will vary depending upon the type of foundations system (stemwall or monolithic). It is the intent of these recommendations that there be a minimum of 1.0 foot of compacted/tested soil beneath all foundation elements and base of floor slabs and on the sides of the footing up to the finish grade. The foundation soils and any fill soils necessary to attain final grades shall be compacted to a minimum density equivalent to 95 percent of the soil's Modified Proctor Density Value (ASTM D-1557) as tested to a depth of 1.0 foot below all foundation elements and the base of floor slabs. Foundation compaction testing procedures for stem wall type and monolithic type foundations are presented below.

Stem Wall and Spread Footings

Following ① the compaction of the foundation areas and prior to the placement of foundation steel, these compaction tests are recommended:

- minimum of 4 density tests (1 test below the base of footings of each outer exterior stem wall footings)
- minimum of 1 density test should be performed below any interior stem wall footing(s)

Following ① the placement and compaction of the stem wall fill, ② the backfilling and compaction of all plumbing trenches, and ③ prior to the placement of moisture barrier and internal foundation steel that may be required, these compaction tests are recommended:

- minimum of 4 density tests (approximate each quadrant of the building pad area) shall be performed below the base of floor slabs
- minimum of 1 density test should be performed below any interior monolithic type load bearing wall footing(s)

Monolithic Type Foundation Systems

Following ① the compaction of the foundation slab soils, ② placement and compaction of any fill soil required to attain final grades, ③ compaction below all foundation elements, ④ the backfilling and compaction of all plumbing trenches, and ⑤ prior to the placement of moisture barrier and foundation steel, the following compaction tests are recommended:

- minimum of 4 density tests (1 test below the base of footings of each of the outer exterior thickened edge wall footings)
- minimum of 4 density tests (approximate each quadrant of the building pad area) shall be performed below the base of floor slabs
- minimum of 1 density test should be performed below internal monolithic type load bearing wall footings

6.8 Lift Station Recommendations

Recommendations related to lift stations (if any) are summarized in Table 21.

Table 21. Geotechnical Recommendations for Lift Station Structure

ITEM	DISCUSSION & RECOMMENDATIONS
DESIGN RECOMMENDATIONS	
General	Provided that organic or yielding soils, if found present beneath the foundation soffit, are removed and replaced with clean compacted sands, the recommendations in this section shall apply.
Settlement	**A maximum bearing pressure of 2,000 lb/ft² is recommended** to limit both the total and differential settlement of the foundation soils to less than 1 inch.
Lateral earth pressure	Unlike a retaining wall, the lift station structures are expected to be rigid. These parts of the structures resist the active (at-rest) earth pressure exerted by the backfill. In this case, **the active earth pressure should be taken as equivalent to the pressure exerted by a fluid weighing 52 lb/ft³**. This equivalent fluid pressure assumes that **adequate drainage is provided to prevent the buildup of hydrostatic pressure behind the wall**. Free-draining sand should be used as backfill or a prefabricated drainage composite such as Miradrain™ 6000 can be used. For this type of design, it should be assumed that full hydrostatic pressure builds up behind the wall, and in that case **the active earth pressure should be taken as equivalent to the pressure exerted by a fluid weighing 90 lb/ft³**. These equivalent fluid densities do not include a factor of safety; they also do not include lateral pressures from any surcharge loads (i.e., traffic, construction equipment, etc.)
Vertical soil pressure	The vertical soil pressure on buried parts of these structures can be estimated by multiplying the unsaturated unit weight (115 lb/ft³) by the height of fill over the structural element and adding any appropriate surcharge loads.
Uplift pressures	For the calculation of uplift due to hydrostatic pressure at the base of the structure, the seasonal high water table altitude is +83 ft NAVD at the location of the lift station. The vertical soil pressure on top of the structures can be estimated by multiplying the unsaturated unit weight by the height of fill over the structure and adding any appropriate surcharge loads.
Corrosion classification	The corrosion classification to be used is ***moderately aggressive***.
GEOTECHNICAL-RELATED CONSTRUCTION RECOMMENDATIONS	

Table 21. Geotechnical Recommendations for Lift Station Structure

ITEM	DISCUSSION & RECOMMENDATIONS
Temporary Slopes During Excavation	Where space is available and it is practical the sides of excavations may be sloped. Slopes for temporary excavations less than 4 feet deep shall be sloped at 1.5 Horizontal to 1 Vertical (1.5H:1V) or flatter. The slopes must be protected from erosion. Temporary excavations between 4 ft and 10 ft deep shall have side slopes of 1.75H:1V or flatter while, temporary excavations greater than 10 ft deep shall have side slopes of 2.0H:1V or flatter. Alternatively, temporary excavations greater than 4 ft deep with steeper slopes are permissible, however, these shall be braced using a plan certified by a professional engineer registered in the state of Florida. Excavated materials shall not be placed at top of slopes within a horizontal distance equal to the depth of excavation. The design and construction of temporary slopes must be in accordance with current OSHA standards. For further information see the OSHA website for regulations regarding safe trench excavations. In areas where temporary slopes are not practical, shoring methods, such as, sheet piling may have to be considered.
Over-excavation	per Section 125-4 of the *FDOT Standard Specifications for Road and Bridge Construction* Over-excavation shall be performed as necessary to remove unsuitable clay, silt and debris that may be present beneath the structure bottom. The over-excavation shall be backfilled with A-3 sand. Compaction below structures shall be in accordance with Section C455-8 of *FDOT Supplemental Specifications to the 1991 Standard Specifications for Road and Bridge Construction (1994).* To achieve the compaction requirements, it may be necessary to over-excavate existing saturated soils at least 1 foot below and backfill with A-3 sand at or below optimum. All structure joints (tops & sides) shall be covered with filter fabric (2 ft minimum width) meeting the requirements of Index 199, Type D-3 with A.O.S. of at least 100.
Dewatering	All foundations shall be constructed in the dry. Dewatering will be required to facilitate the structure construction. Dewatering shall be performed in accordance with Sections C455-4 and C455-6.2 of *FDOT Supplemental Specifications to the 1991 Standard Specifications for Road and Bridge Construction (1994).* The contractor is solely responsible for the design, operation and safety of the dewatering method/plan. The contractor shall make adequate provisions to divert surface runoff and to collect and remove any water entering the excavation.
Protection of existing structures	per Section C455-3 of *FDOT Supplemental Specifications to the 1991 Standard Specifications for Road and Bridge Construction (1994).*
Preservation of channel	per Section 125-5 of the *FDOT Standard Specifications for Road and Bridge Construction*
Fill or Backfill	per Section C455-7 of *FDOT Supplemental Specifications to the 1991 Standard Specifications for Road and Bridge Construction (1994).*
Compaction & Density requirements	per Section C455-8 of *FDOT Supplemental Specifications to the 1991 Standard Specifications for Road and Bridge Construction (1994).*
Drainage composite	install as per manufacturer's recommendation

FIGURES

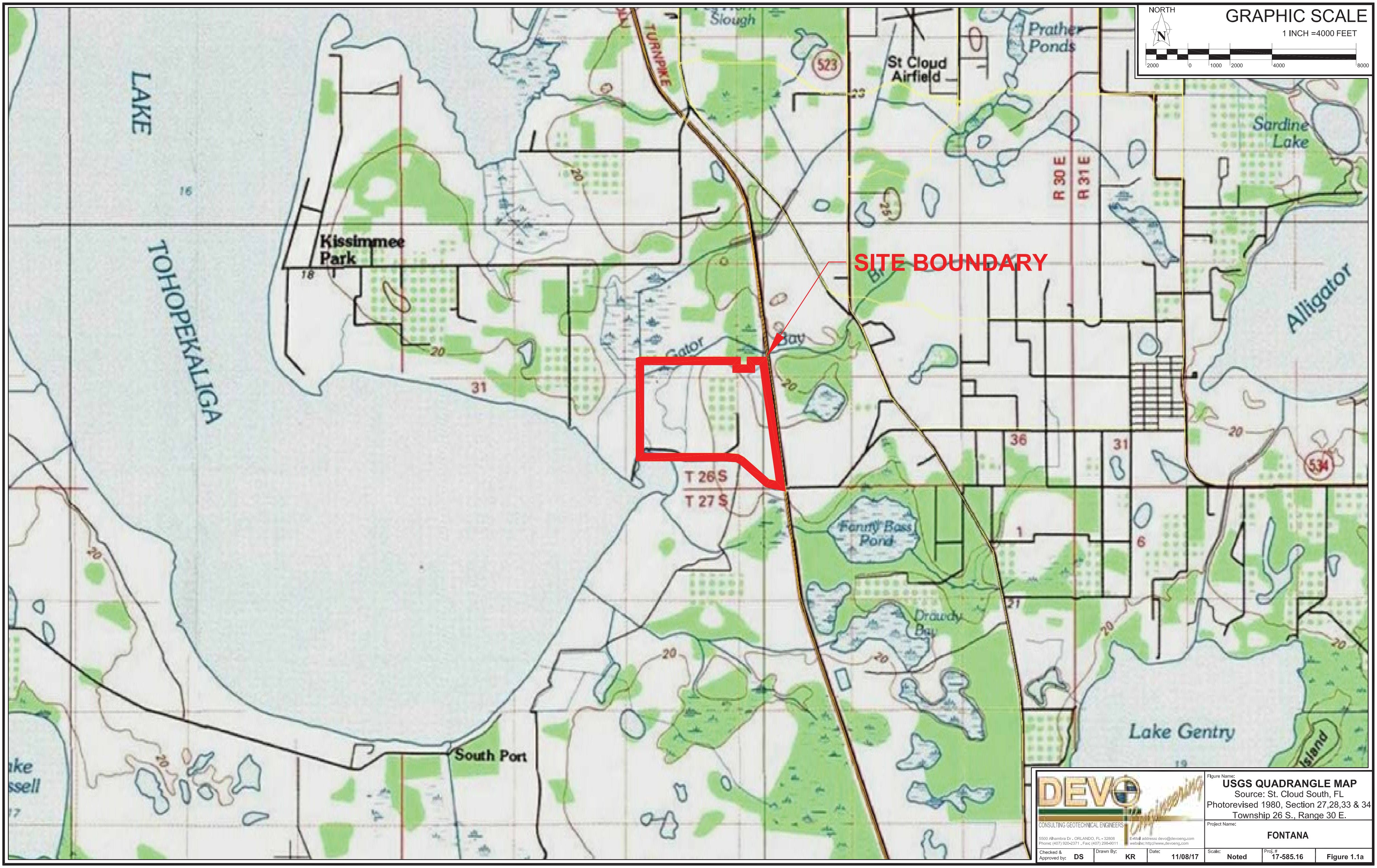
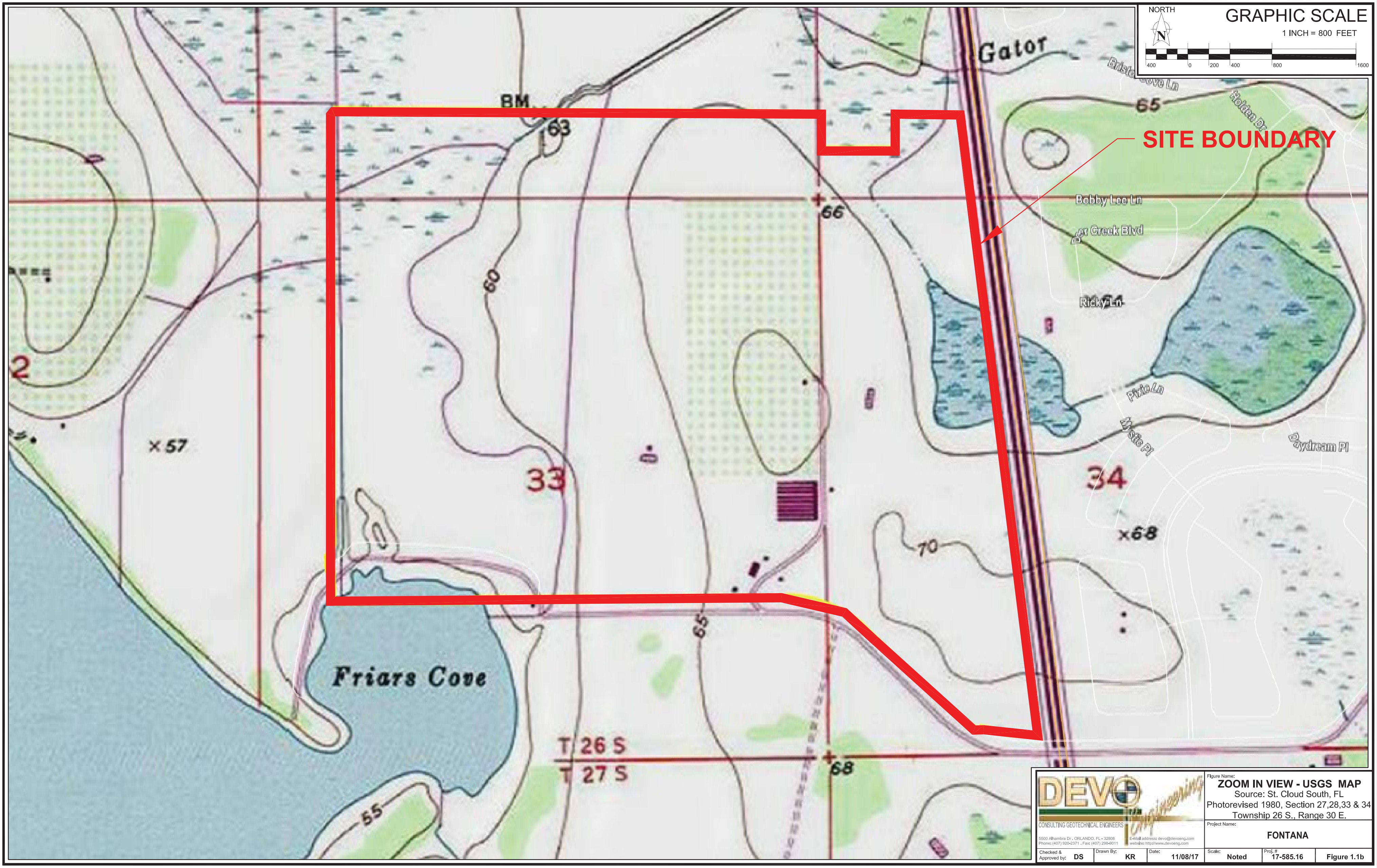


Figure Name:
USGS QUADRANGLE MAP
Source: St. Cloud South, FL
Photorevised 1980, Section 27,28,33 & 34
Township 26 S., Range 30 E.

Project Name:
FONTANA

CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 920-2371 . Fax: (407) 298-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Checked & Approved by: **DS**	Drawn By: **KR**	Date: **11/08/17**	Scale: **Noted**	Proj. # **17-585.16**	**Figure 1.1a**



DEVO Engineering
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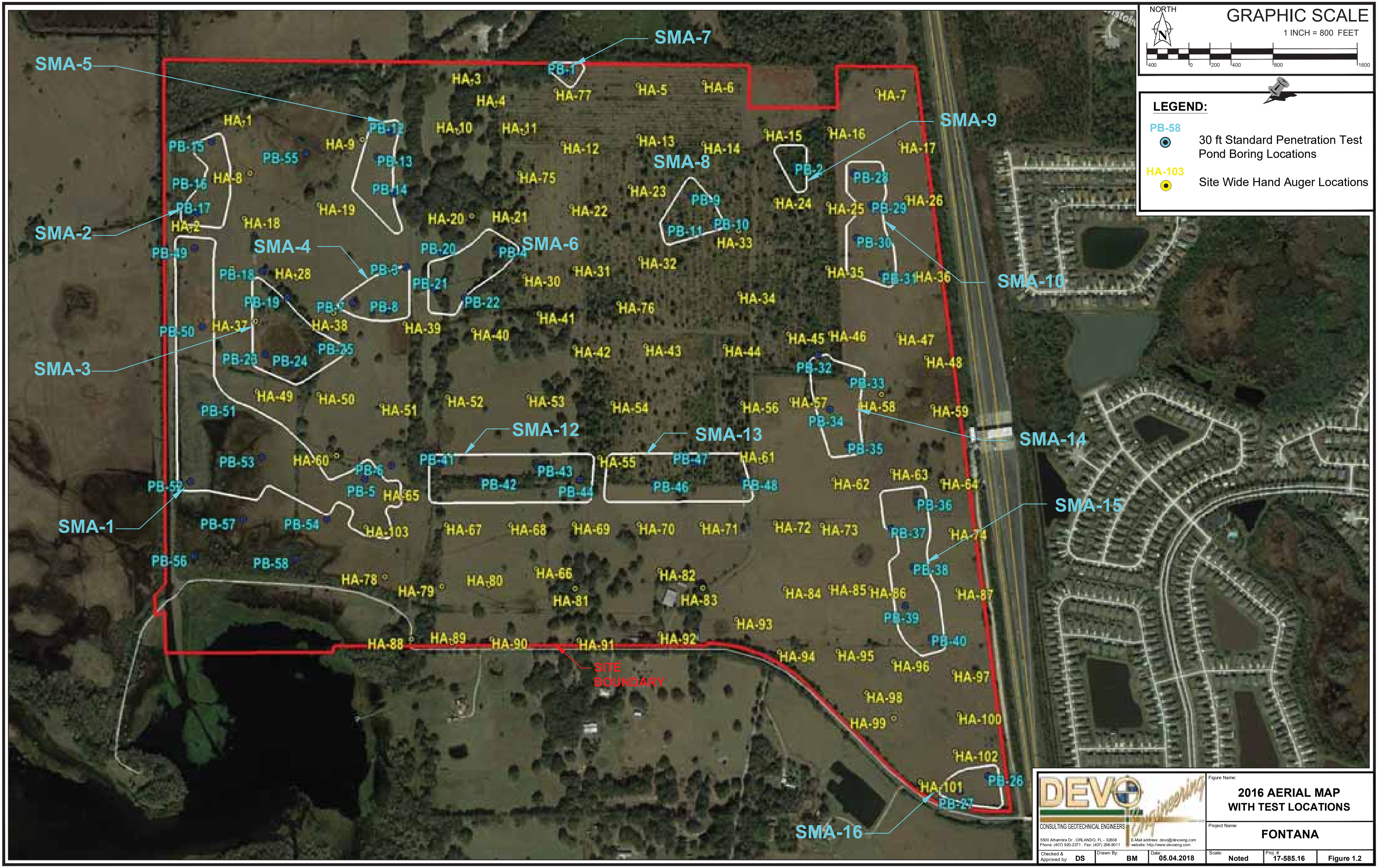
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
ZOOM IN VIEW - USGS MAP
Source: St. Cloud South, FL
Photorevised 1980, Section 27,28,33 & 34
Township 26 S., Range 30 E.

Project Name:
FONTANA

Checked & Approved by: **DS**
Drawn By: **KR**
Date: **11/08/17**
Scale: **Noted**
Proj. # **17-585.16**
Figure 1.1b



GRAPHIC SCALE

1 INCH = 800 FEET

400 0 200 400 800 1600

LEGEND:

PB-58 ◉	30 ft Standard Penetration Test Pond Boring Locations
HA-103 ⊙	Site Wide Hand Auger Locations

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E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

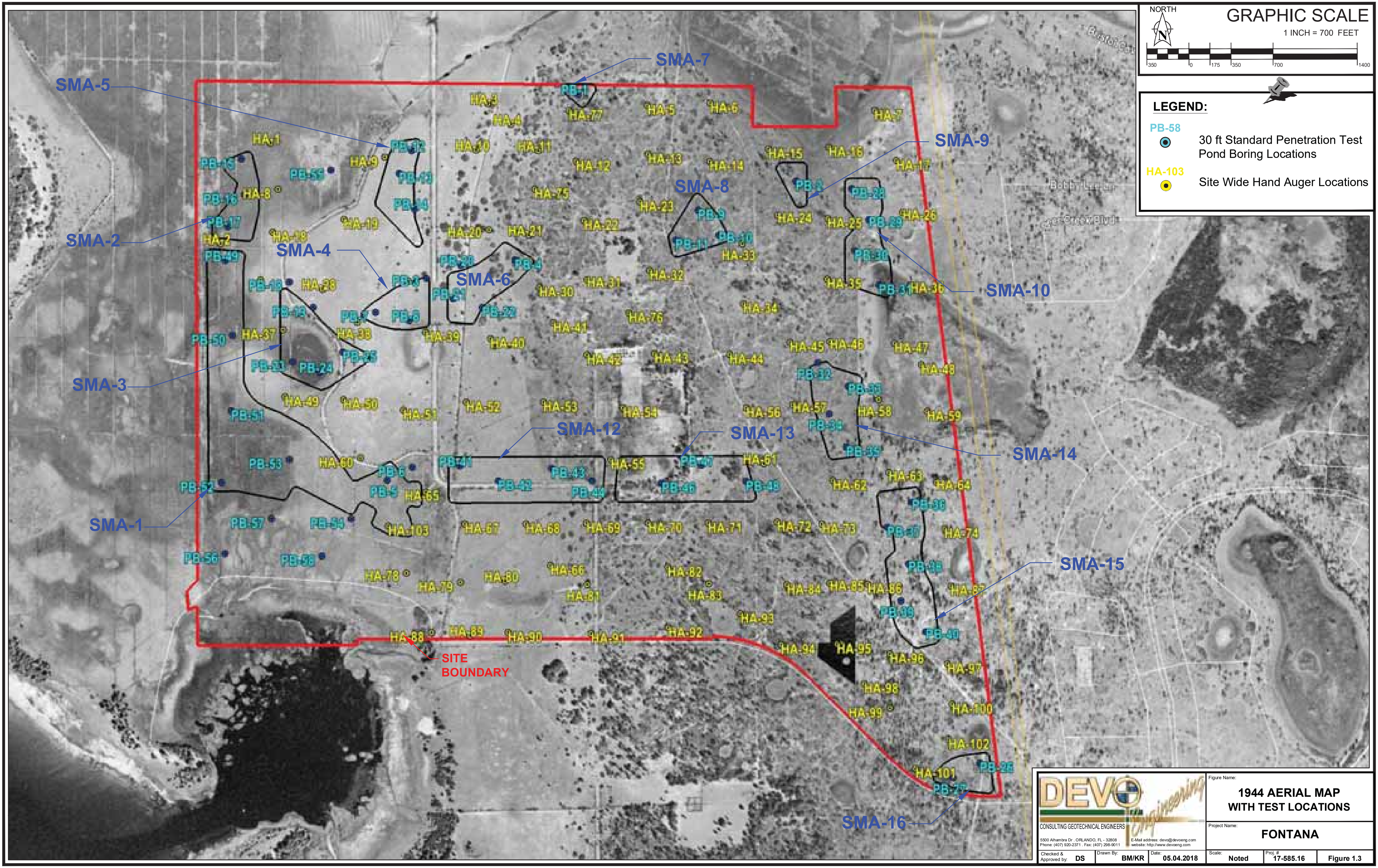
Figure Name:

2016 AERIAL MAP WITH TEST LOCATIONS

Project Name:

FONTANA

Checked & Approved by: DS	Drawn By: BM	Date: 05.04.2018	Scale: Noted	Proj. # 17-585.16	Figure 1.2



LEGEND:

PB-58 ●	30 ft Standard Penetration Test Pond Boring Locations
HA-103 ●	Site Wide Hand Auger Locations

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CONSULTING GEOTECHNICAL ENGINEERS
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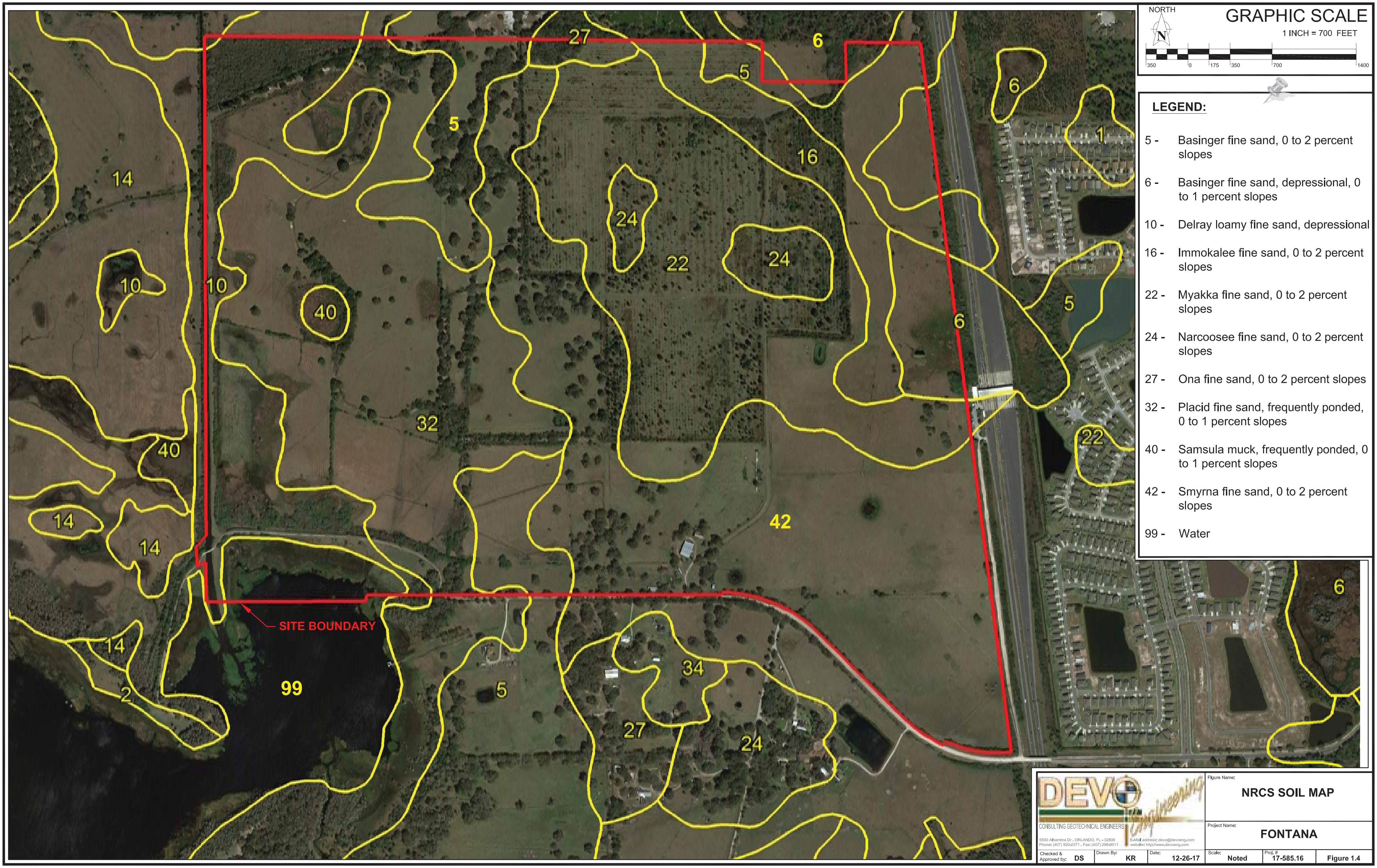
Phone: (407) 920-2371 . Fax: (407) 298-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
1944 AERIAL MAP WITH TEST LOCATIONS

Project Name:
FONTANA

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	BM/KR	05.04.2018	Noted	17-585.16	Figure 1.3



GRAPHIC SCALE

1 INCH = 700 FEET

LEGEND:

5 - Basinger fine sand, 0 to 2 percent slopes
6 - Basinger fine sand, depressional, 0 to 1 percent slopes
10 - Delray loamy fine sand, depressional
16 - Immokalee fine sand, 0 to 2 percent slopes
22 - Myakka fine sand, 0 to 2 percent slopes
24 - Narcoosee fine sand, 0 to 2 percent slopes
27 - Ona fine sand, 0 to 2 percent slopes
32 - Placid fine sand, frequently ponded, 0 to 1 percent slopes
40 - Samsula muck, frequently ponded, 0 to 1 percent slopes
42 - Smyrna fine sand, 0 to 2 percent slopes
99 - Water

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Phone: (407) 920-2371 . Fax: (407) 298-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name: **NRCS SOIL MAP**

Project Name: **FONTANA**

Checked & Approved by: DS	Drawn By: KR	Date: 12-26-17	Scale: Noted	Proj. # 17-585.16	Figure 1.4

CONSULTING GEOTECHNICAL ENGINEERS

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Phone: (407) 920-2371 . Fax: (407) 298-9011

E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
POND BORROW SUITABILITY INDEXES

Project Name:
FONTANA

Checked & Approved by: **DS**	Drawn By: **BM/KR**	Date: **05.04.2018**	Scale: **Noted**	Proj. # **17-585.16**	**Figure 1.5**

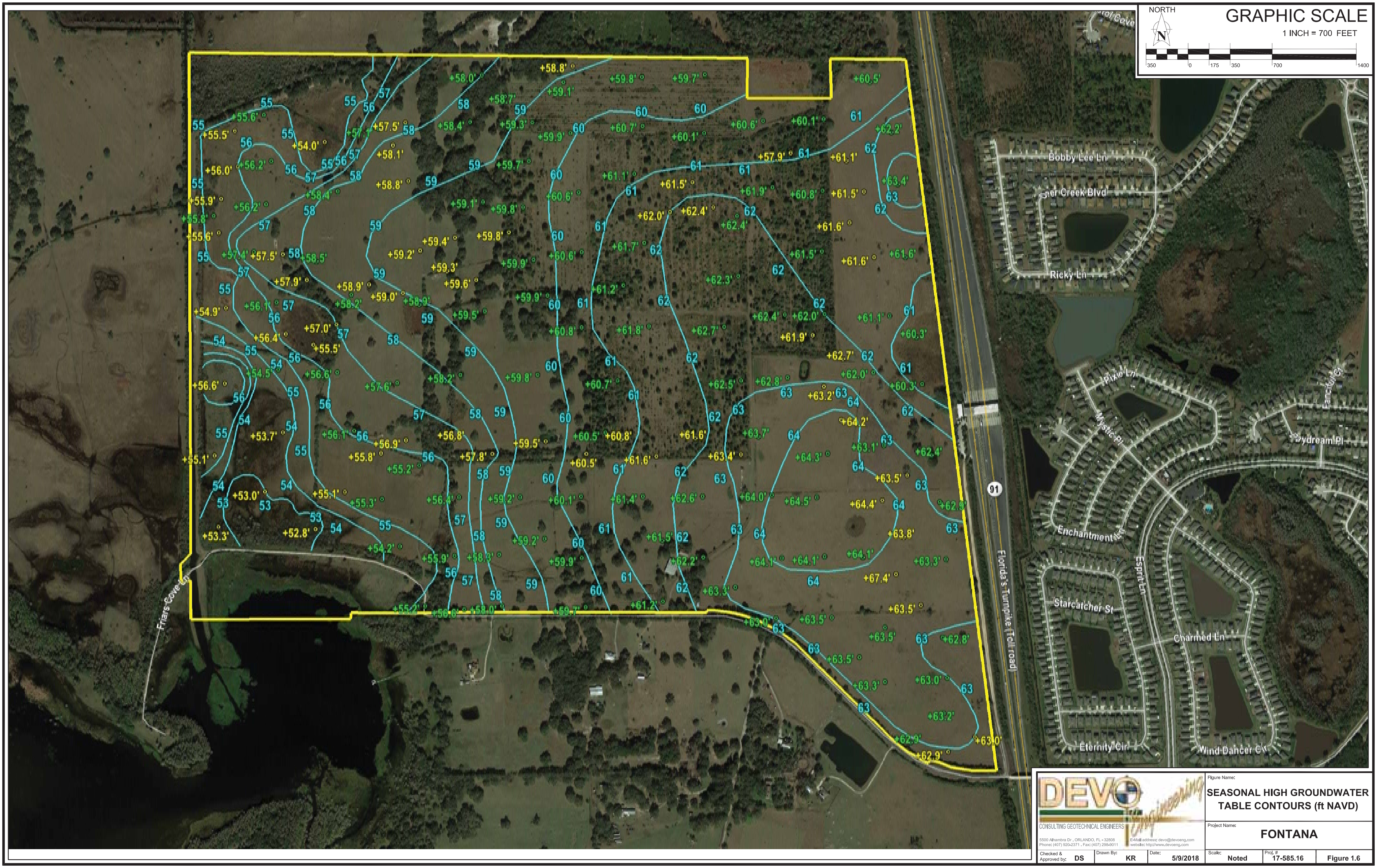

Figure Name:
SEASONAL HIGH GROUNDWATER TABLE CONTOURS (ft NAVD)

Project Name:
FONTANA

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr . ORLANDO, FL - 32808
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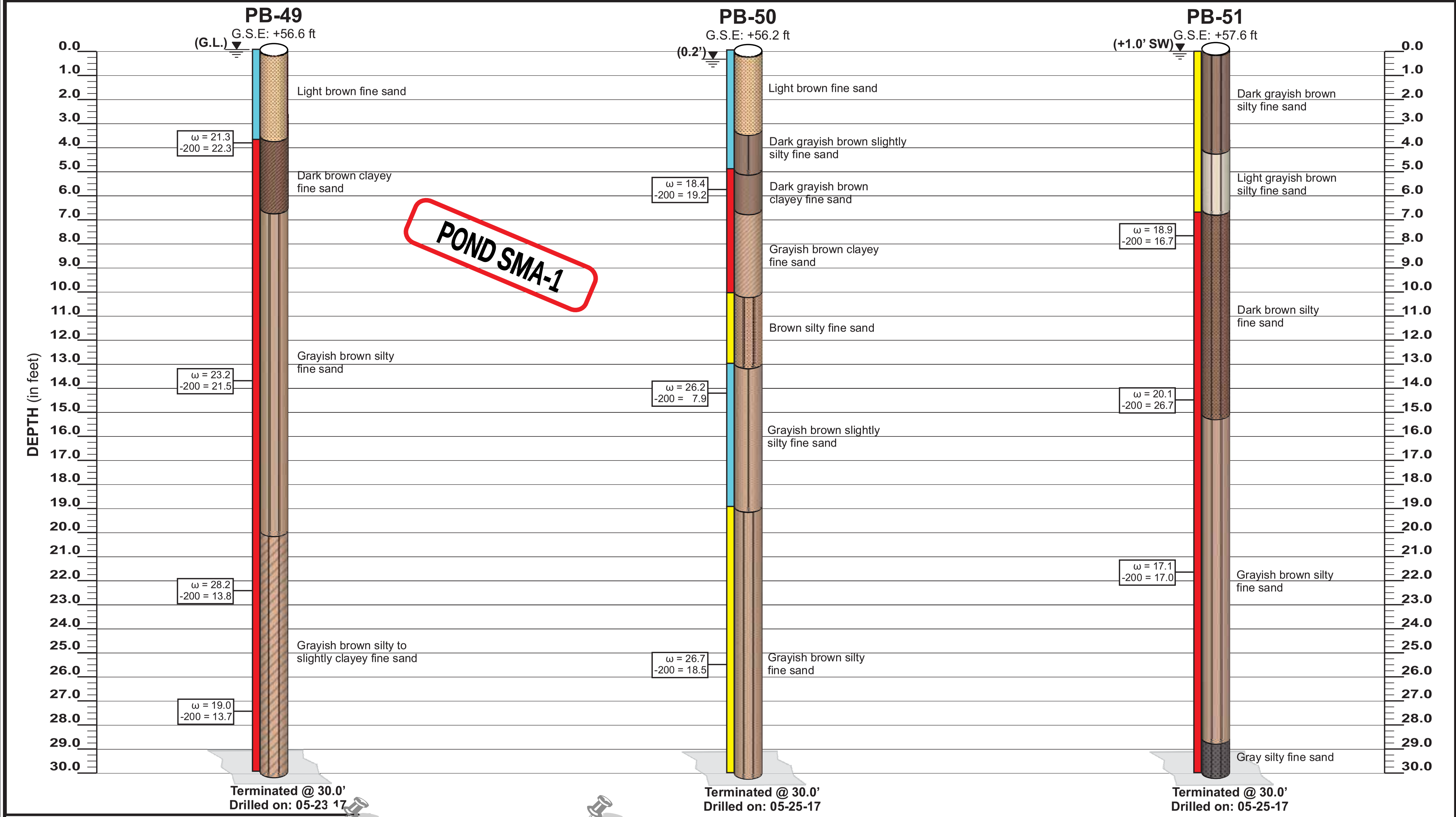
website: http://www.devoeng.com

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	KR	5/9/2018	Noted	17-585.16	Figure 1.6



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)
G.L. Ground Level

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

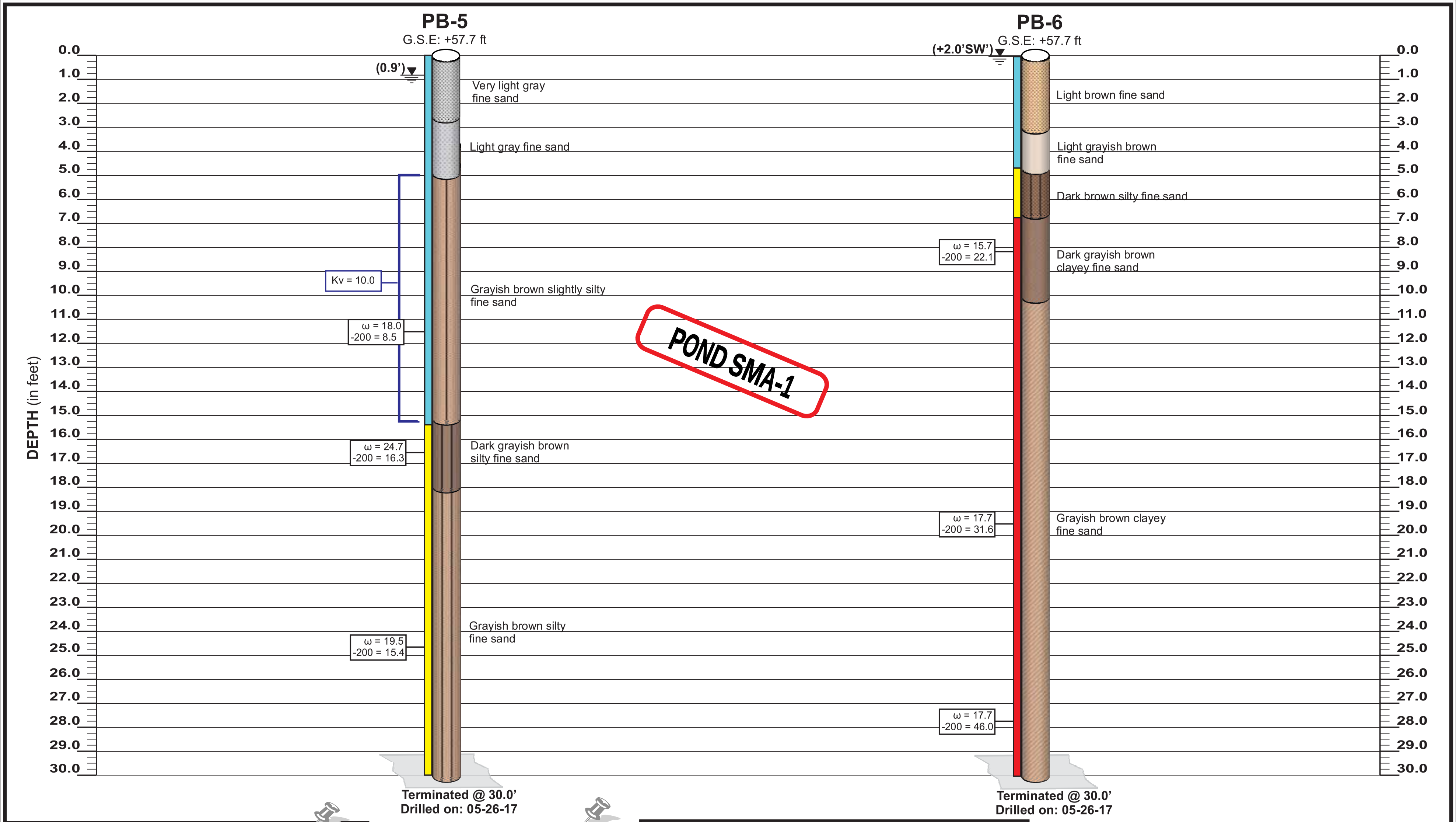
NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-1

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-06-17	NOTED	17-585.16	Figure 2.1a



NOTES:

	Borings drilled on the date noted
▼	Water level measured on July 21, 2017 unless otherwise noted
G.S.E	Surveyed ground surface elevation (ft NGVD)
SW	Standing Water

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

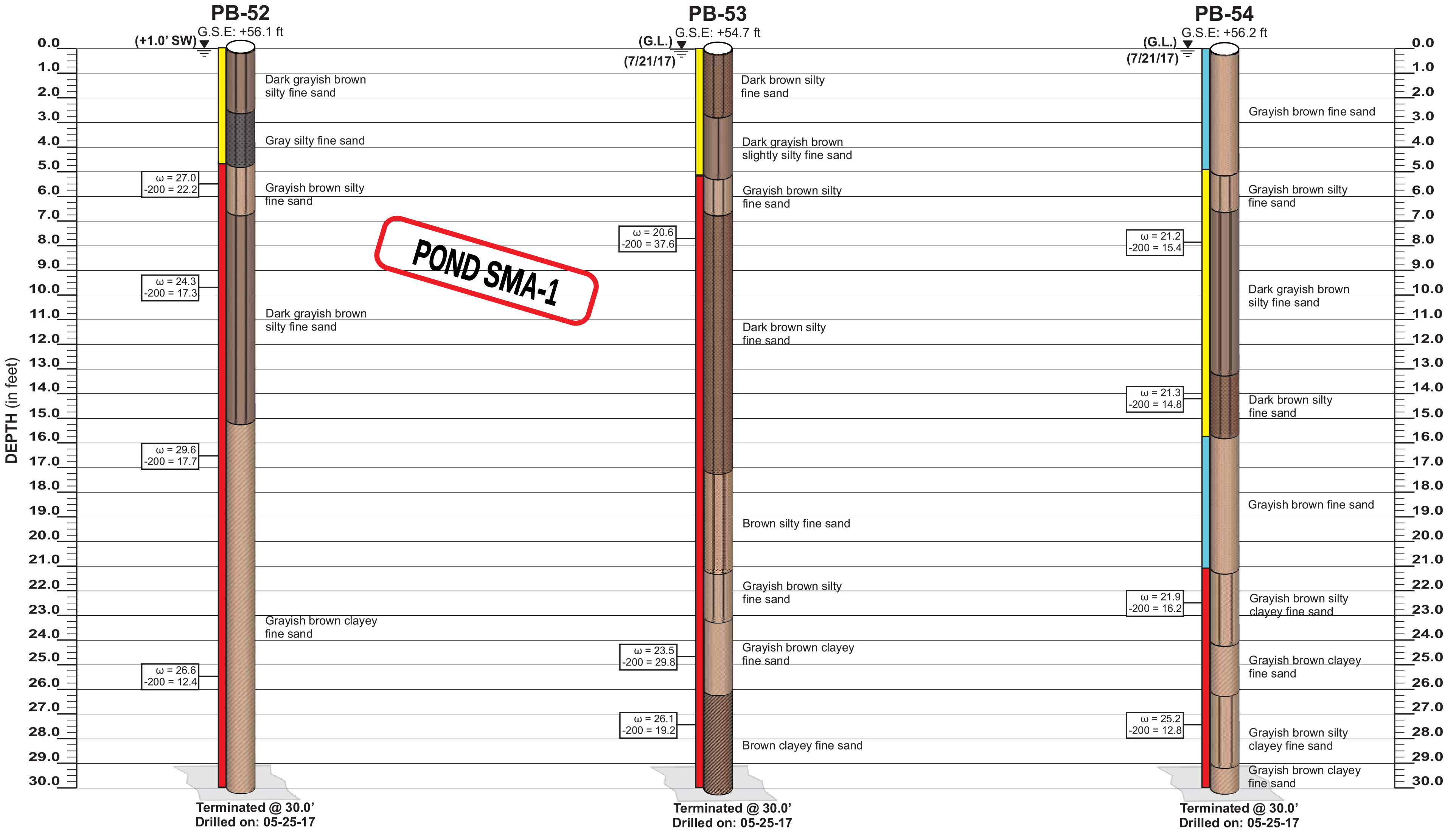
NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-1

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-02-17	NOTED	17-585.16	Figure 2.1b



NOTES:

Borings drilled on the date noted

▼ Water level measured on July 22, 2017 unless otherwise noted

G.S.E Surveyed ground surface elevation (ft NGVD)
SW Standing Water
G.L. Ground Level

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

NOTES:

🟦 Suitable fill for veneer

🟨 Suitable fill for all but veneer but with limitations on placement and compaction

🟥 Unsuitable for fill

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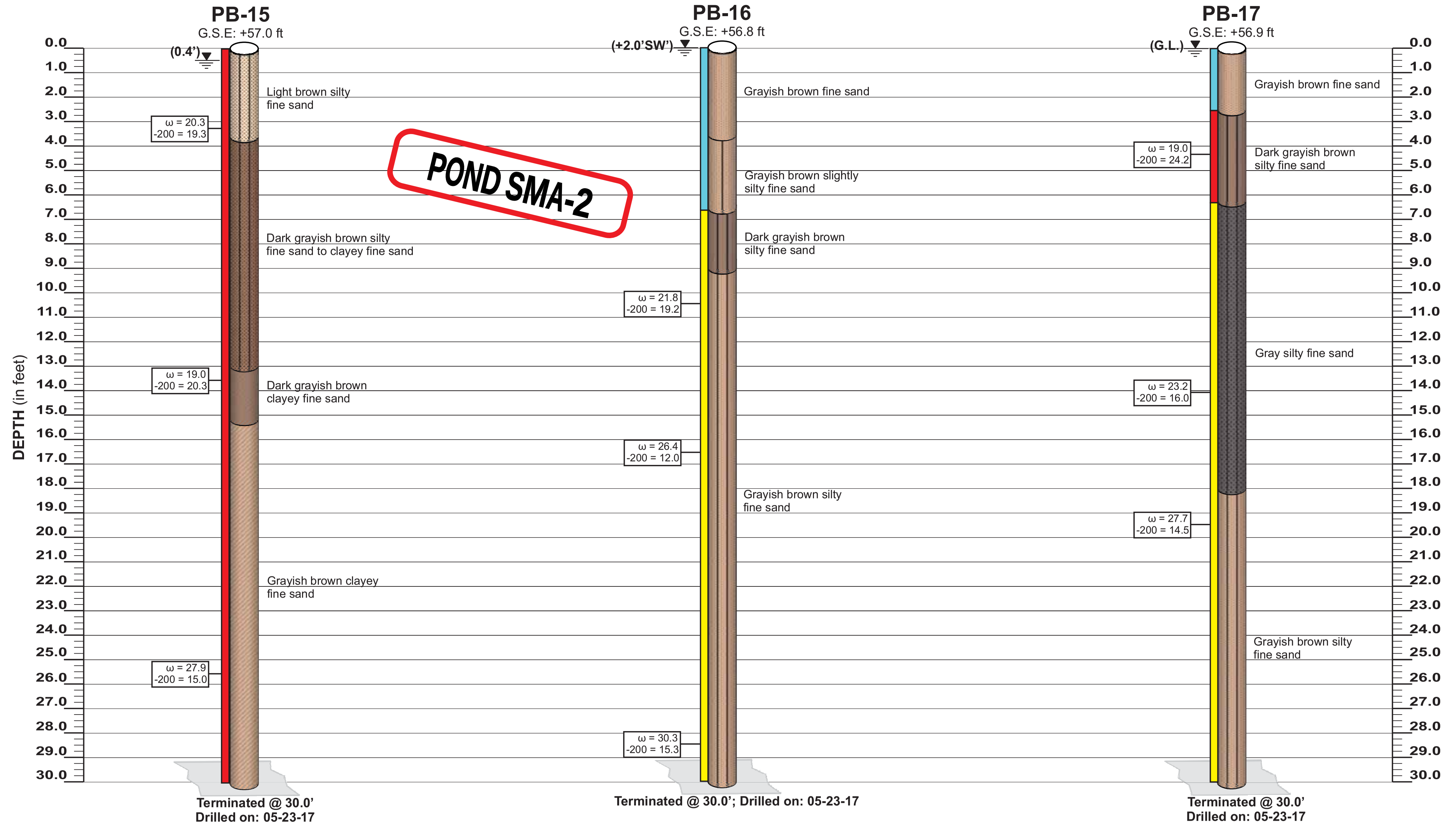
Figure Name:
SOIL PROFILES FOR POND SMA-1

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-06-17	NOTED	17-585.16	Figure 2.2



NOTES:

Borings drilled on the date noted

▼ Water level measured on July 21, 2017 unless otherwise noted

G.S.E Surveyed ground surface elevation (ft NGVD)
SW Standing Water
G.L. Ground Level

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

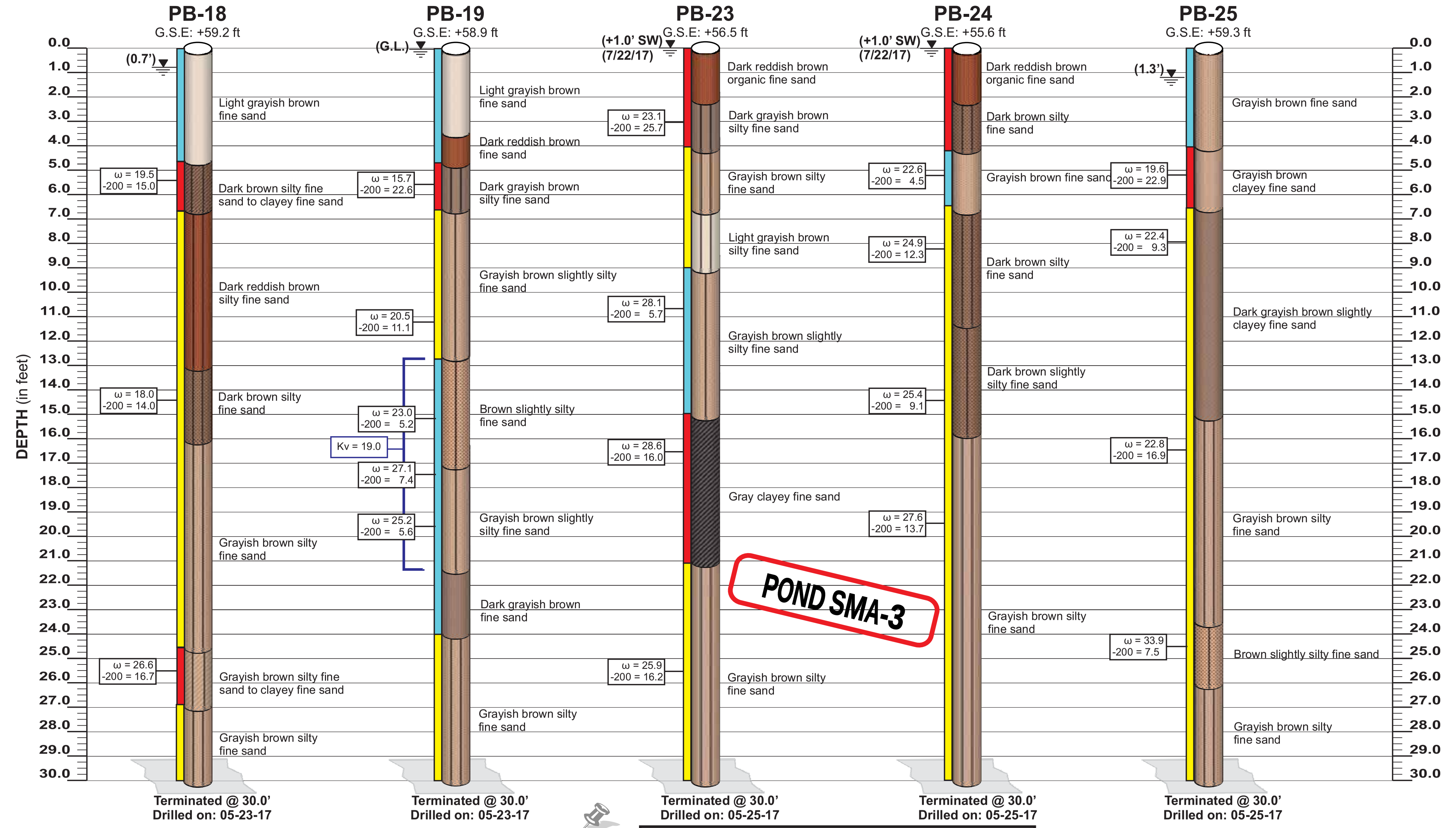
NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-2

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.3



NOTES:

Borings drilled on Date as noted

▼	Water level measured on the date borehole was drilled.
G.S.E	Surveyed ground surface elevation (ft NGVD)
SW	Standing Water

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

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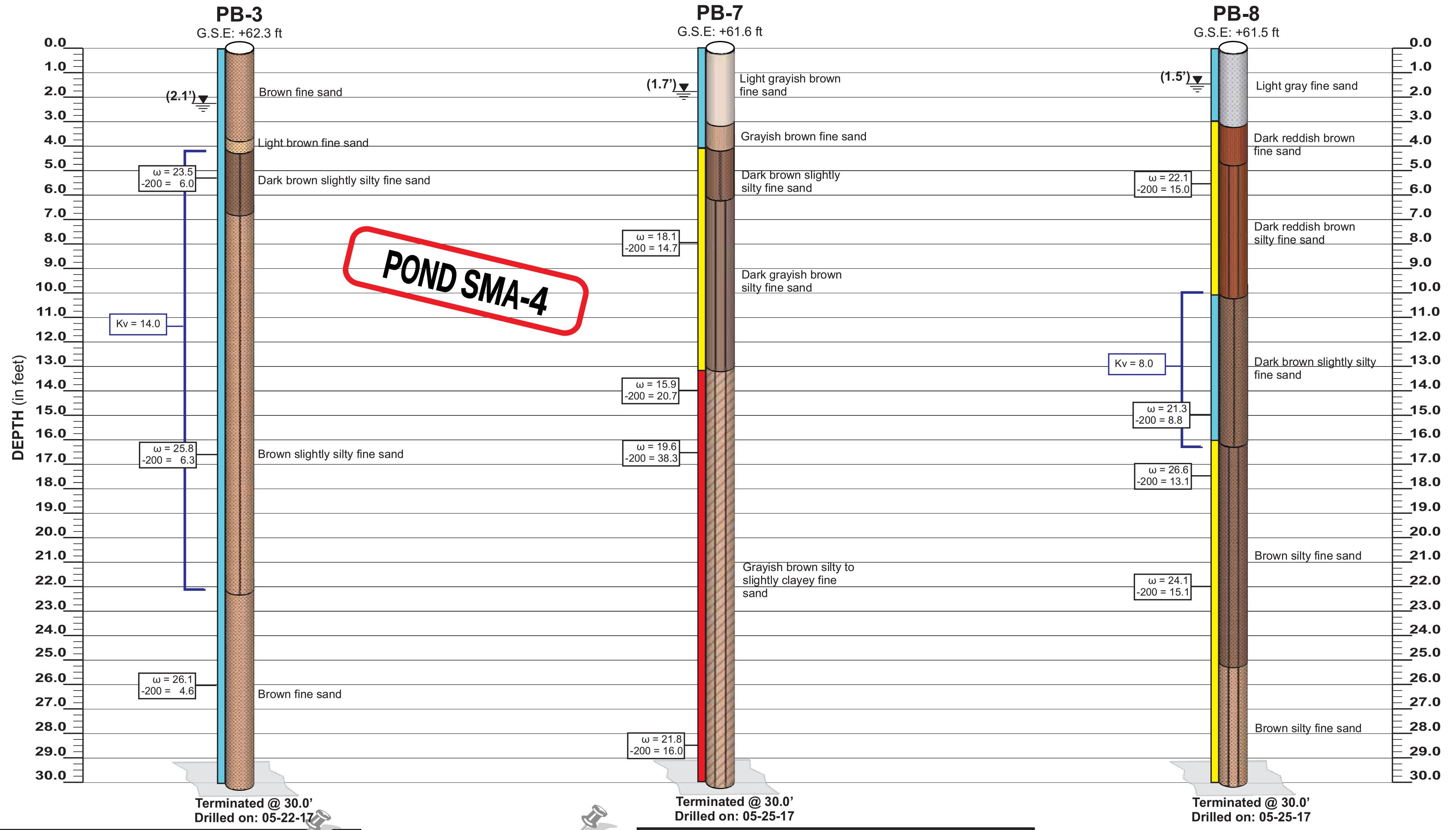
Figure Name: SOIL PROFILES FOR POND SMA-3

Project Name: FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.4



NOTES:

Borings drilled on the date noted

▼ Water level measured on July 21, 2017 unless otherwise noted

G.S.E Surveyed ground surface elevation (ft NGVD)

SW Standing Water

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

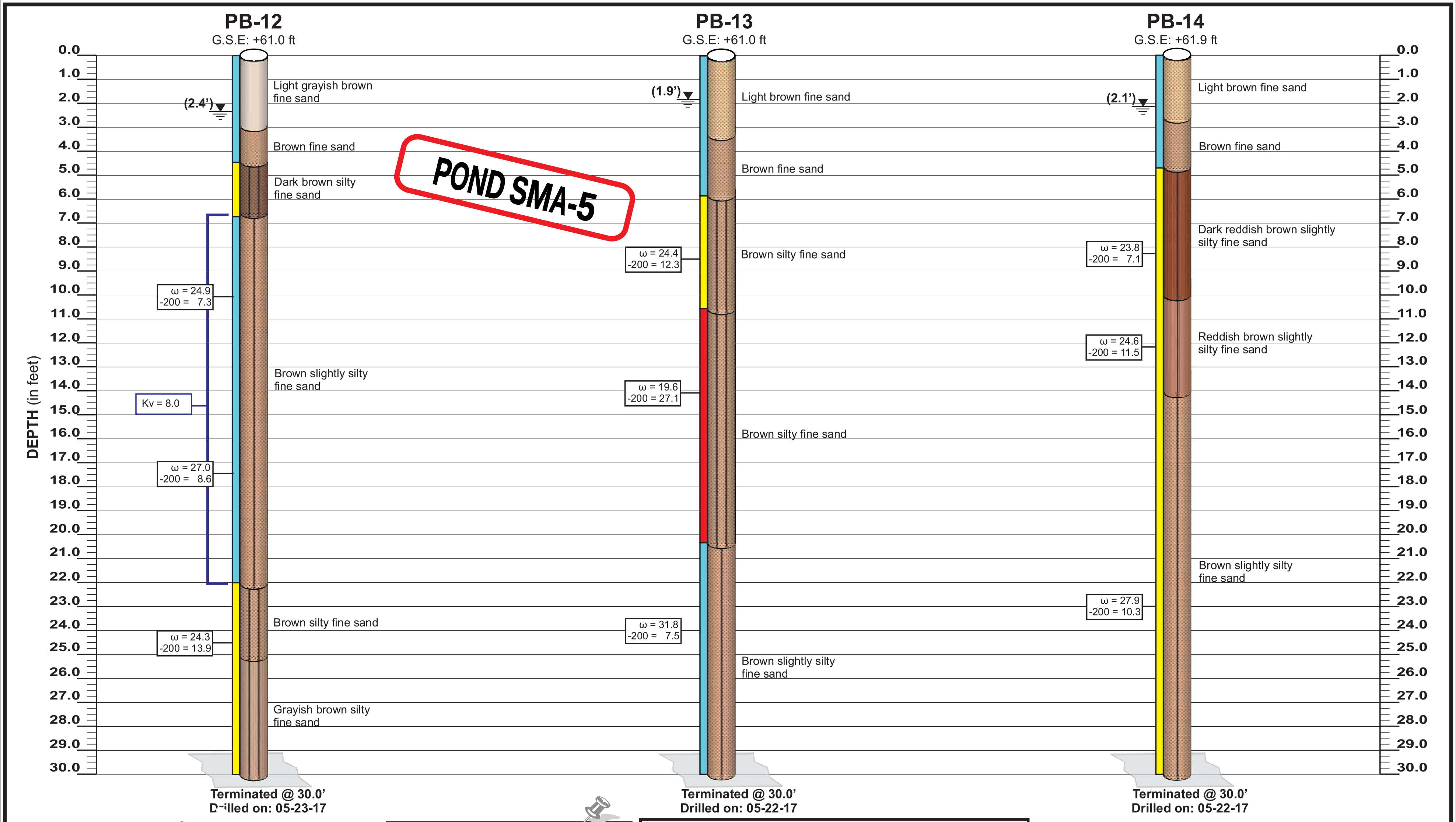
🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

DEVO Engineering

Figure Name:
SOIL PROFILES FOR POND SMA-4

Project Name:
FONTANA

Checked & Approved By: KR
Drawn By: DM
Date: 06-02-17
Scale: NOTED
Project #: 17-585.16
Figure 2.5



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

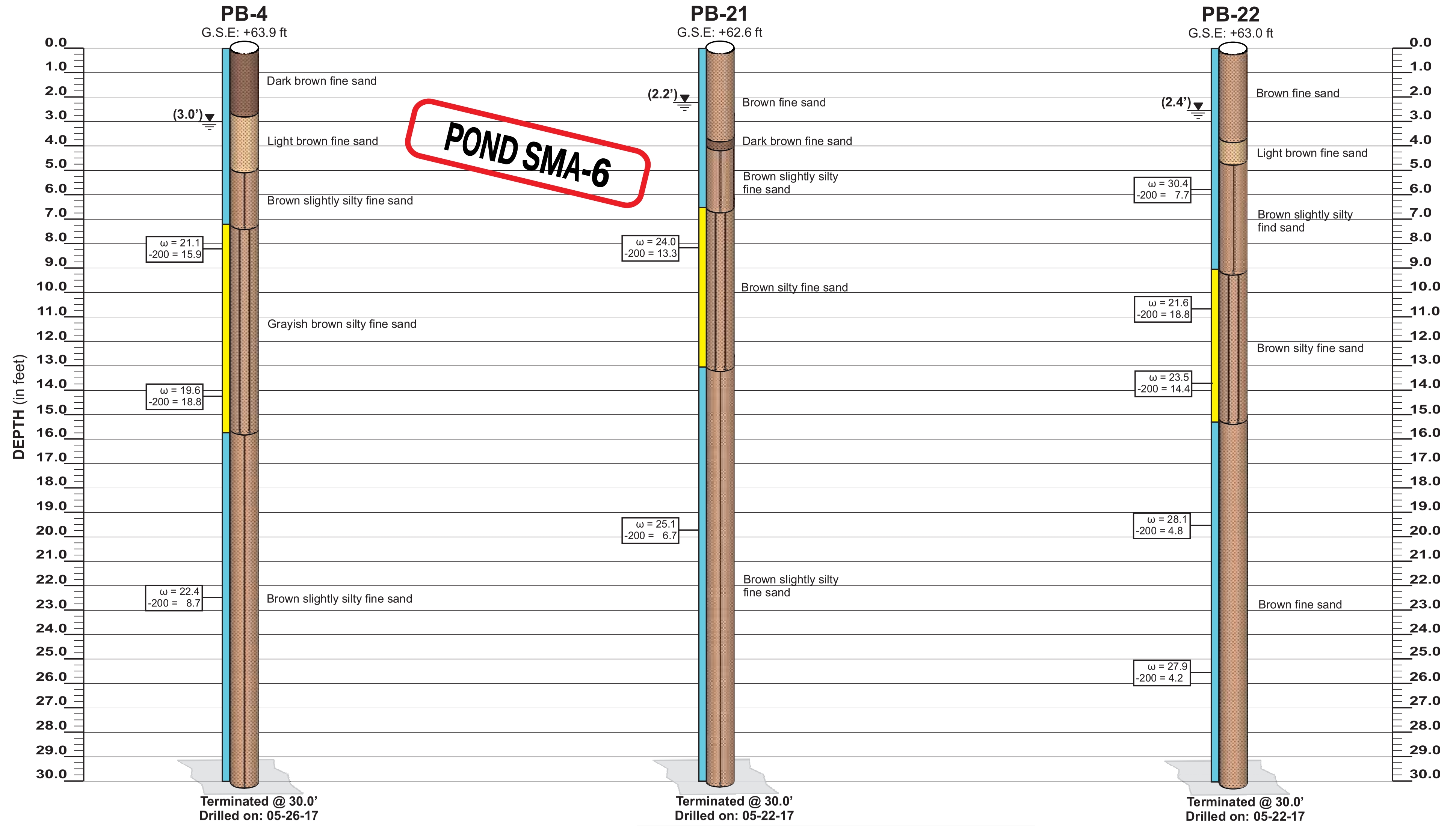
NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-5

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.6



NOTES:

	Borings drilled on Date as noted
▽	Water level measured on the date borehole was drilled.
G.S.E	Surveyed ground surface elevation (ft NGVD)
SW	Standing Water

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

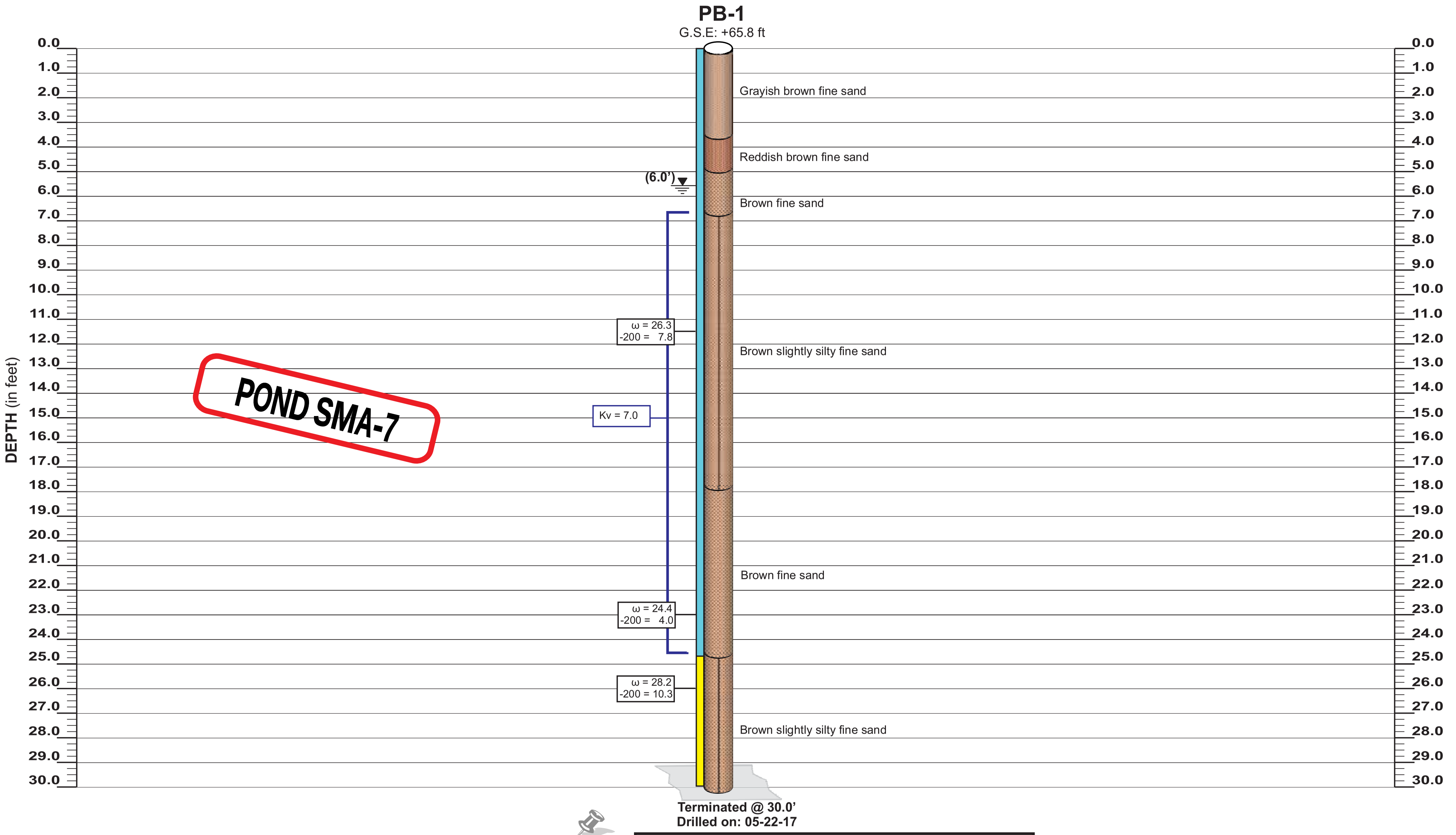
NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-6

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.7



NOTES:

Borings drilled on date noted

Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

🟦 Suitable fill for veneer

🟨 Suitable fill for all but veneer but with limitations on placement and compaction

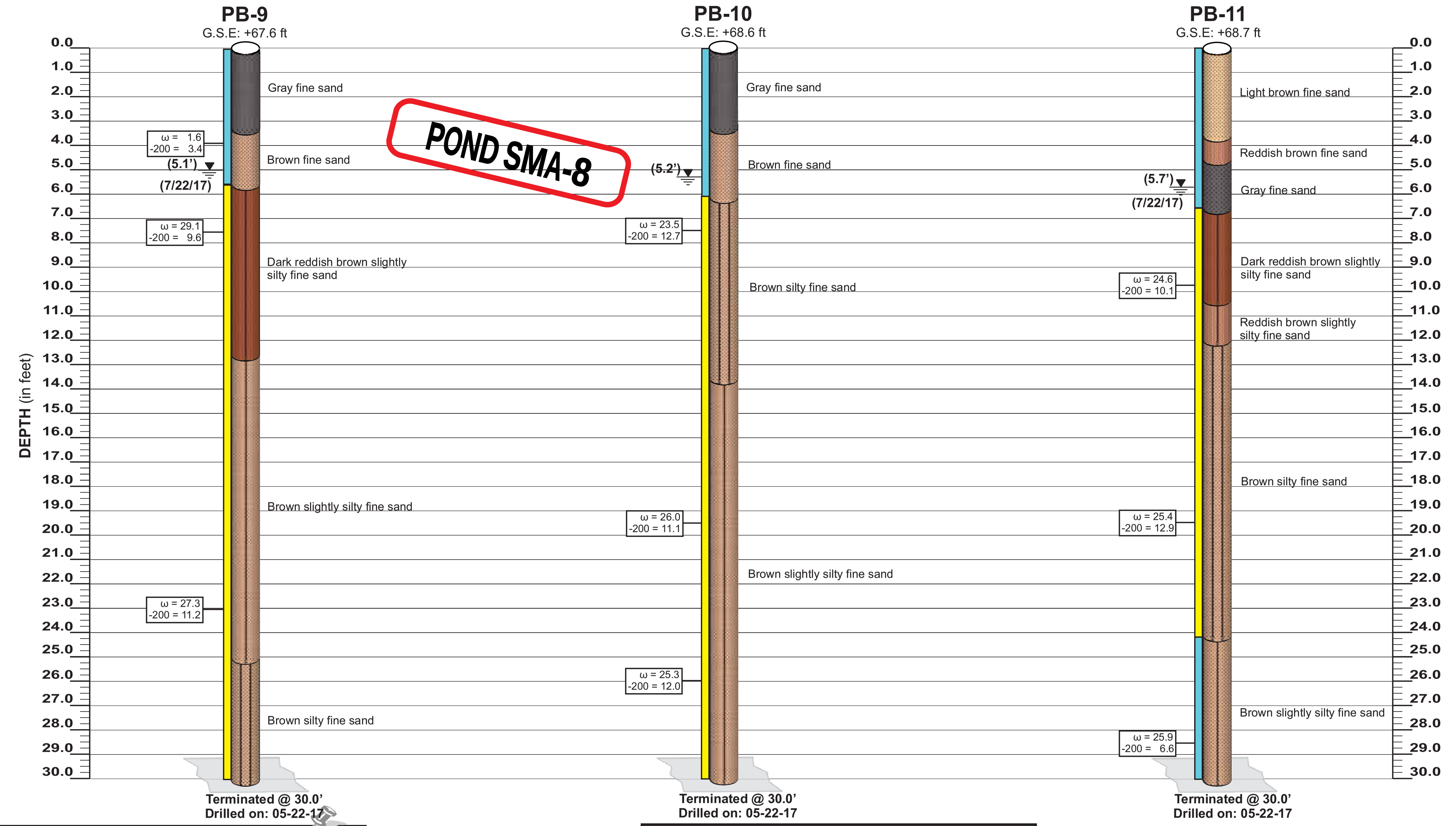
🟥 Unsuitable for fill

DEVO Engineering

Figure Name:
SOIL PROFILES FOR POND SMA-7

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-01-17	NOTED	17-585.16	Figure 2.8



NOTES:

Borings drilled on the date noted

▽ Water level measured on July 21, 2017 unless otherwise noted

G.S.E Surveyed ground surface elevation (ft NGVD)

SW Standing Water

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

NOTES:

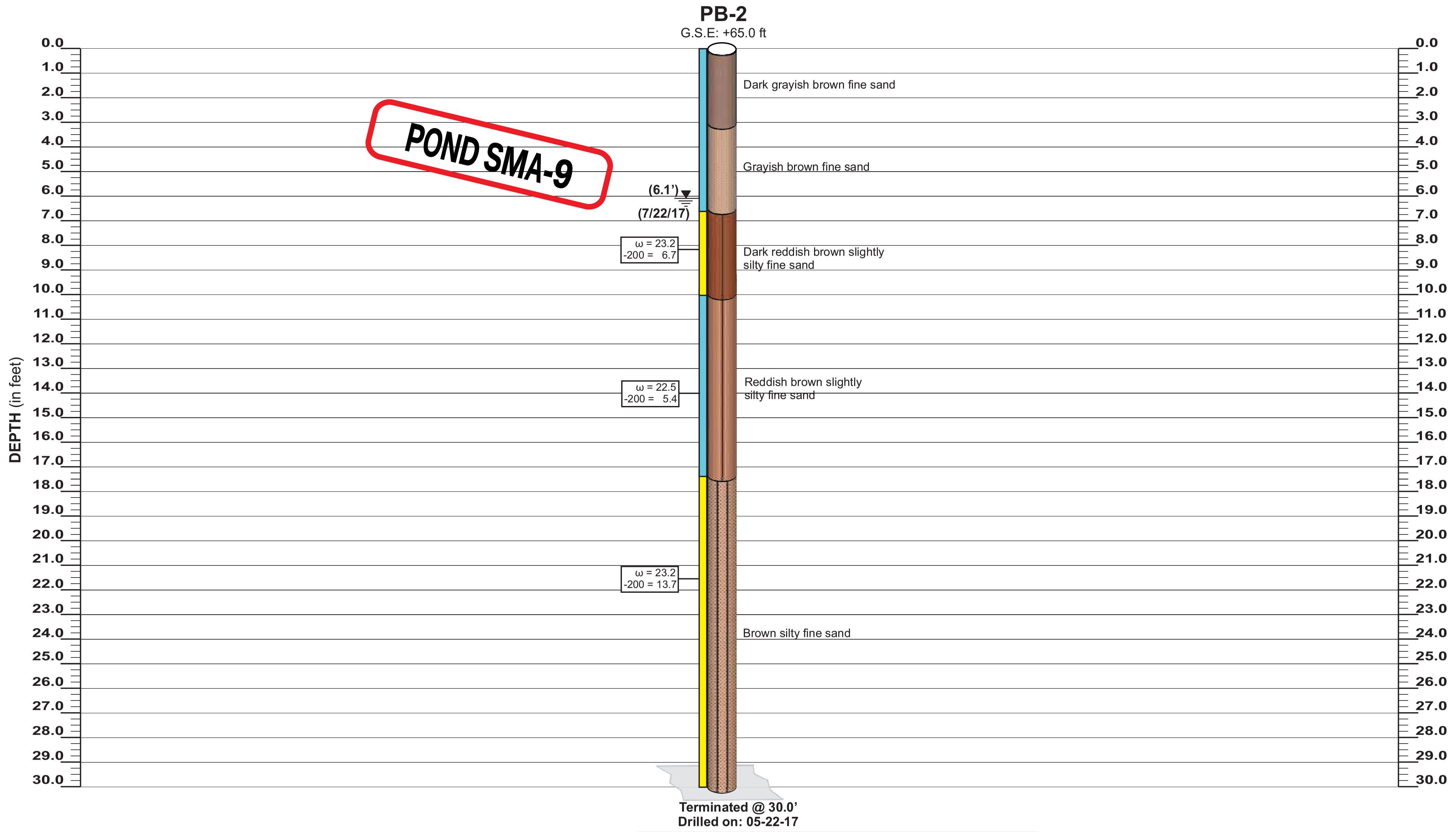
🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

DEVO Engineering

Figure Name:
SOIL PROFILES FOR POND SMA-8

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-02-17	NOTED	17-585.16	Figure 2.9



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

NOTES:

🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

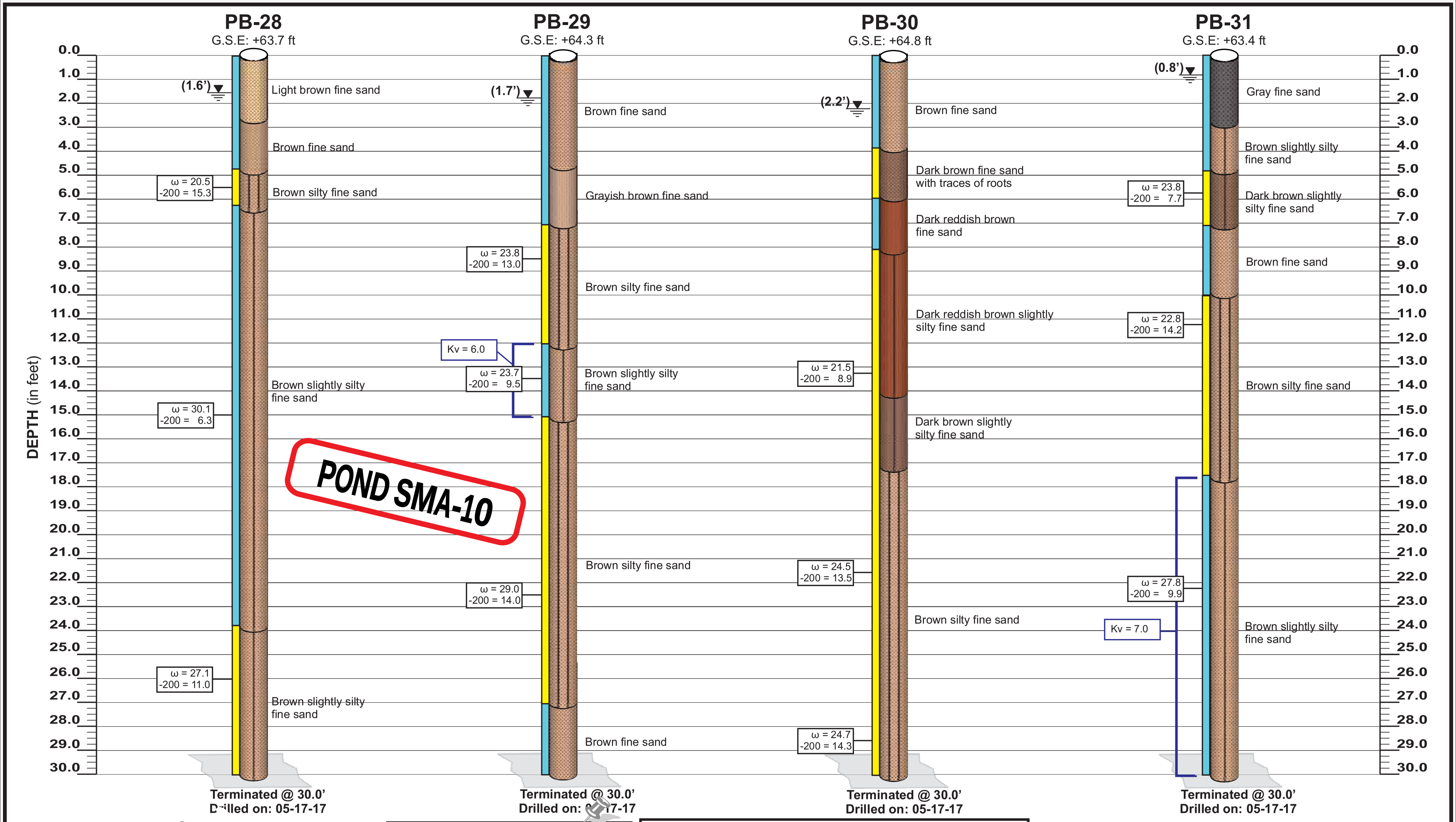
Figure Name:

SOIL PROFILES FOR POND SMA-9

Project Name:

FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-01-17	NOTED	17-585.16	Figure 2.10



NOTES:

Borings drilled on date noted

▽ Water level measured on July 22, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

🟦 Suitable fill for veneer

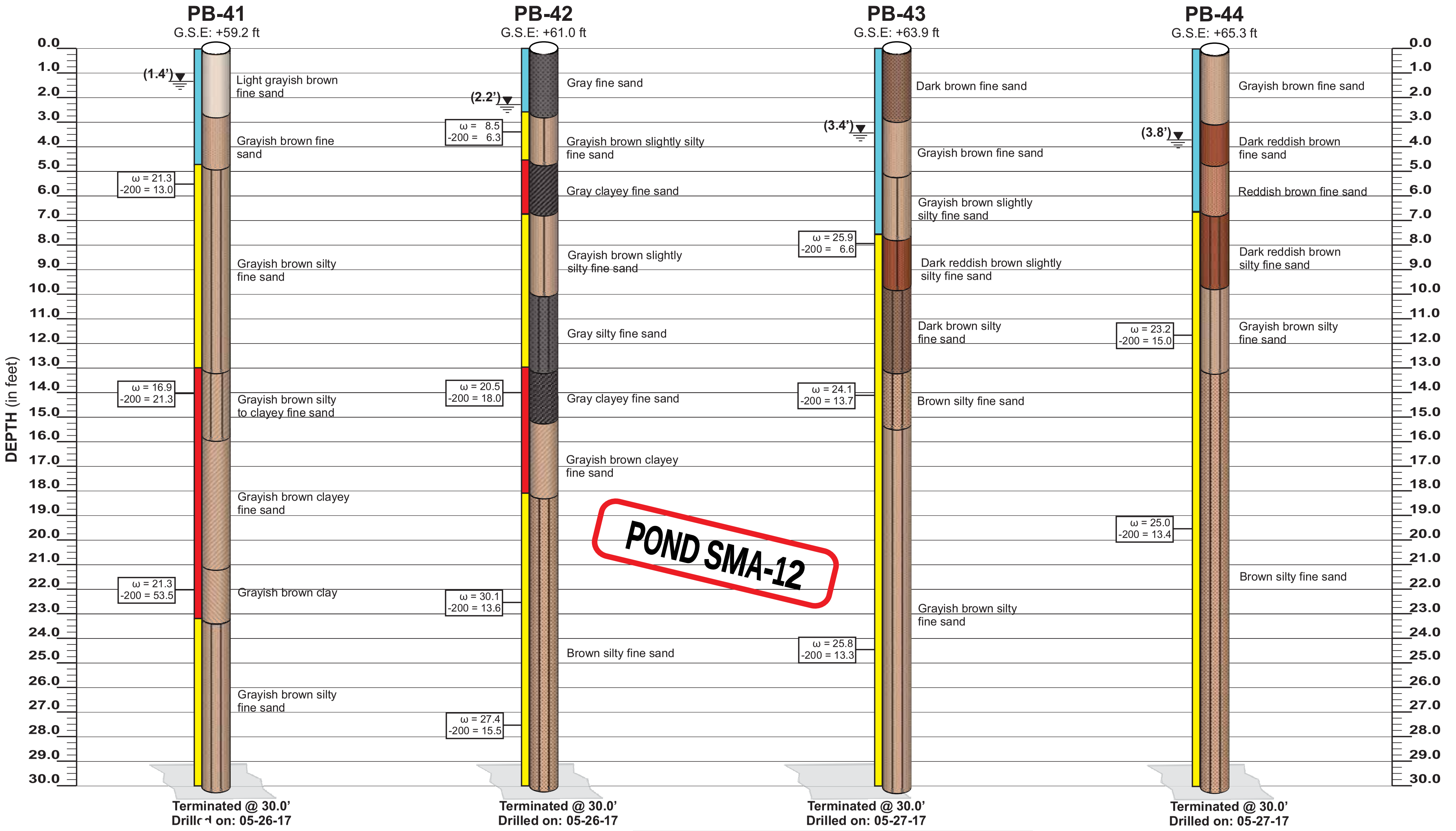
🟨 Suitable fill for all but veneer but with limitations on placement and compaction

🟥 Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-10

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.11



NOTES:

Borings drilled on date noted

▽ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

NOTES:

🟦 Suitable fill for veneer

🟨 Suitable fill for all but veneer but with limitations on placement and compaction

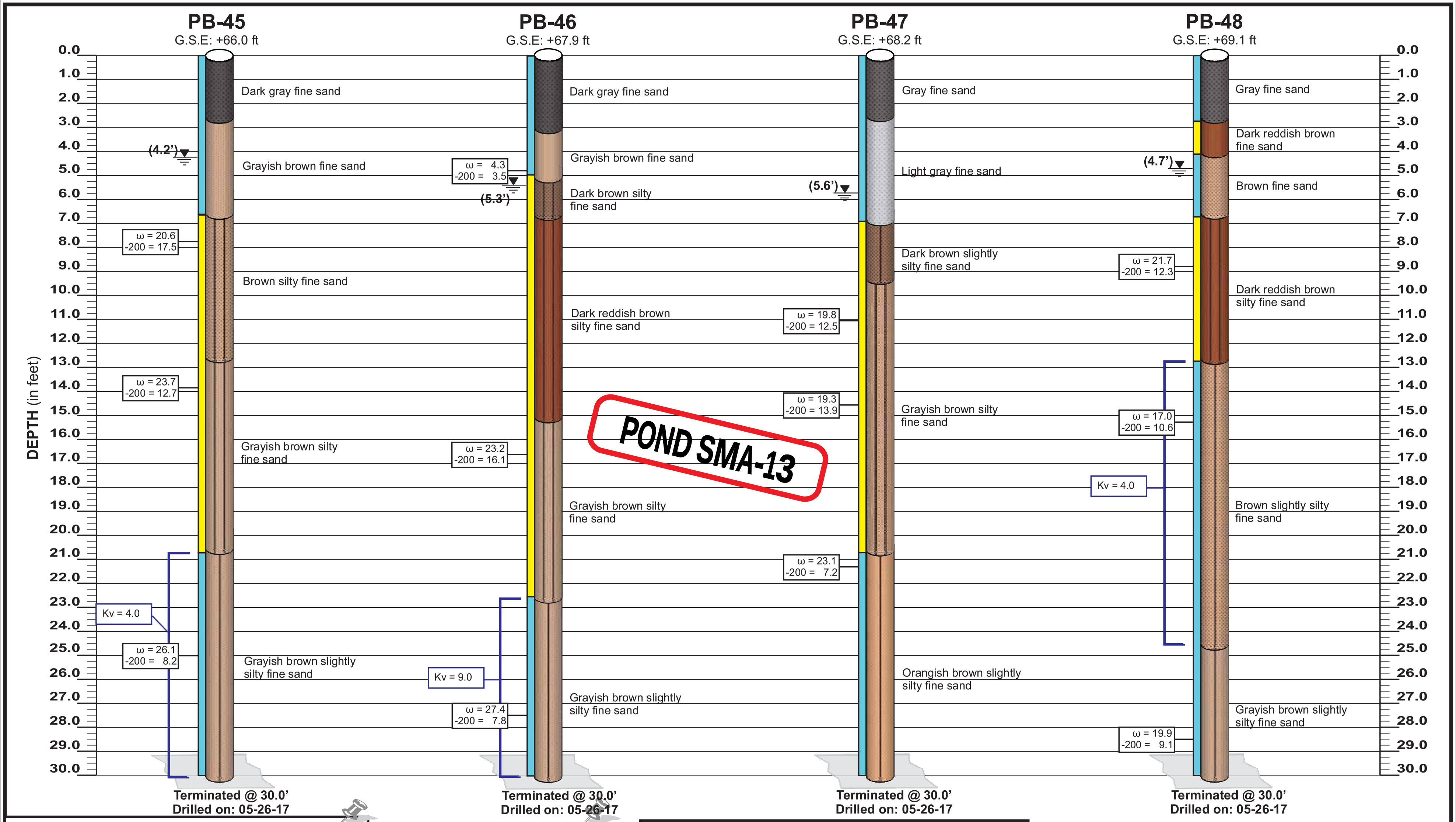
🟥 Unsuitable for fill

DEVO Engineering

Figure Name:
SOIL PROFILES FOR POND SMA-12

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-06-17	NOTED	17-585.16	Figure 2.12



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)
G.L. Ground Level

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

🟦 Suitable fill for veneer

🟨 Suitable fill for all but veneer but with limitations on placement and compaction

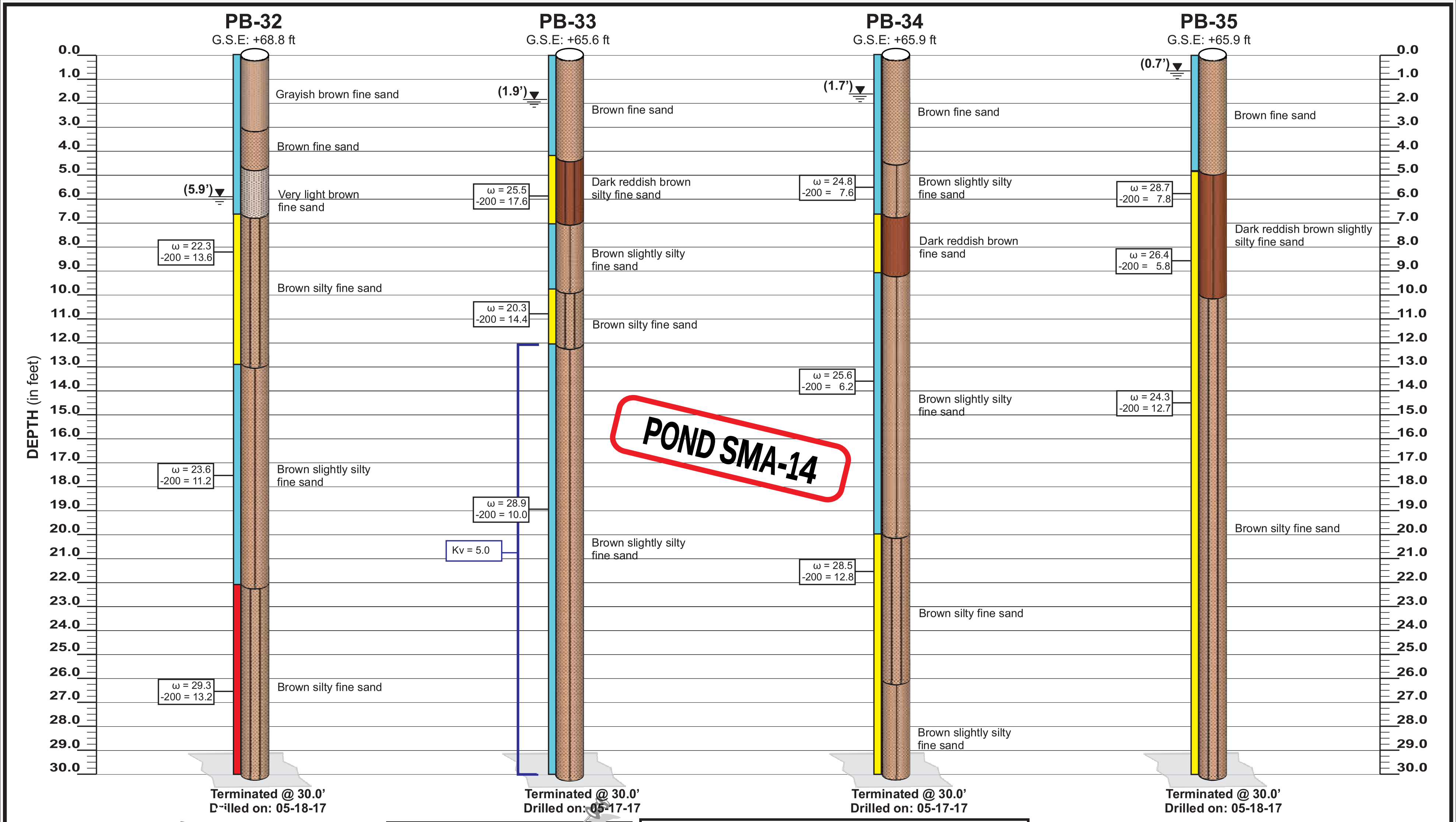
🟥 Unsuitable for fill

DEVO Engineering

Figure Name:
SOIL PROFILES FOR POND SMA-13

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-06-17	NOTED	17-585.16	Figure 2.13



NOTES:

Borings drilled on date noted

▽ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

🟦 Suitable fill for veneer

🟨 Suitable fill for all but veneer but with limitations on placement and compaction

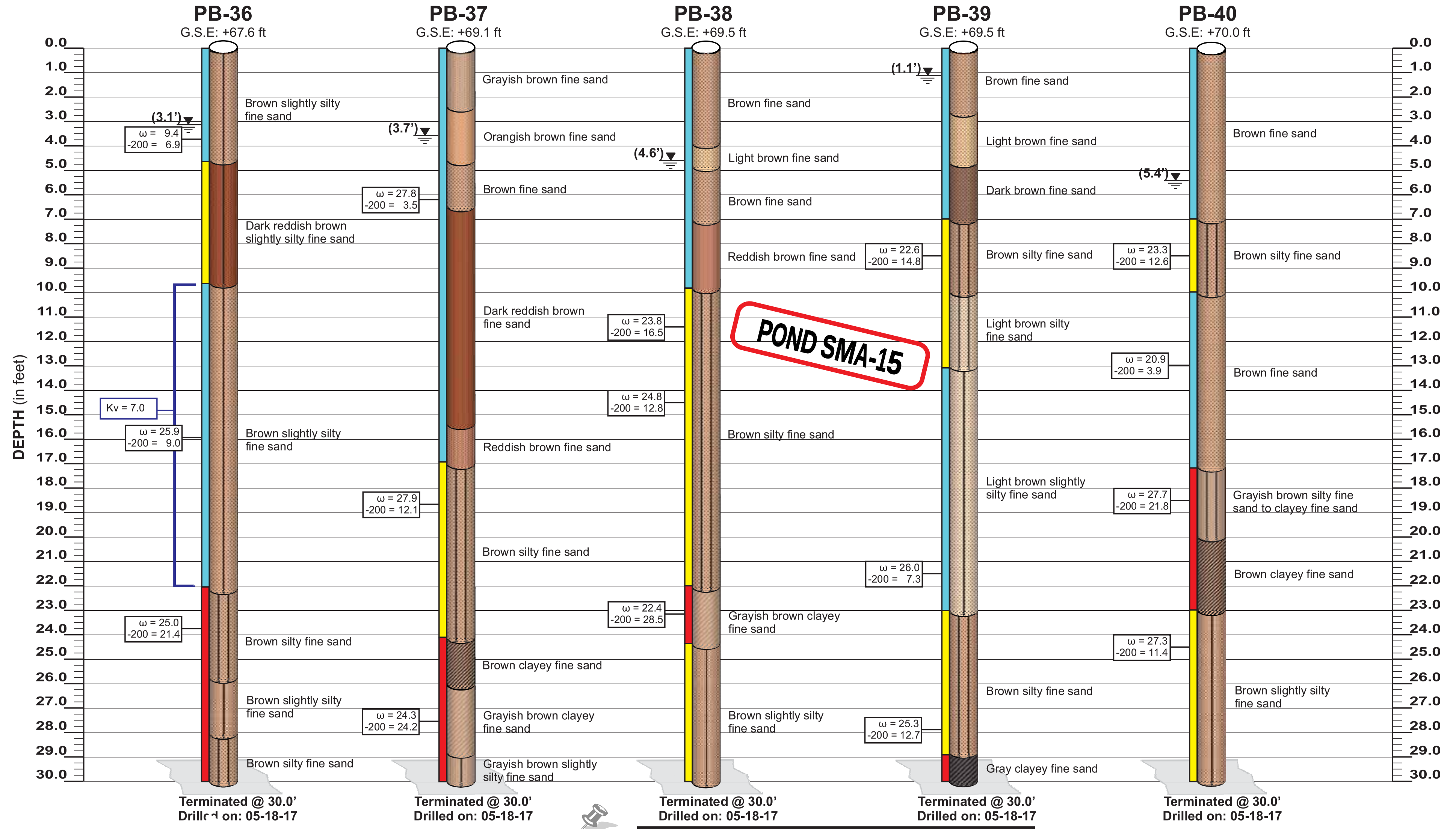
🟥 Unsuitable for fill

DEVO Engineering

Figure Name: **SOIL PROFILES FOR POND SMA-14**

Project Name: **FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.14



NOTES:

	Borings drilled on date noted
▽	Water level measured on July 22, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

Kv = Remolded hydraulic conductivity (densely packed) (ft/day)

NOTES:

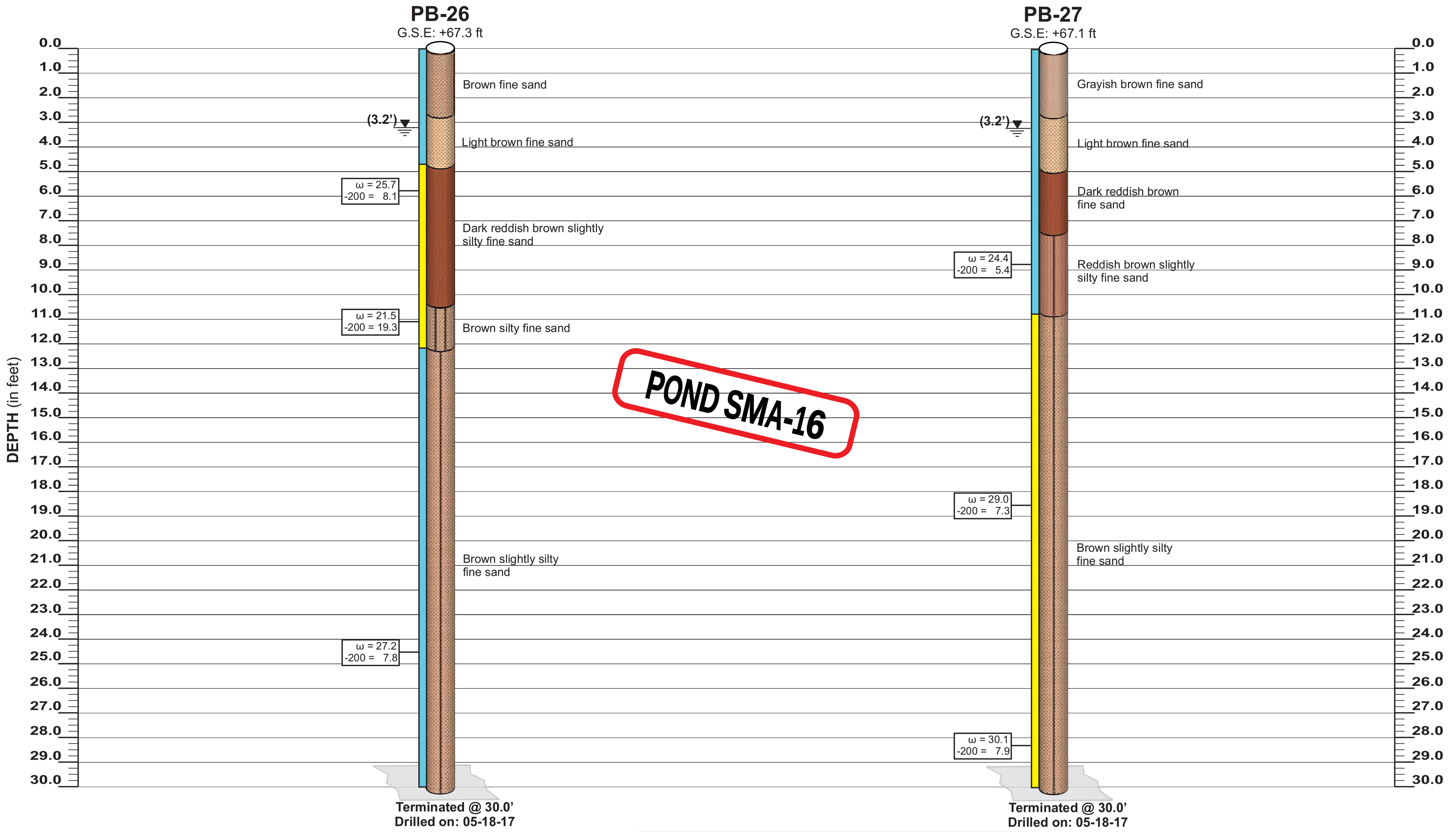
🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS

Figure Name:
SOIL PROFILES FOR POND SMA-15

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.15



NOTES:

Borings drilled on date noted

▼ Water level measured on July 22, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

NOTES:

🟦 Suitable fill for veneer

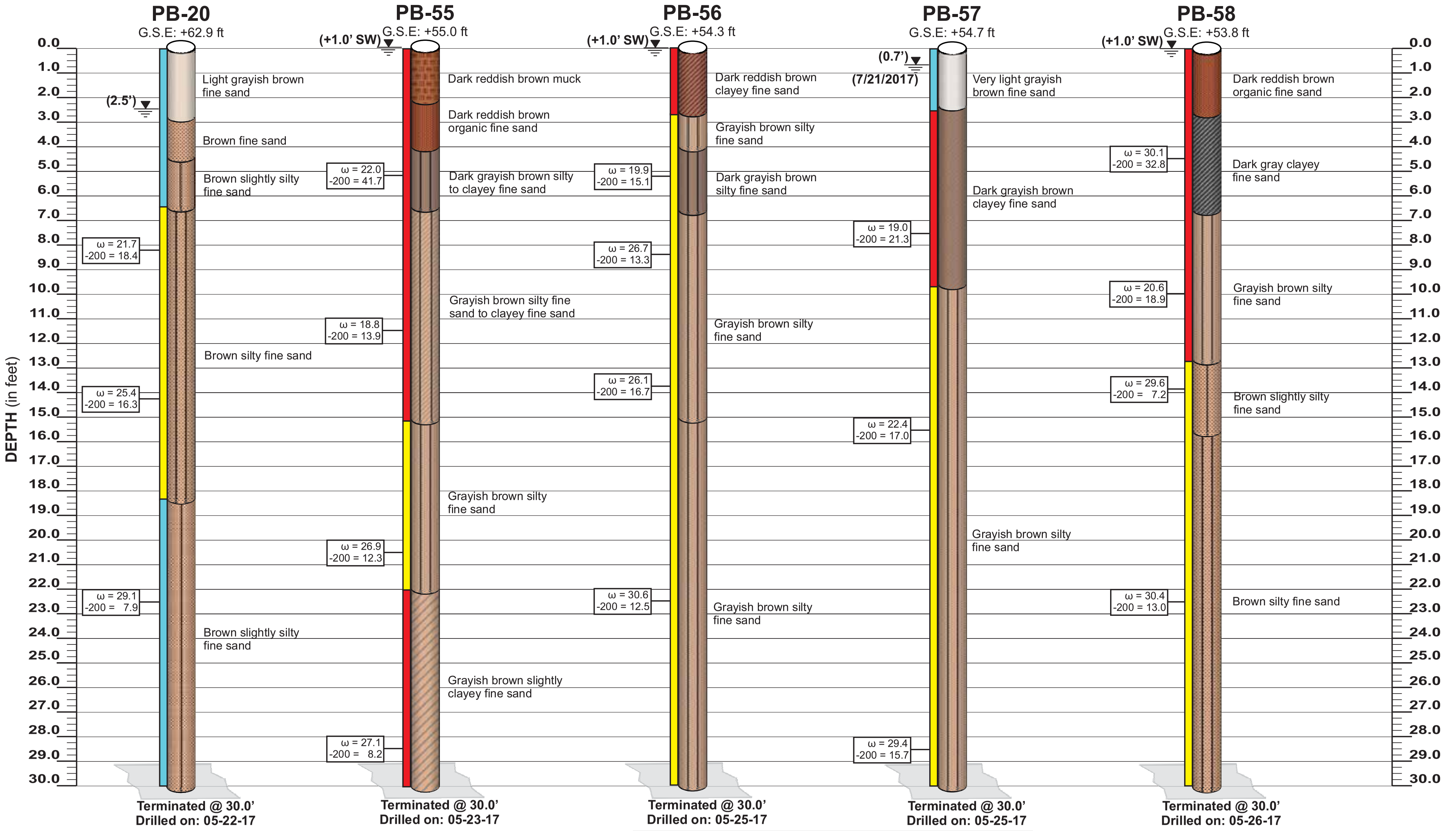
🟨 Suitable fill for all but veneer but with limitations on placement and compaction

🟥 Unsuitable for fill

Figure Name:
SOIL PROFILES FOR POND SMA-16

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.16



NOTES:

Borings drilled on date noted

▽ Water level measured on July 22, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NGVD)

NOTES:

ω = Field moisture content %

-200 = Percent passing US #200 Sieve

NOTES:

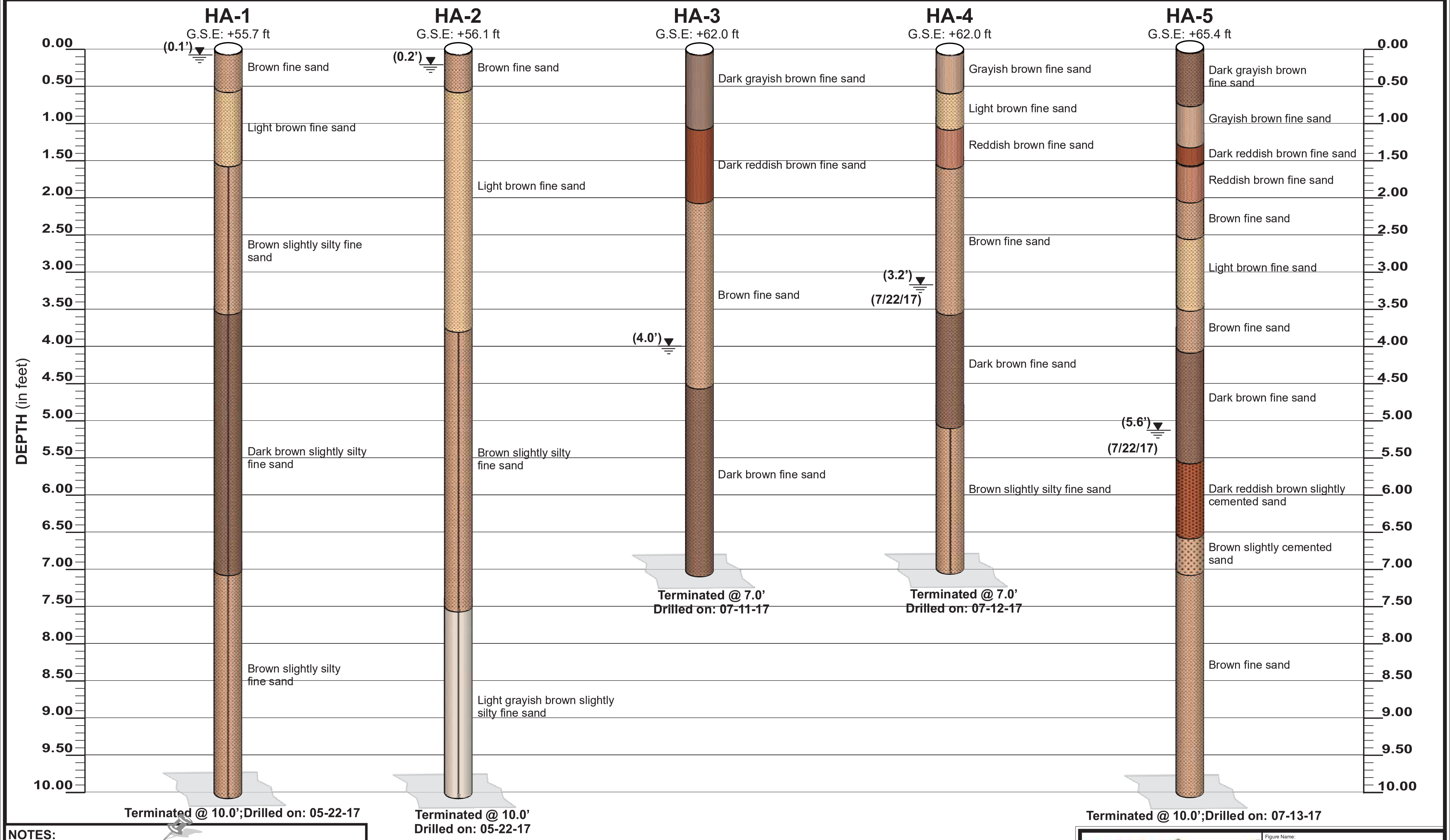
🟦	Suitable fill for veneer
🟨	Suitable fill for all but veneer but with limitations on placement and compaction
🟥	Unsuitable for fill

DEVO Engineering

Figure Name:
SOIL PROFILES FOR
PB Borings Outside
Current Pond Configuration

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
KR	DM	06-05-17	NOTED	17-585.16	Figure 2.17



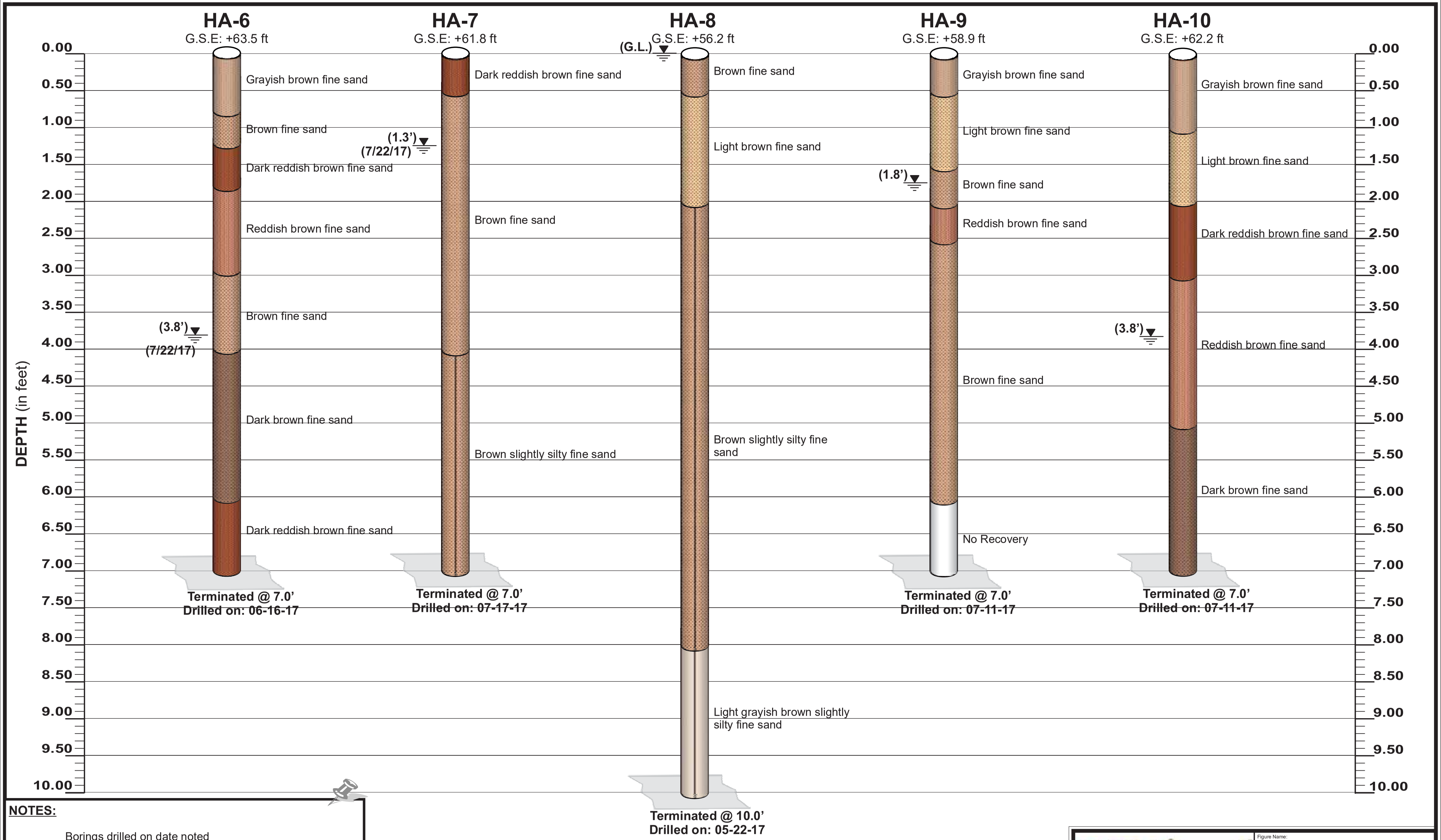
NOTES:

	Borings drilled on date noted
▼	Water level measured on July 21, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name:	**SOIL PROFILES FOR HA-1 TO HA-5**
Project Name:	**FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.1



NOTES:

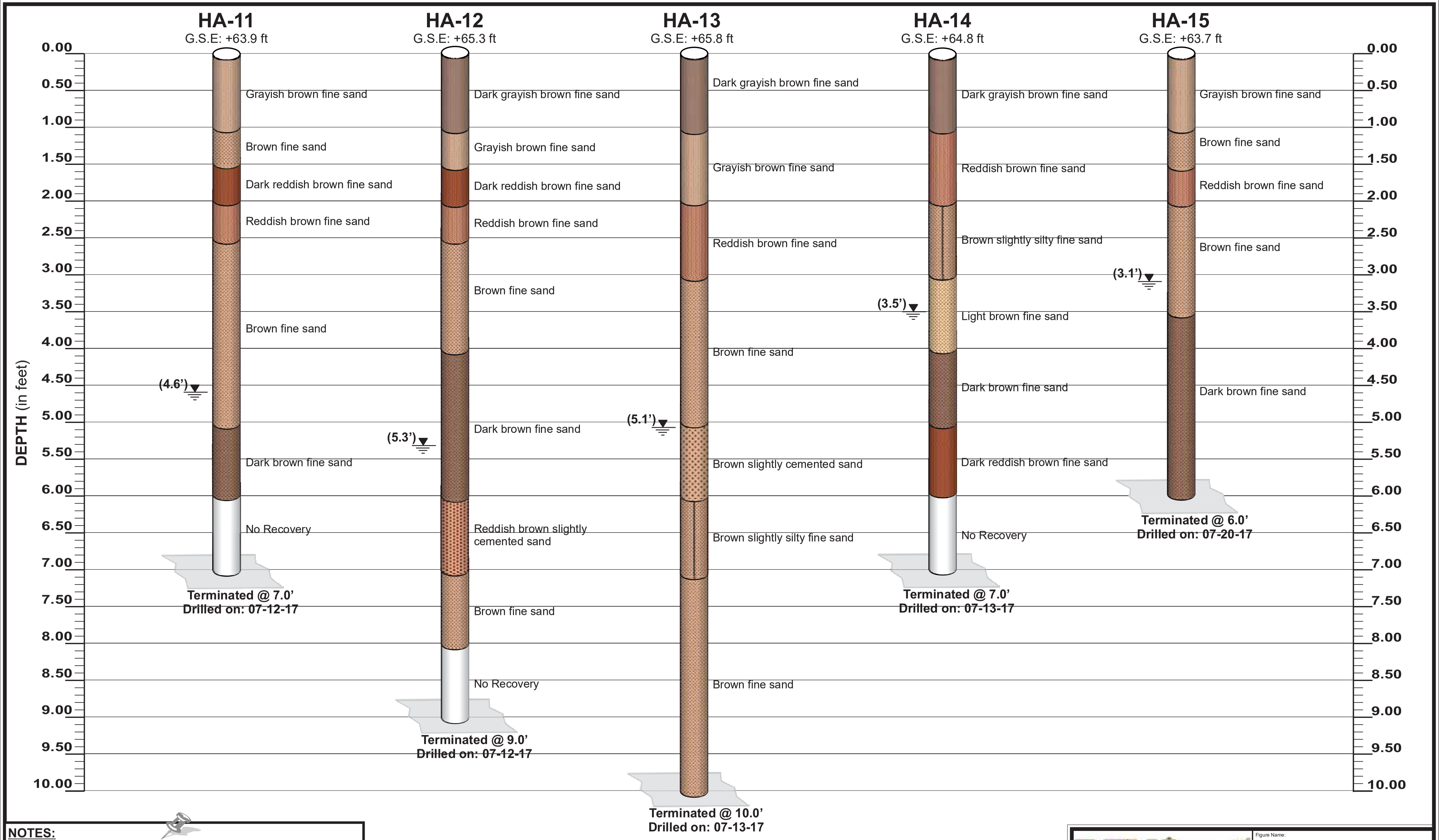
	Borings drilled on date noted
▼	Water level measured on July 21, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)
G.L.	Ground Level

DEVO Engineering

Figure Name:
SOIL PROFILES FOR HA-6 TO HA-10

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.2



NOTES:

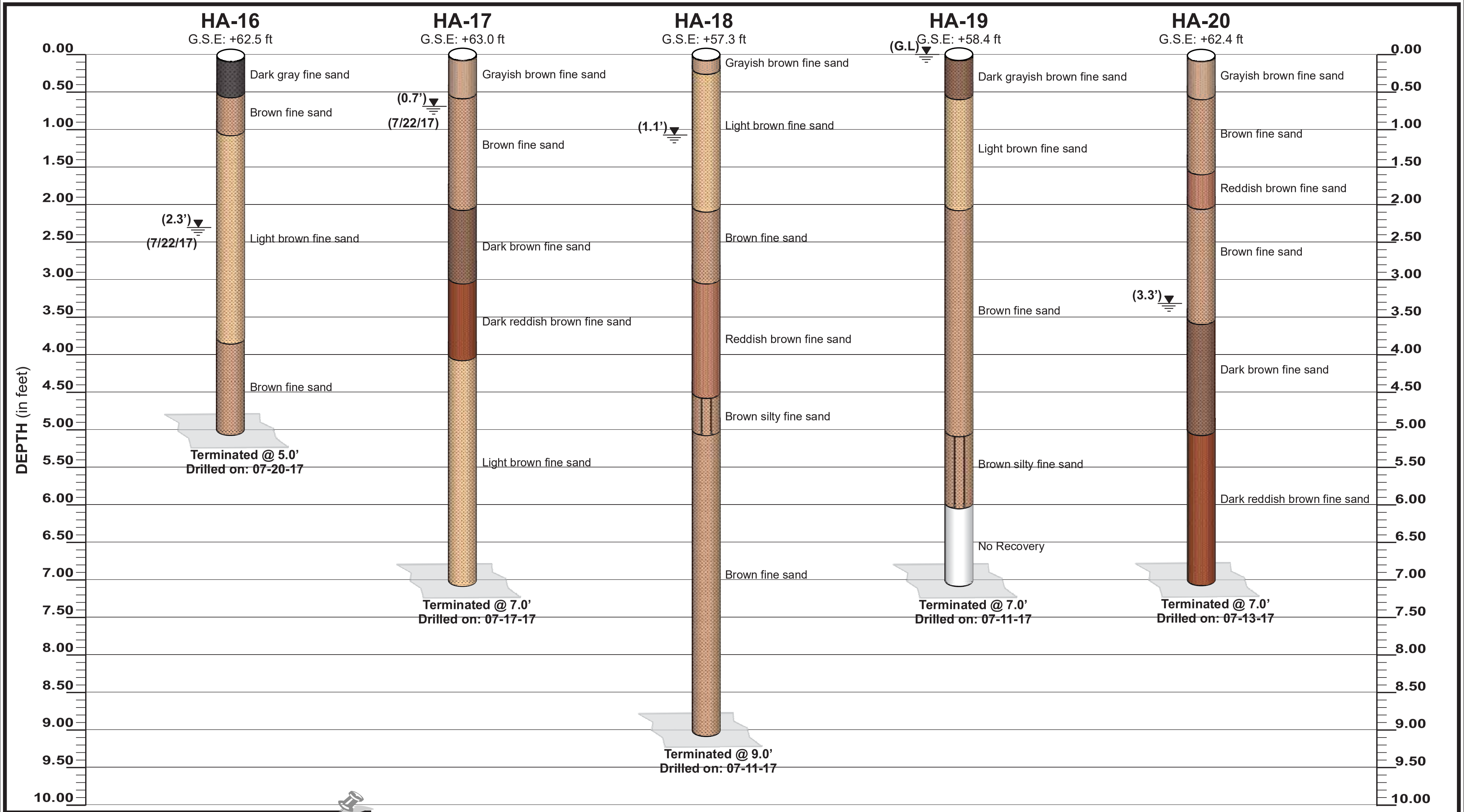
Borings drilled on date noted

▼ Water level measured on July 22, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NAVD)

Figure Name:	SOIL PROFILES FOR HA-11 TO HA-15
Project Name:	FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.3



NOTES:

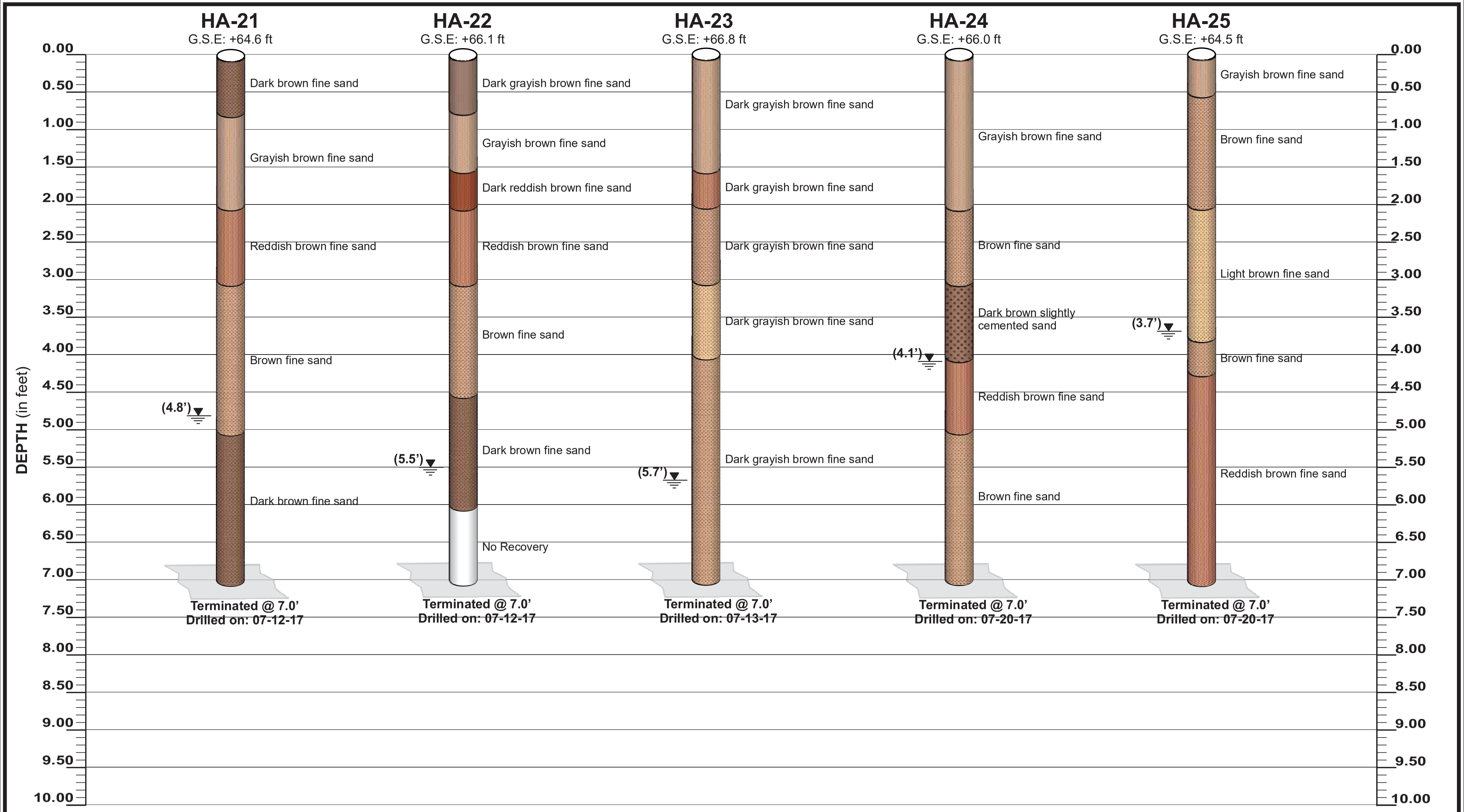
	Borings drilled on date noted
▼	Water level measured on July 21, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NGVD)
G.L.	Ground Level

DEVO Engineering

Figure Name: **SOIL PROFILES FOR HA-16 TO HA-20**

Project Name: **FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.4



NOTES:

Borings drilled on date noted

▽ Water level measured on July 22, 2017 unless otherwise indicated

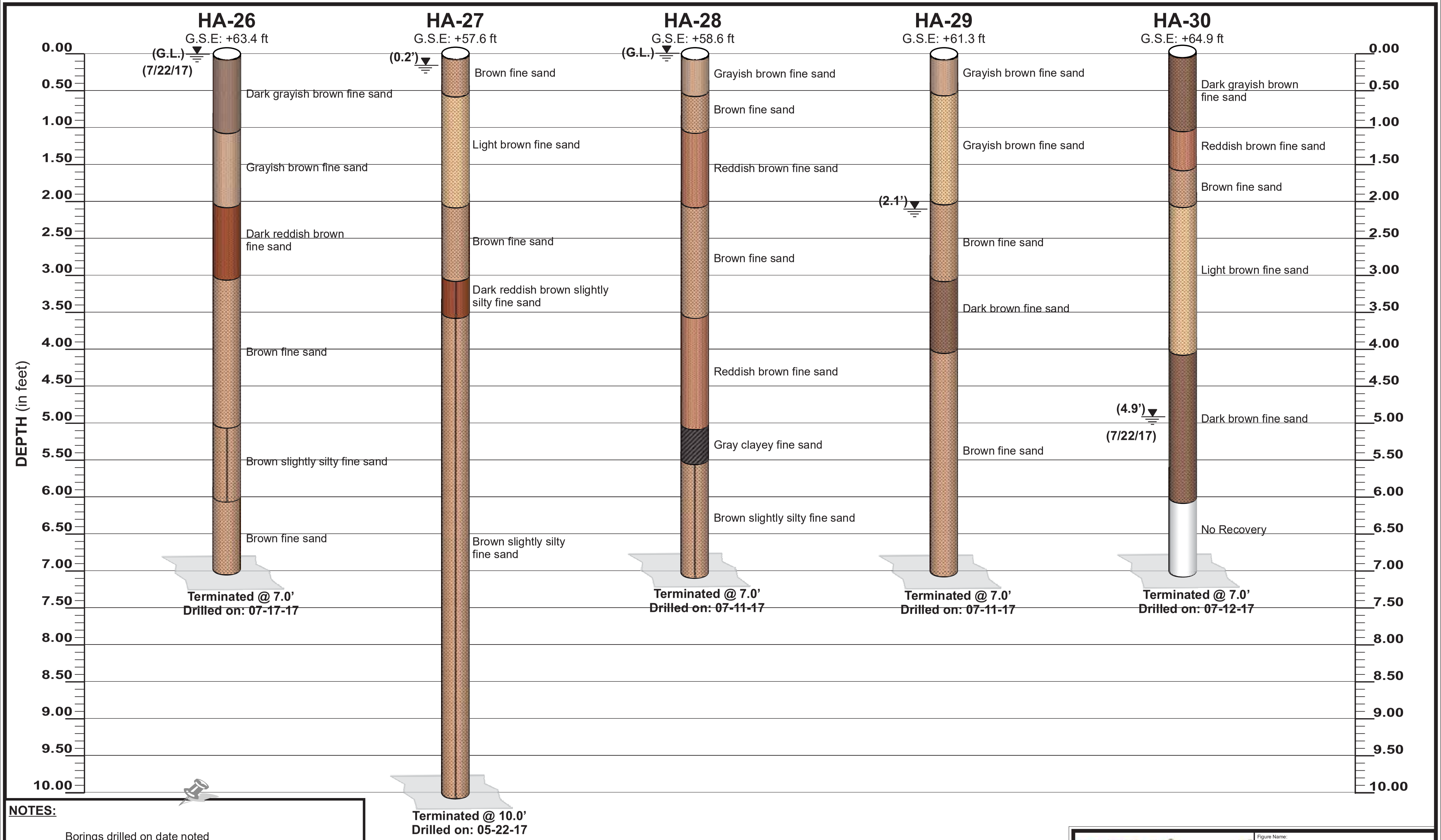
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name: **SOIL PROFILES FOR HA-21 TO HA-25**

Project Name: **FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.5



NOTES:

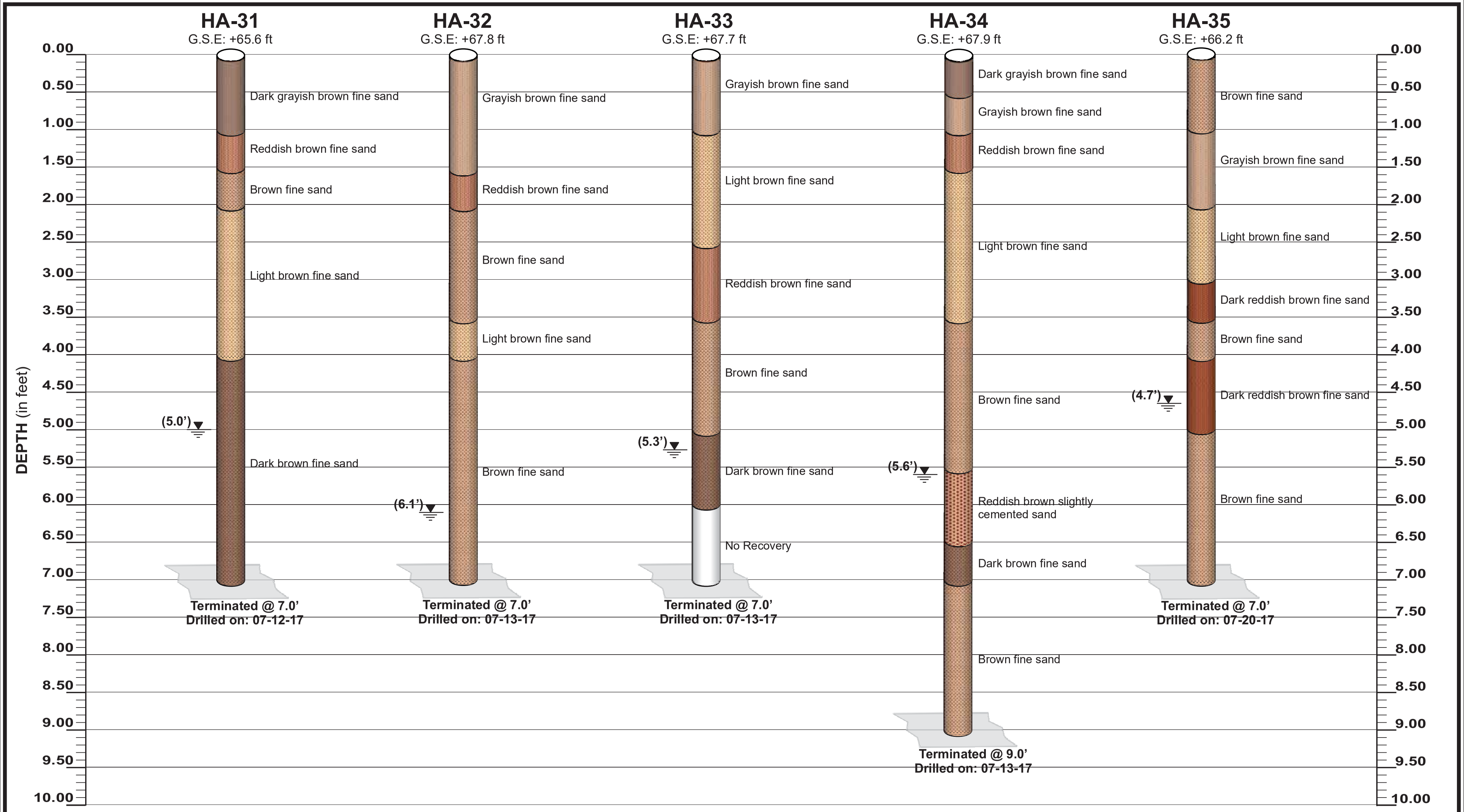
	Borings drilled on date noted
▼	Water level measured on July 21, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)
G.L.	Ground Level

DEVO Engineering

Figure Name: **SOIL PROFILES FOR HA-26 TO HA-30**

Project Name: **FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.6



NOTES:

Borings drilled on date noted

▽ Water level measured on July 22, 2017 unless otherwise indicated

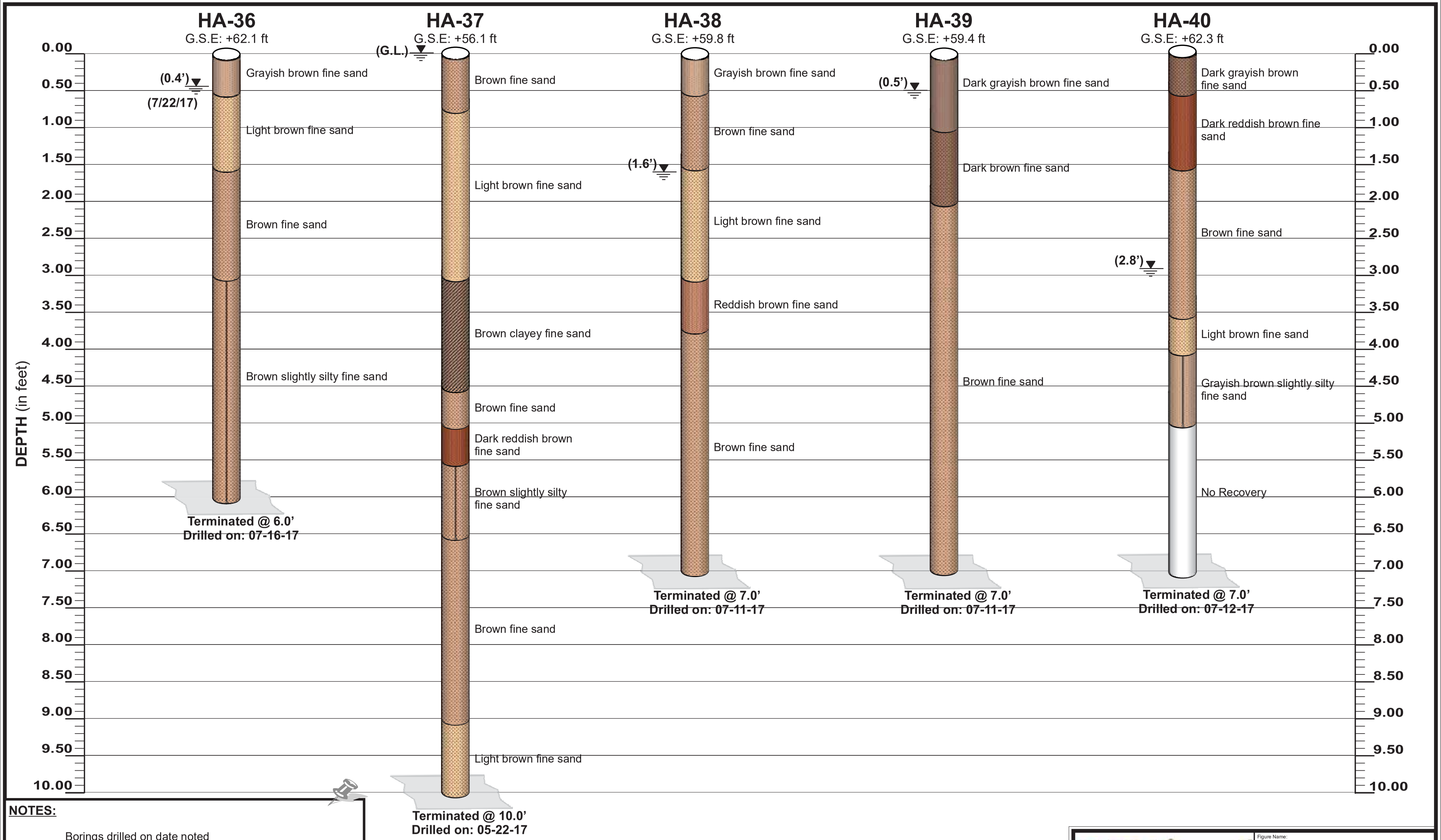
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name: SOIL PROFILES FOR HA-31 TO HA-35

Project Name: FONTANA

Checked & Approved By:	DS	Drawn By:	KR	Date:	07/10/2017	Scale:	NOTED	Project #	17-585.16	Figure 3.7



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NAVD)

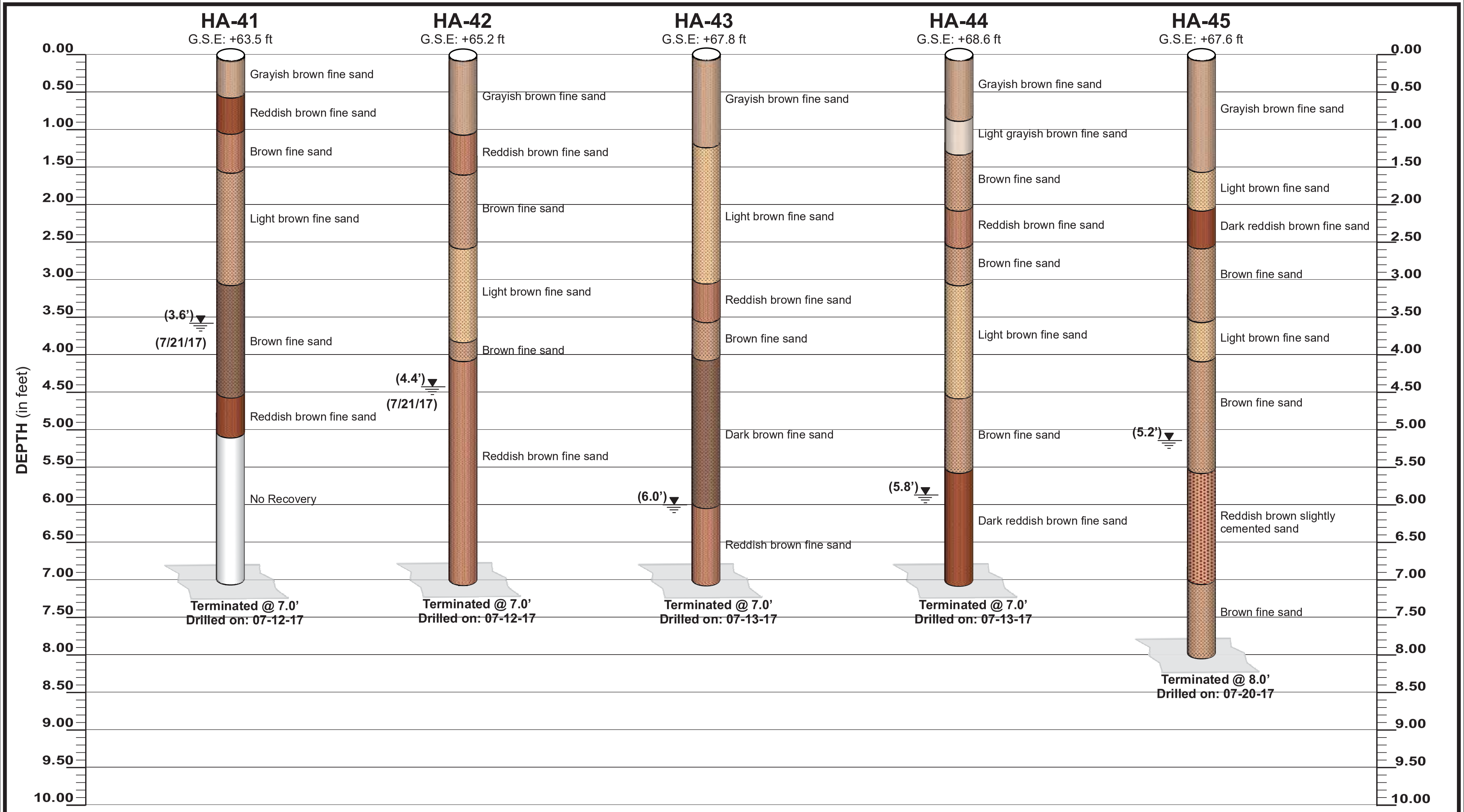
G.L. Ground Level

DEVO Engineering

Figure Name: SOIL PROFILES FOR HA-36 TO HA-40

Project Name: FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.8



NOTES:

Borings drilled on date noted

$\underline{\blacktriangledown}$ Water level measured on July 22, 2017 unless otherwise indicated

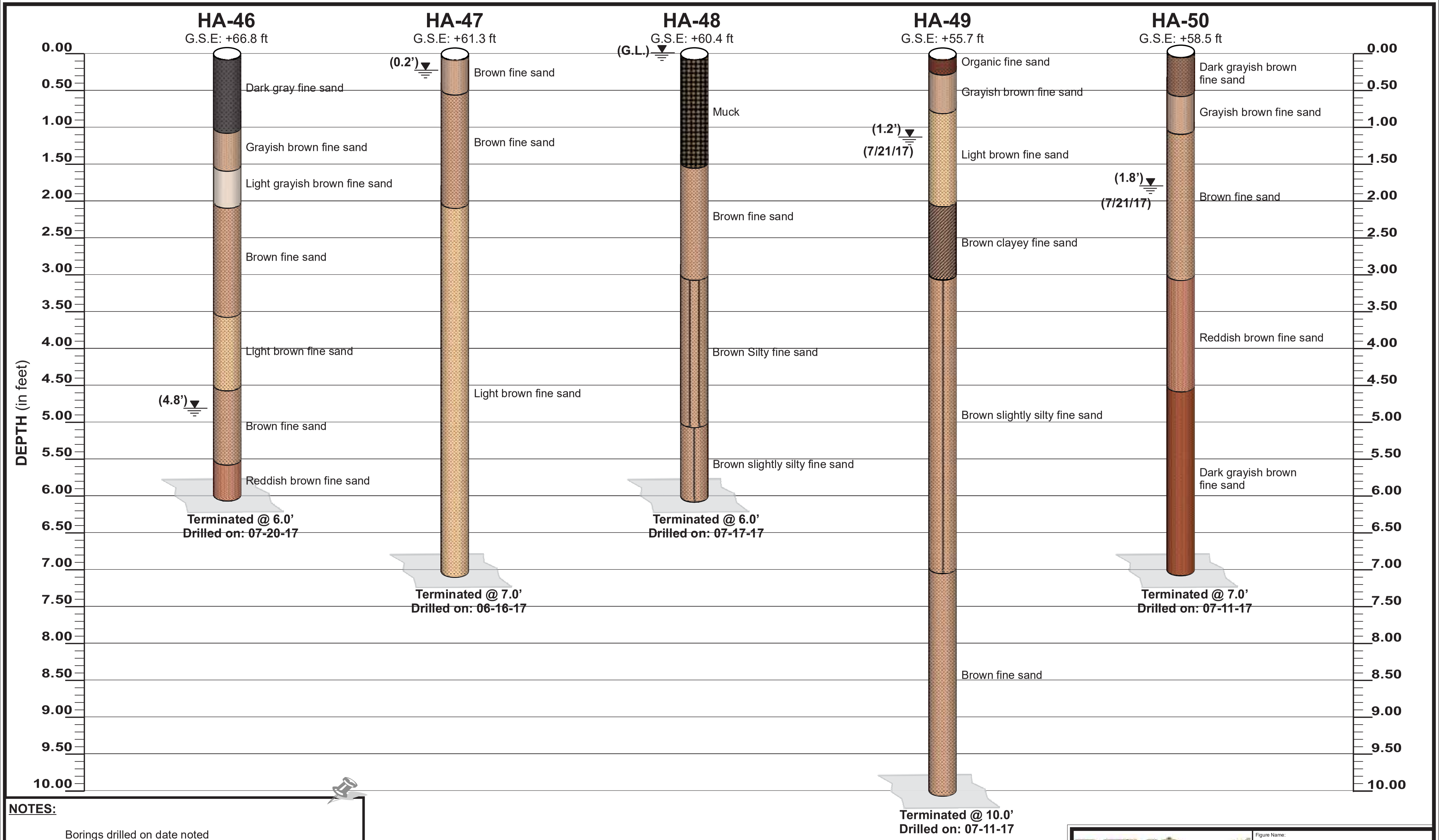
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name:
SOIL PROFILES FOR
HA-41 TO HA-45

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.9



NOTES:

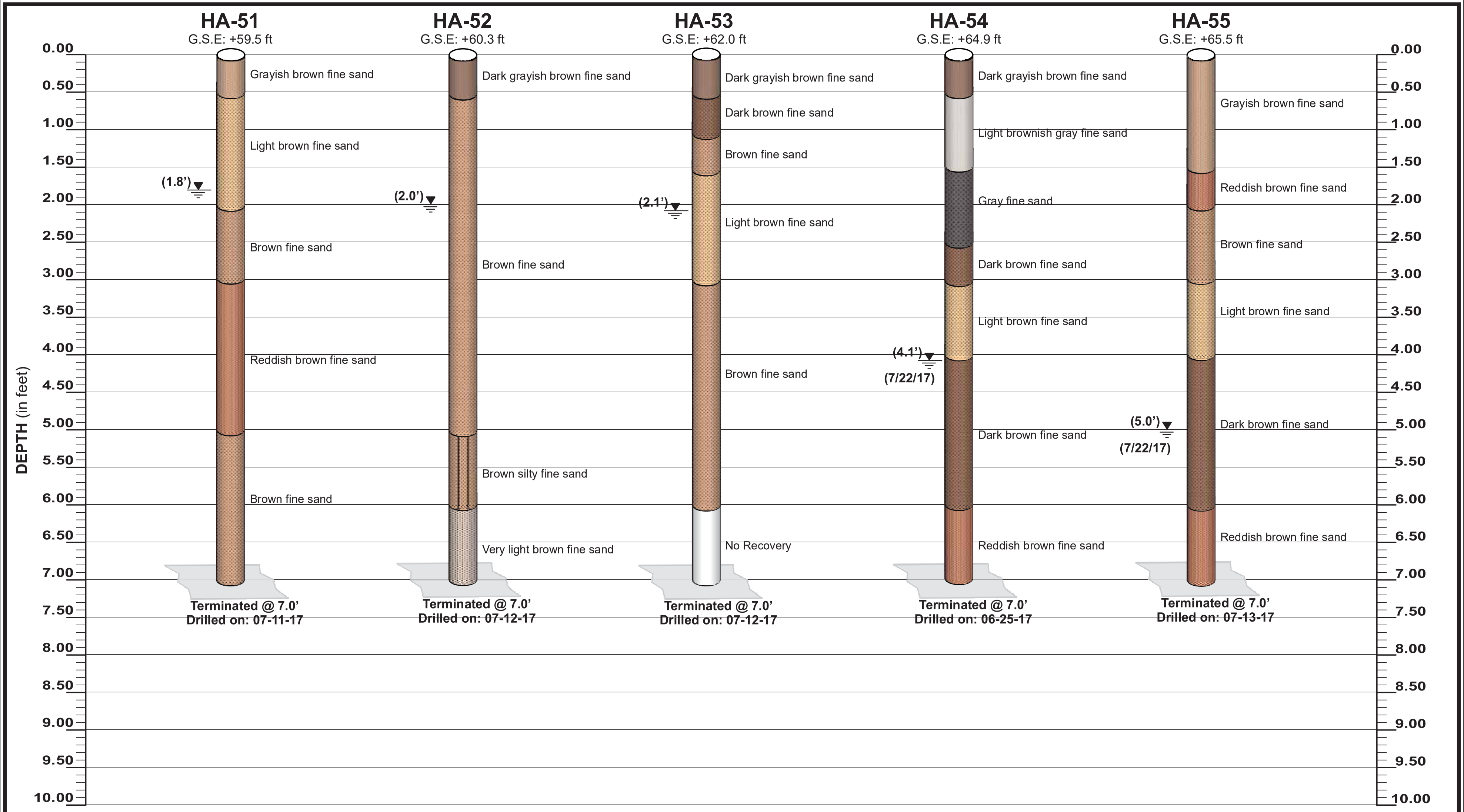
	Borings drilled on date noted
▼	Water level measured on July 22, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)
G.L.	Ground Level

DEVO Engineering

Figure Name:
SOIL PROFILES FOR HA-46 TO HA-50

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.10



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NAVD)

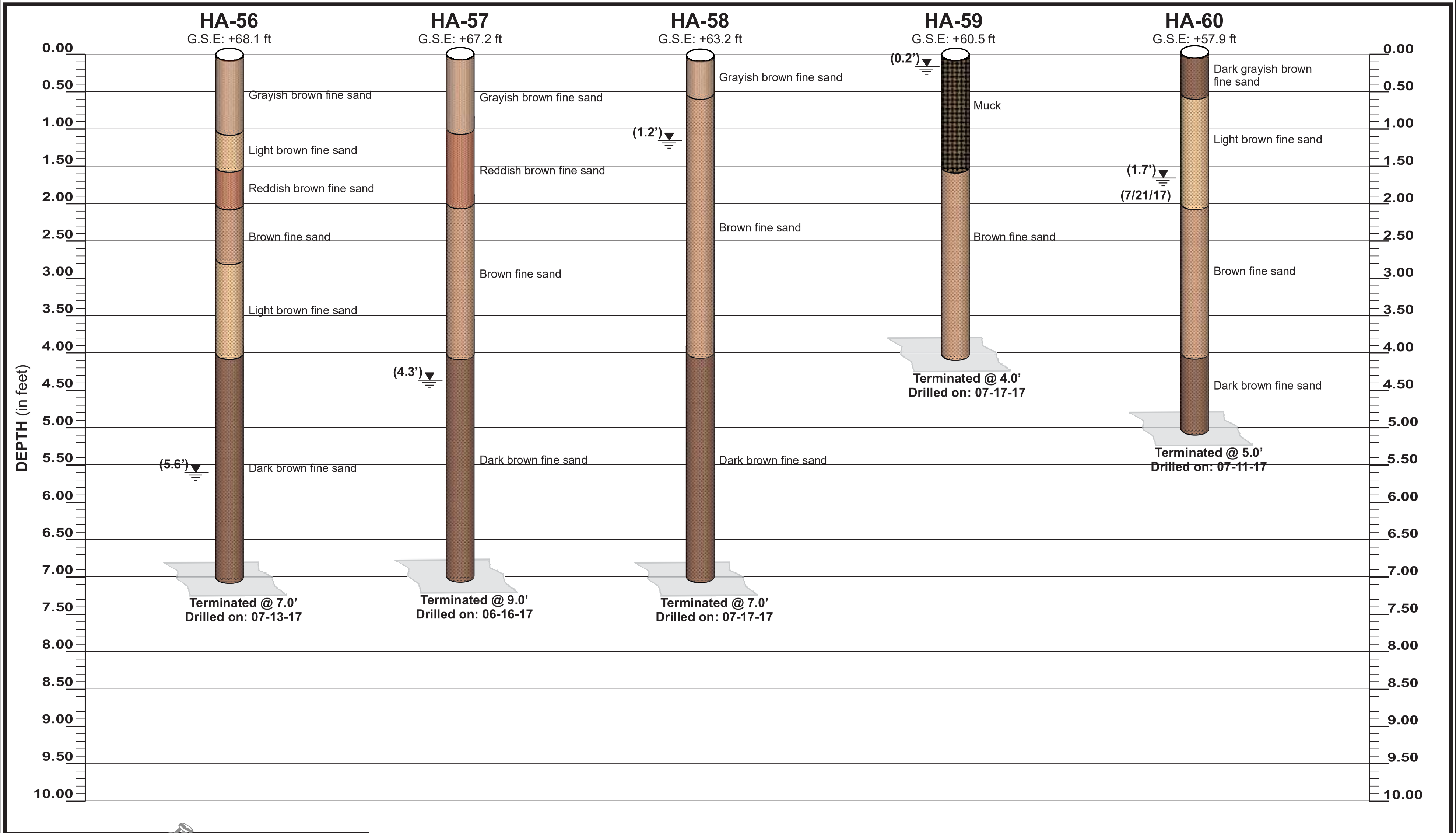
Figure Name:

SOIL PROFILES FOR HA-51 TO HA-55

Project Name:

FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.11



NOTES:

Borings drilled on date noted

▽ Water level measured on July 22, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NAVD)

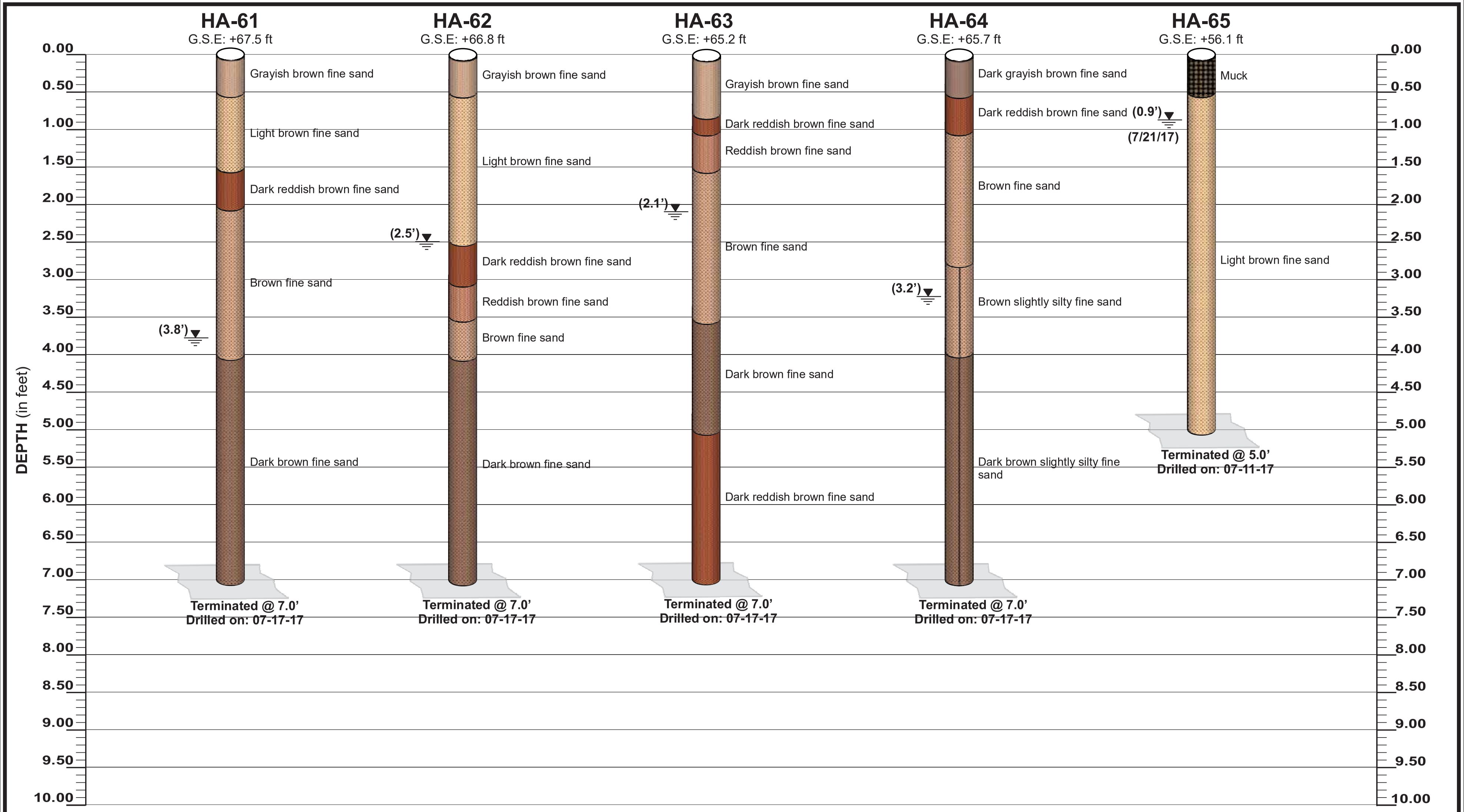
Figure Name:

SOIL PROFILES FOR HA-56 TO HA-60

Project Name:

FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.12



NOTES:

Borings drilled on date noted

▼ Water level measured on July 22, 2017 unless otherwise indicated

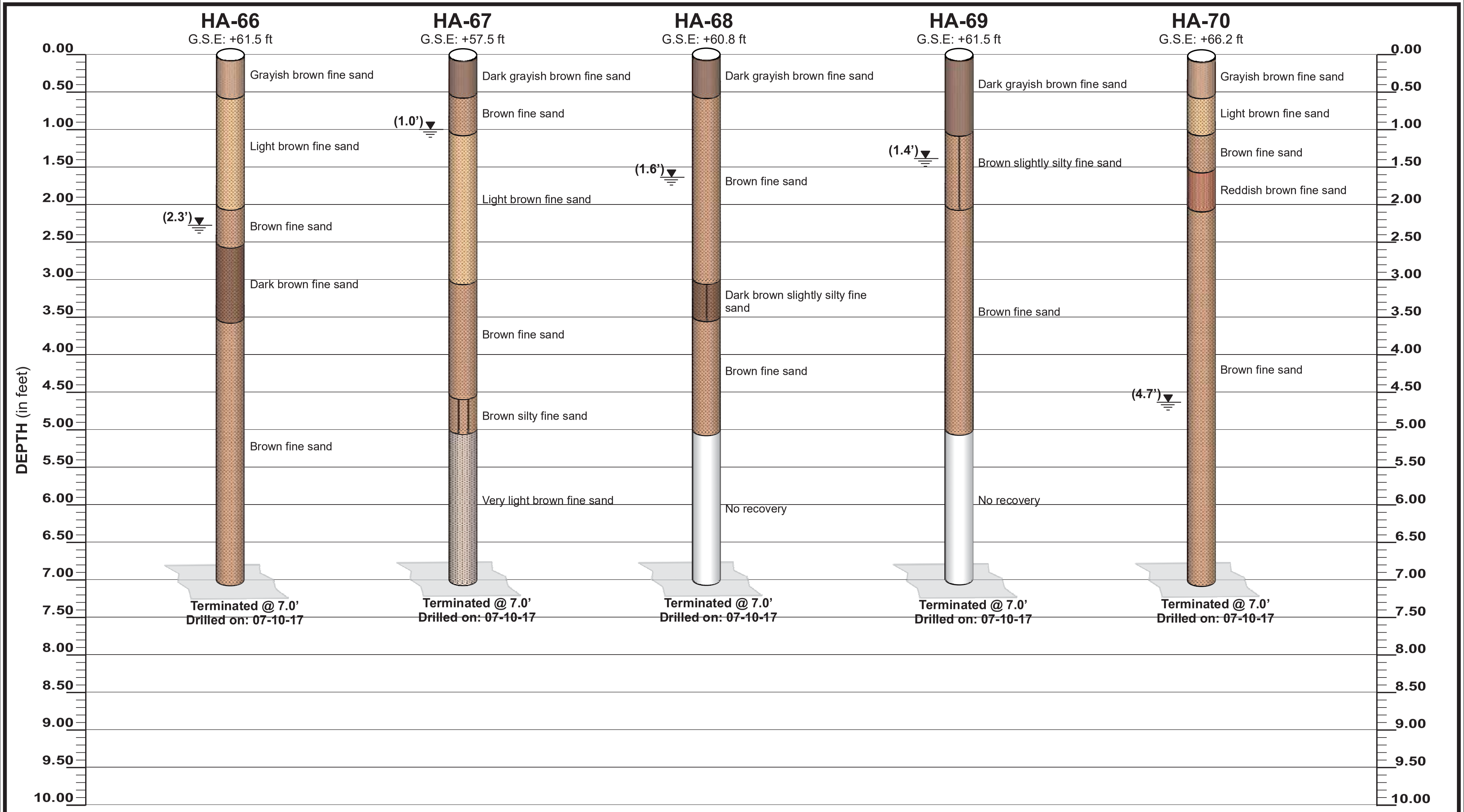
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS

Figure Name: SOIL PROFILES FOR HA-61 TO HA-65

Project Name: FONTANA

Checked & Approved By: DS	Drawn By: KR	Date: 07/10/2017	Scale: NOTED	Project # 17-585.16	Figure 3.13



NOTES:

Borings drilled on date noted

▼ Water level measured on July 21, 2017 unless otherwise indicated

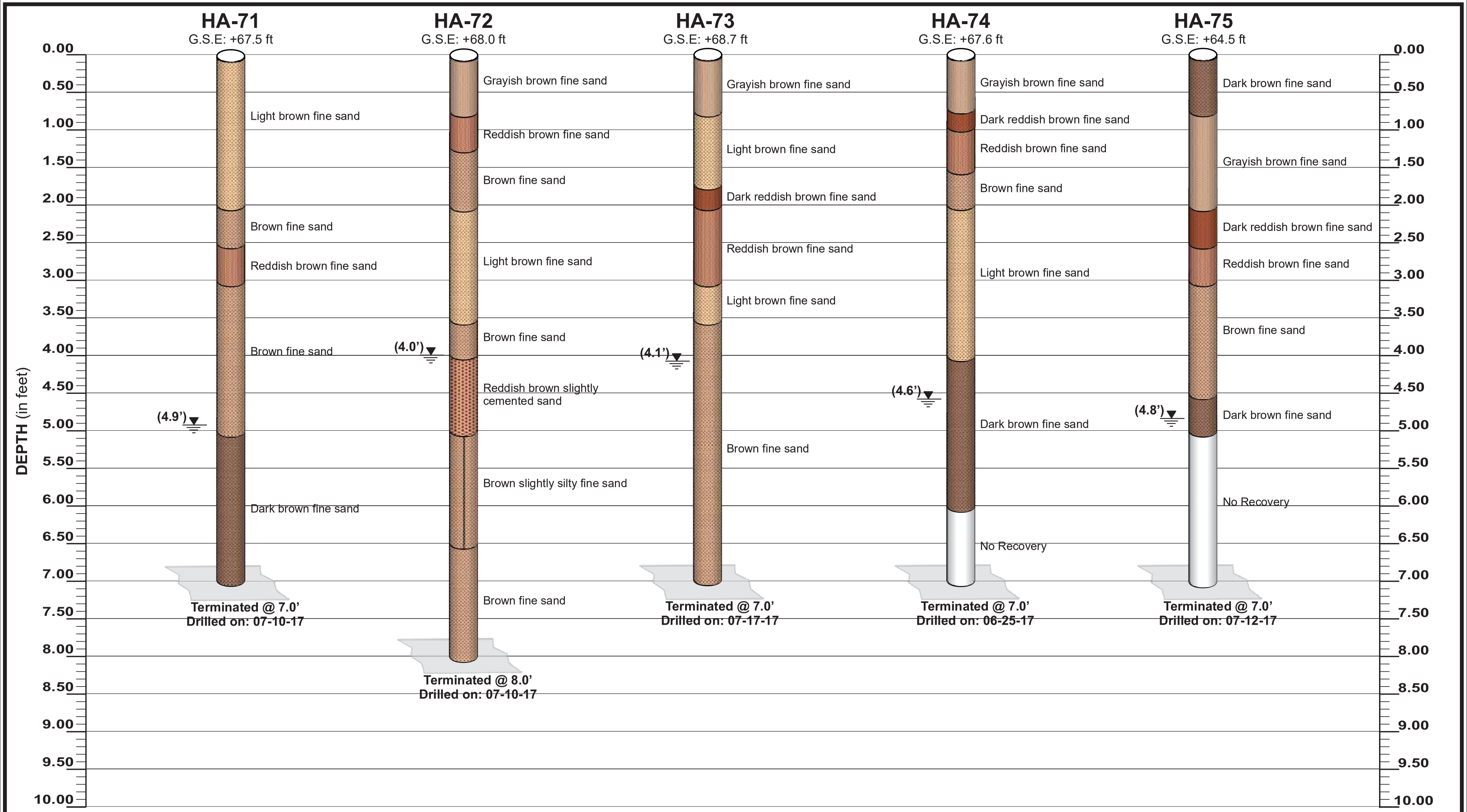
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name: **SOIL PROFILES FOR HA-66 TO HA-70**

Project Name: **FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.14



NOTES:

Borings drilled on date noted

▼ Water level measured on July 22, 2017 unless otherwise indicated

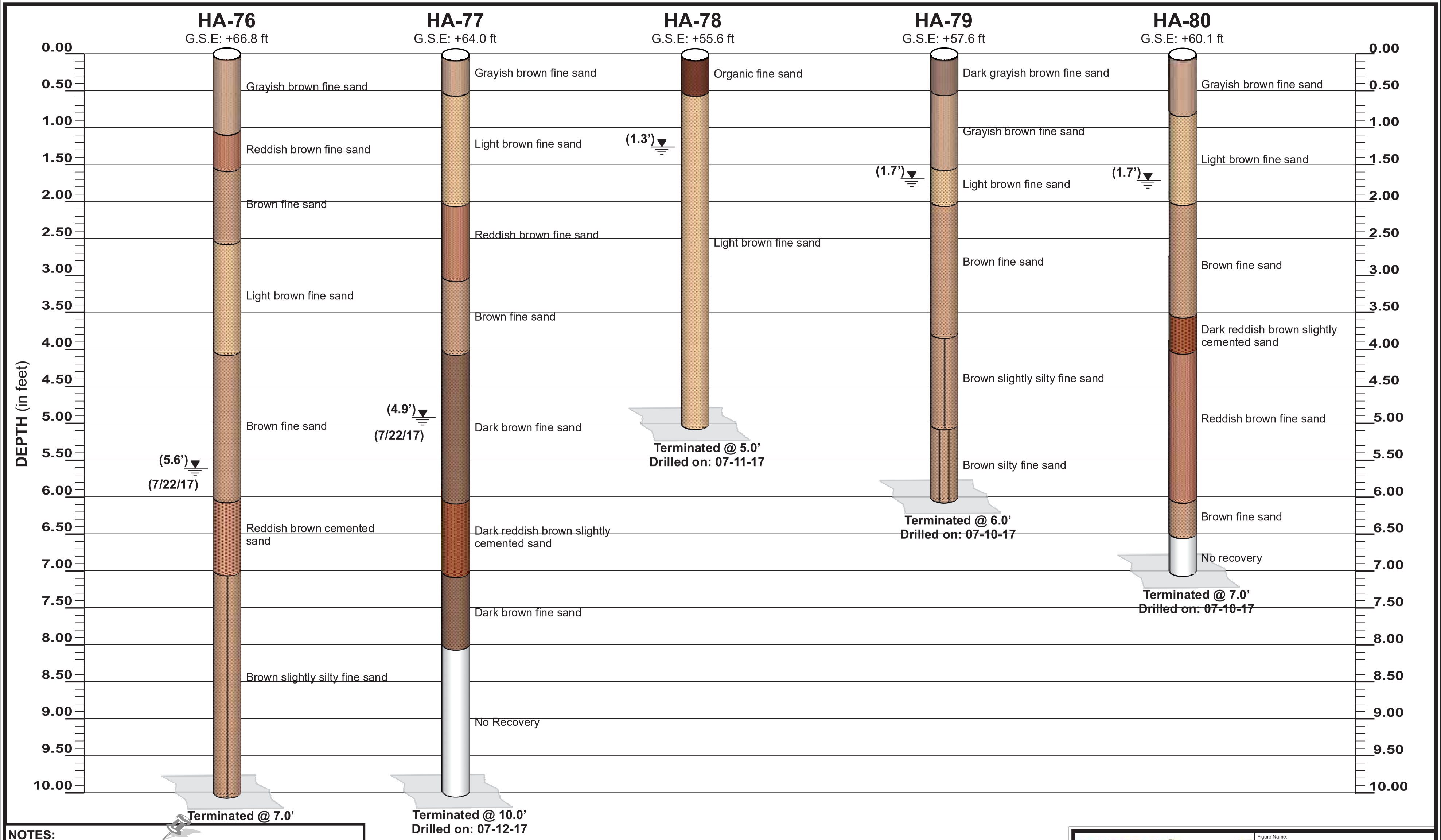
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name:
SOIL PROFILES FOR HA-71 TO HA-75

Project Name:
FONTANA

Checked & Approved By:	DS	Drawn By:	KR	Date: 07/10/2017	Scale:	NOTED	Project # 17-585.16	Figure 3.15



NOTES:

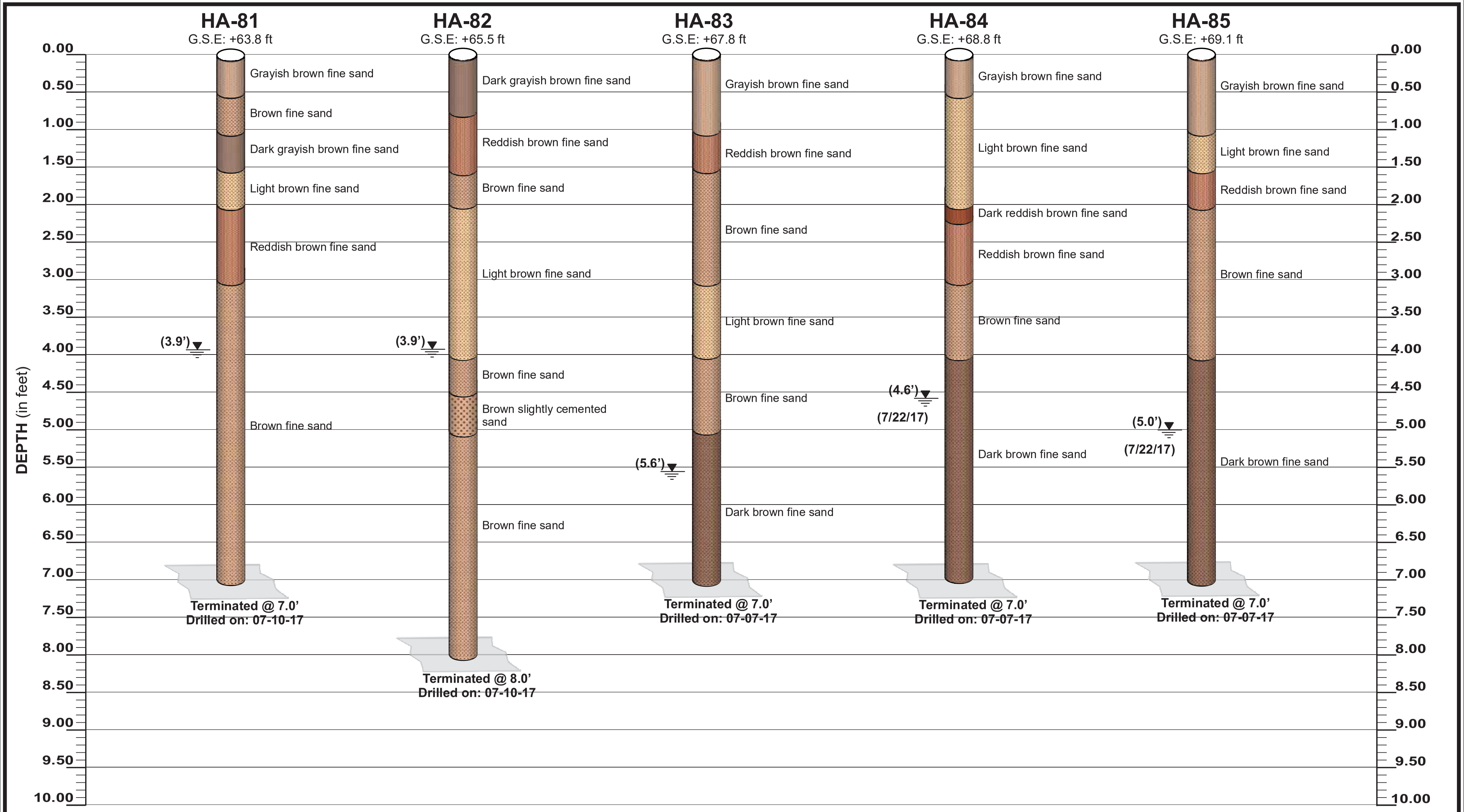
	Borings drilled on date noted
▼	Water level measured on July 21, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name:
SOIL PROFILES FOR
HA-76 TO HA-80

Project Name:
FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.16



NOTES:

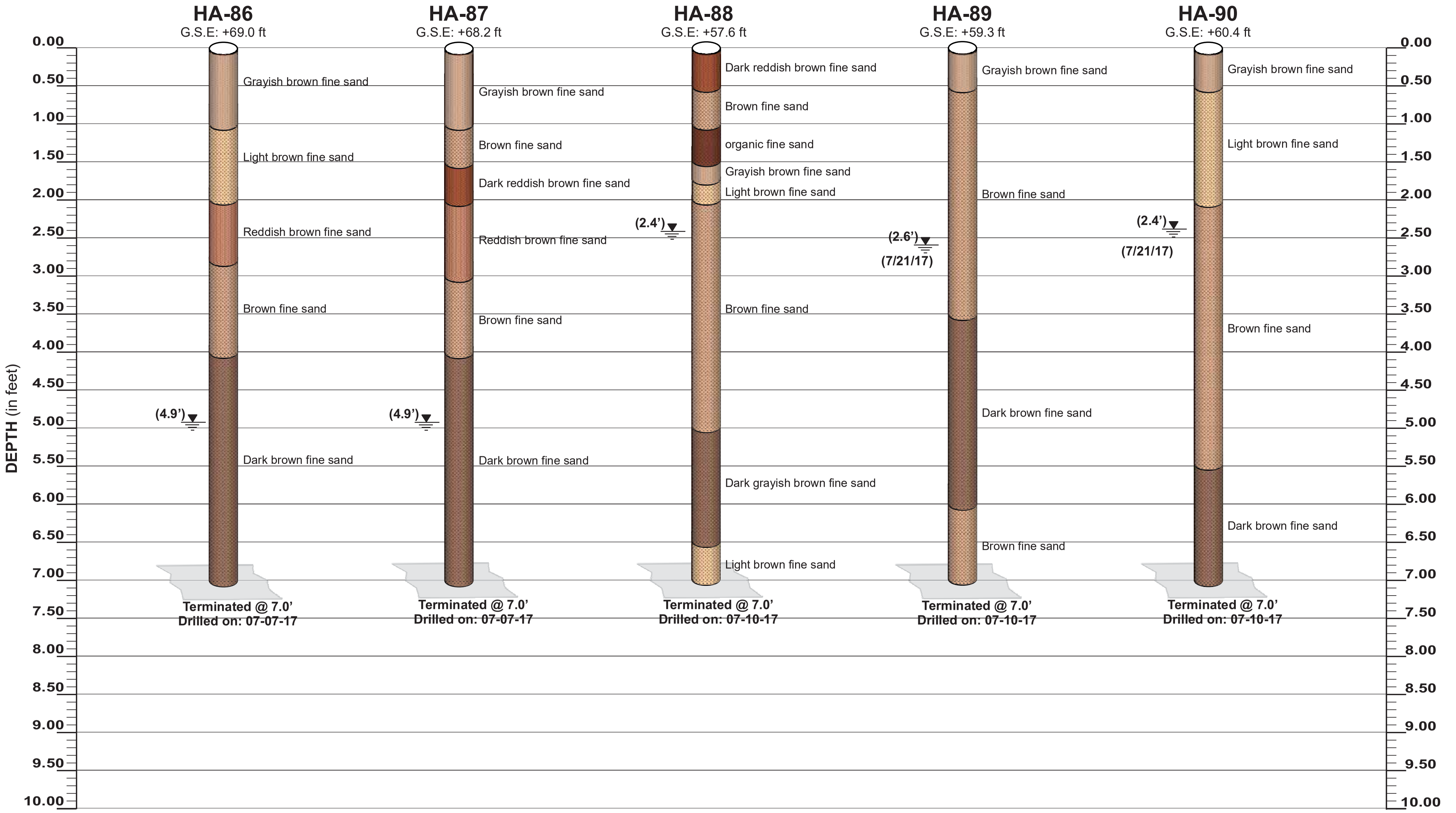
	Borings drilled on date noted
▼	Water level measured on July 21, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name: **SOIL PROFILES FOR HA-81 TO HA-85**

Project Name: **FONTANA**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.17



NOTES:

Borings drilled on date noted

Water level measured on July 22, 2017 unless otherwise indicated

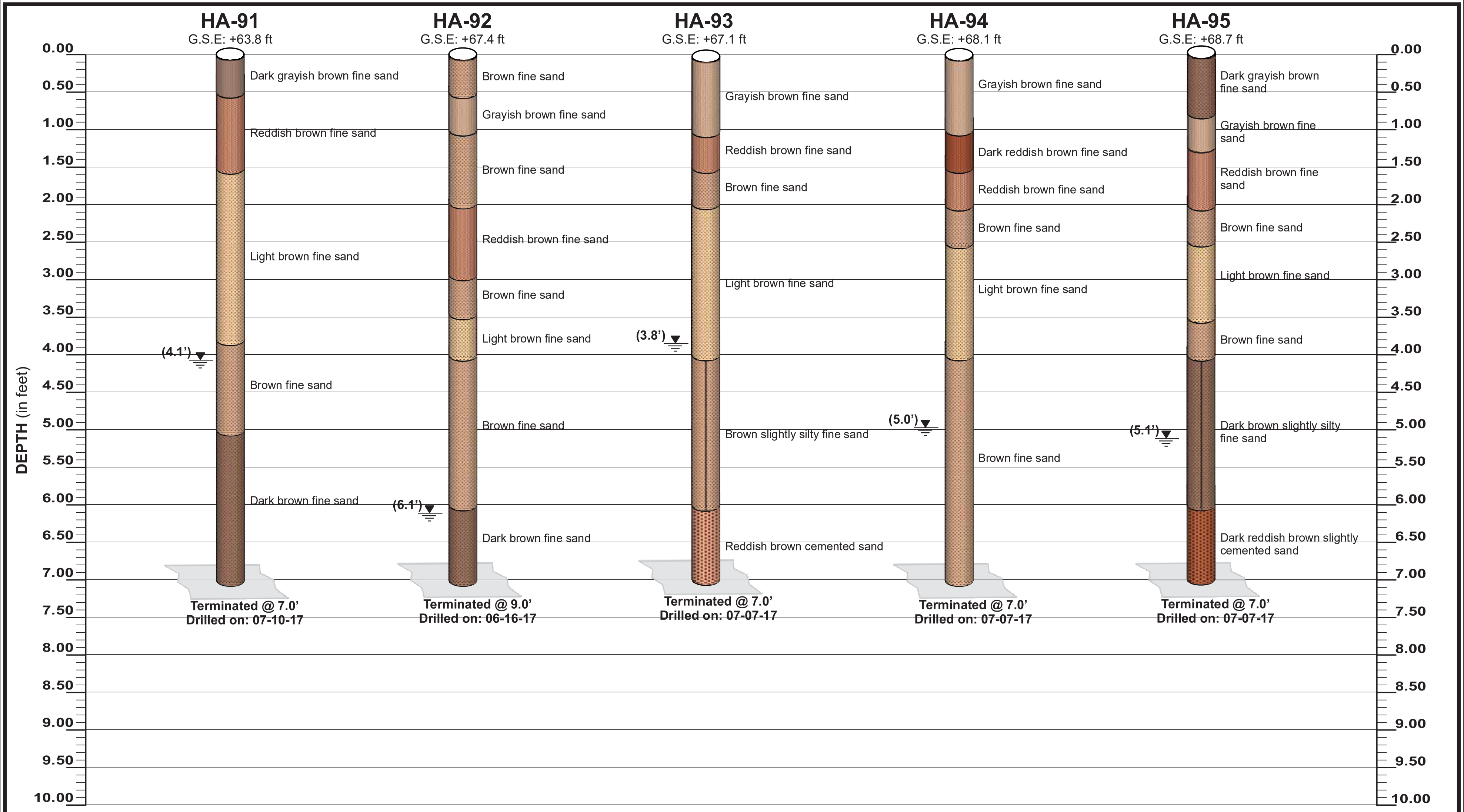
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name: **SOIL PROFILES FOR HA-86 TO HA-90**

Project Name: **FONTANA**

Checked & Approved By: DS	Drawn By: KR	Date: 07/10/2017	Scale: NOTED	Project #: 17-585.16	Figure 3.18		



NOTES:

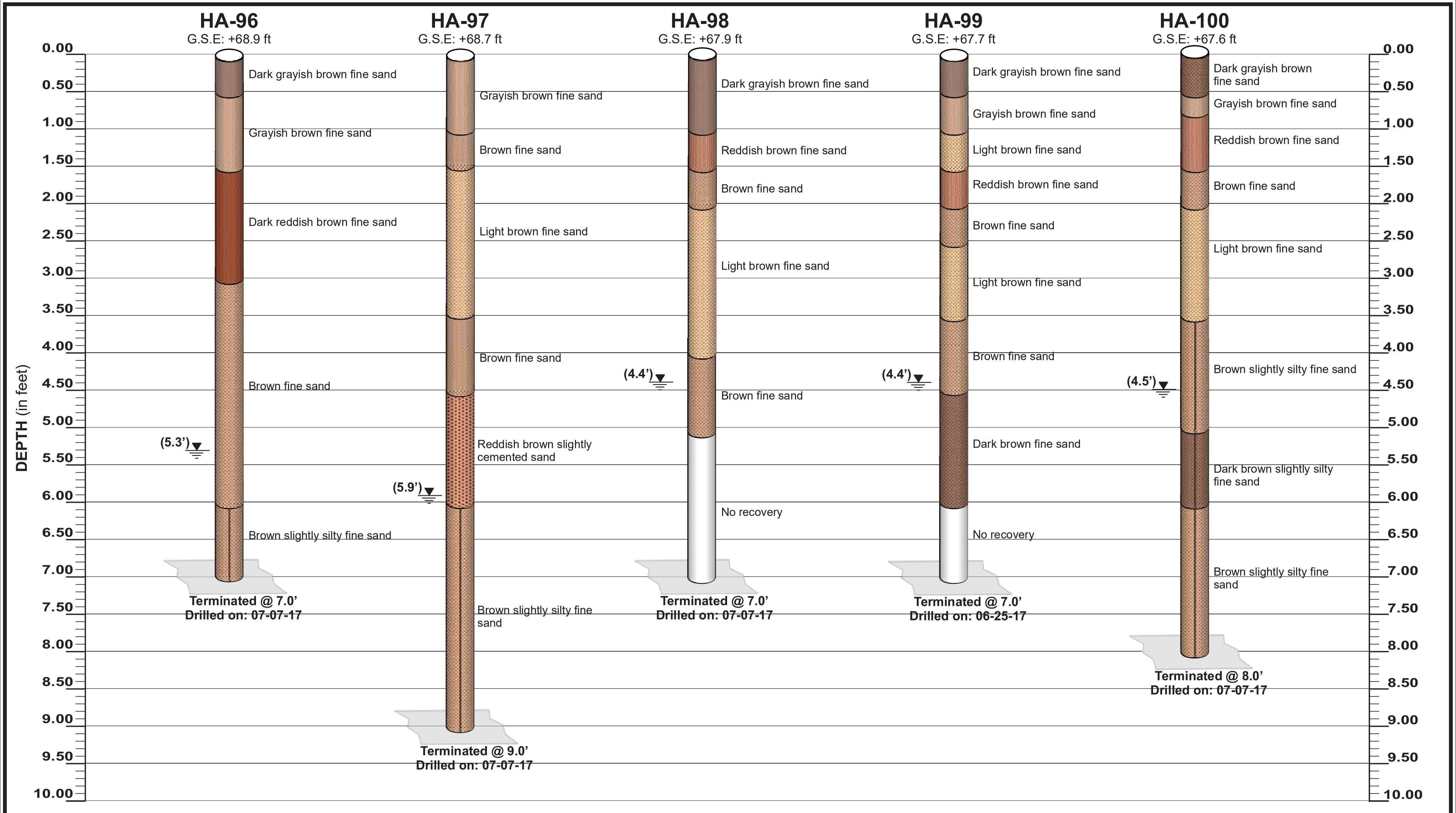
Borings drilled on date noted

▼ Water level measured on July 22, 2017 unless otherwise indicated

G.S.E Surveyed ground surface elevation (ft NAVD)

Figure Name:	SOIL PROFILES FOR HA-91 TO HA-95
Project Name:	FONTANA

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	KR	07/10/2017	NOTED	17-585.16	Figure 3.19



NOTES:

Borings drilled on date noted

▽ Water level measured on July 22, 2017 unless otherwise indicated

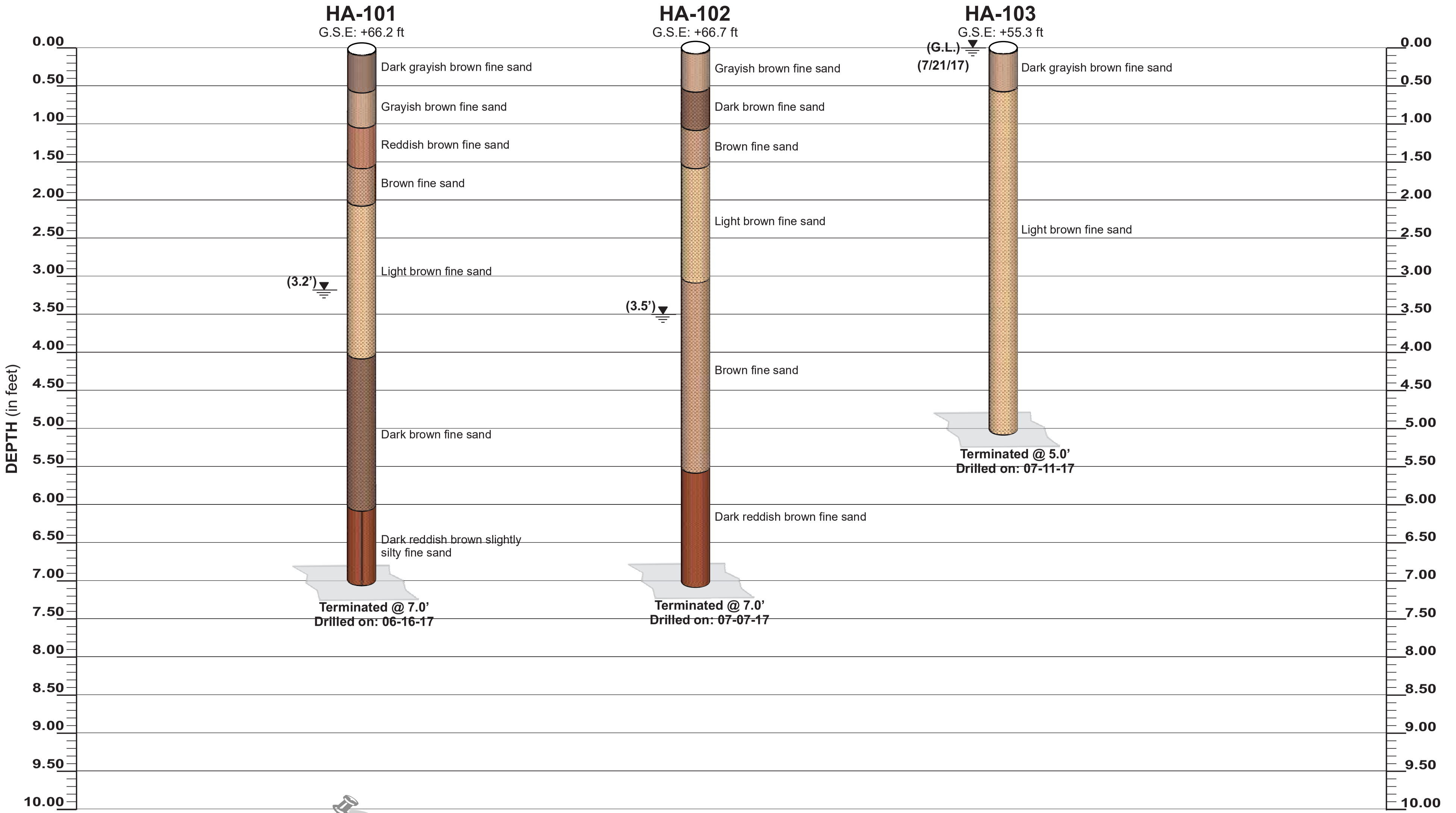
G.S.E Surveyed ground surface elevation (ft NAVD)

DEVO Engineering

Figure Name:
SOIL PROFILES FOR HA-96 TO HA-100

Project Name:
FONTANA

Checked & Approved By: DS	Drawn By: KR	Date: 07/10/2017	Scale: NOTED	Project #: 17-585.16	Figure 3.20



NOTES:

	Borings drilled on date noted
▼	Water level measured on July 22, 2017 unless otherwise indicated
G.S.E	Surveyed ground surface elevation (ft NAVD)
G.L.	Ground Level

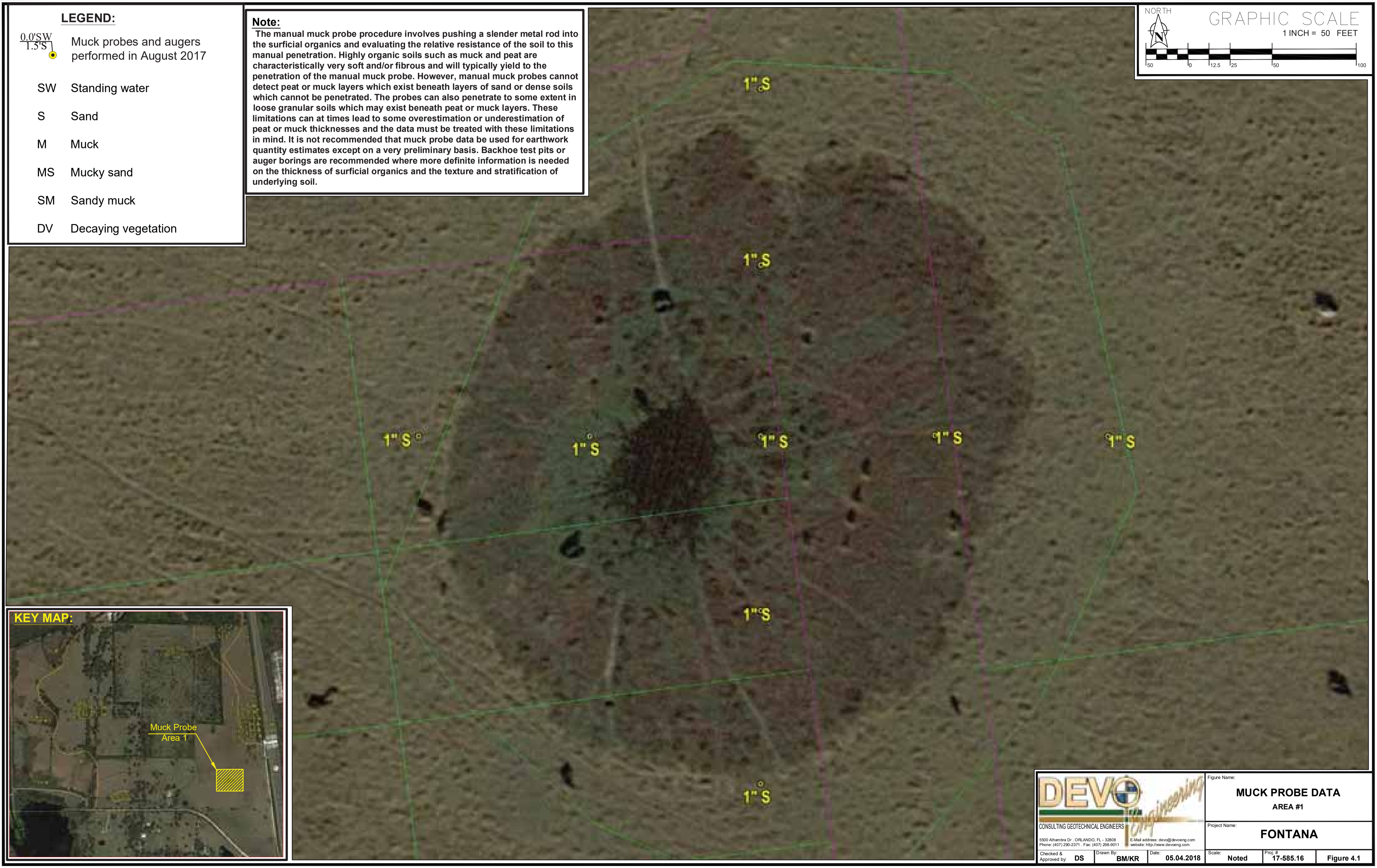
DEVO Engineering

Figure Name: SOIL PROFILES FOR HA-101 TO HA-103			
Project Name: FONTANA			
Checked & Approved By: DS	Drawn By: KR	Date: 07/10/2017	Scale: NOTED
Project #: 17-585.16	Figure 3.21		

LEGEND:

0.0'SW 1.5'S ●	Muck probes and augers performed in August 2017
SW	Standing water
S	Sand
M	Muck
MS	Mucky sand
SM	Sandy muck
DV	Decaying vegetation

Note:
The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.



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E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name: **MUCK PROBE DATA**
AREA #1

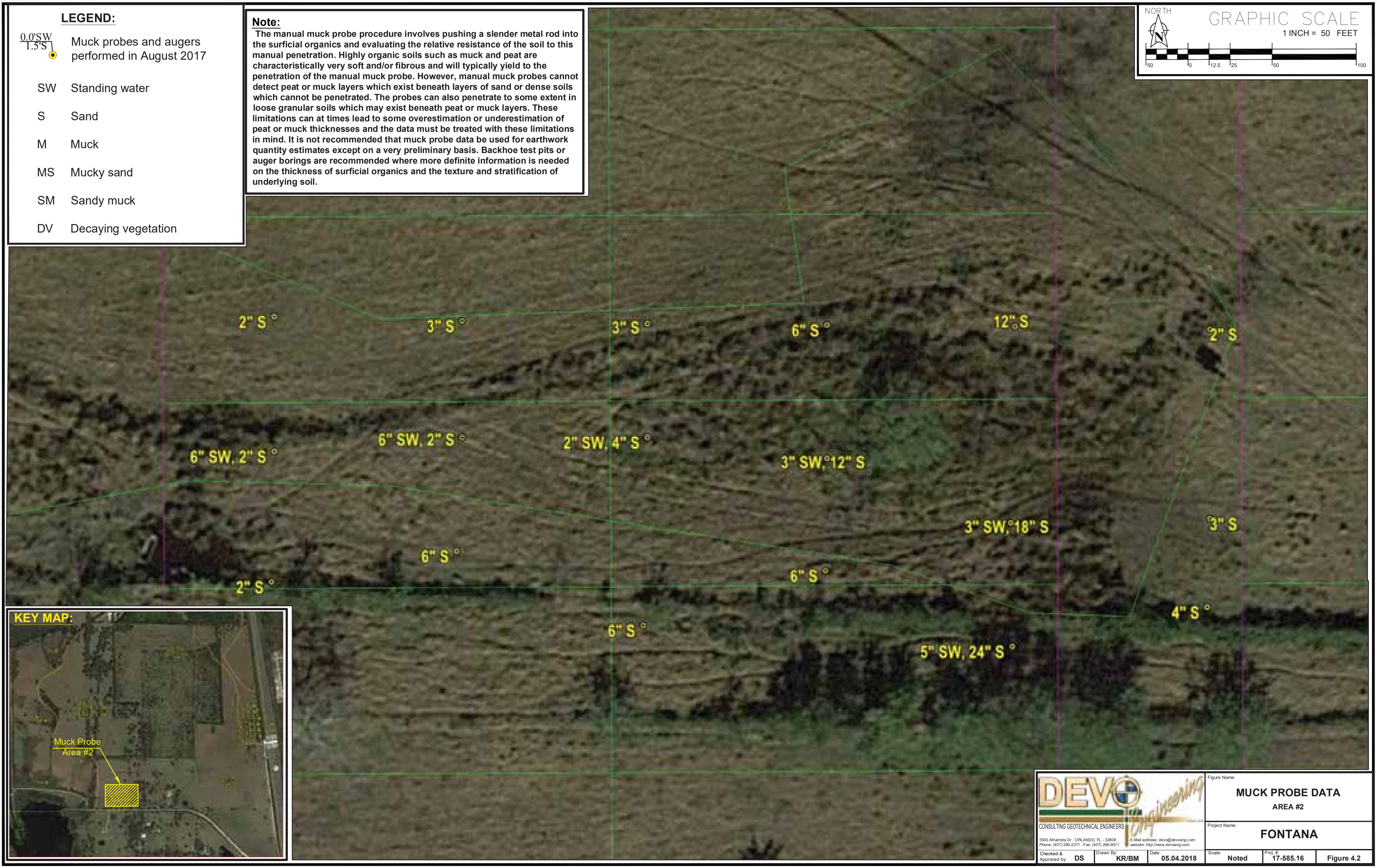
Project Name: **FONTANA**

Checked & Approved by: **DS**	Drawn By: **BM/KR**	Date: **05.04.2018**	Scale: **Noted**	Proj. # **17-585.16**	**Figure 4.1**

LEGEND:

$\frac{0.0'SW}{1.5'S}$ ●	Muck probes and augers performed in August 2017
SW	Standing water
S	Sand
M	Muck
MS	Mucky sand
SM	Sandy muck
DV	Decaying vegetation

Note:
The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.



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website: http://www.devoeng.com

Figure Name:
MUCK PROBE DATA
AREA #2

Project Name:
FONTANA

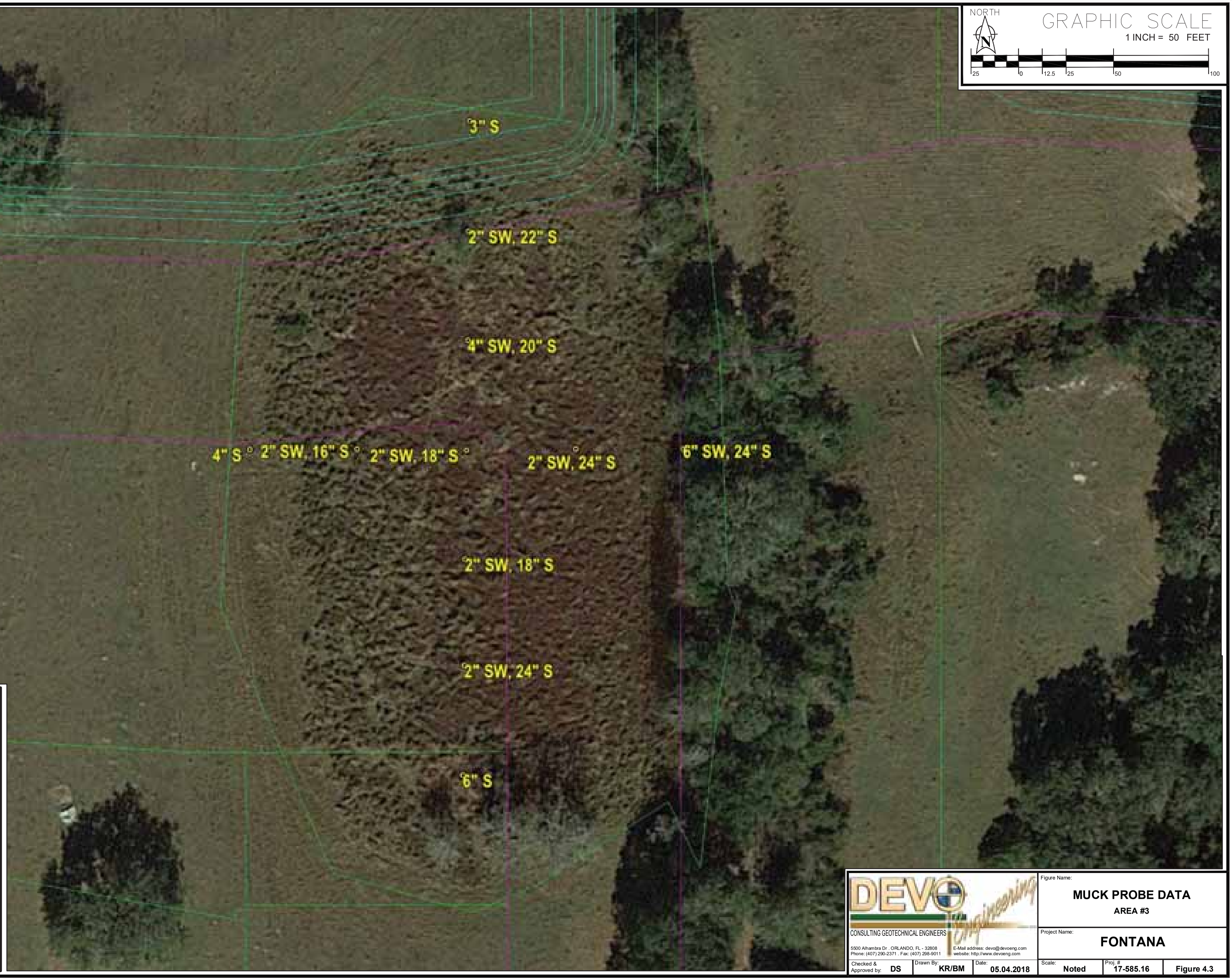
Checked & Approved by: DS	Drawn By: KR/BM	Date: 05.04.2018	Scale: Noted	Proj. # 17-585.16	Figure 4.2

LEGEND:

0.0'SW 1.5'S ●	Muck probes and augers performed in August 2017
SW	Standing water
S	Sand
M	Muck
MS	Mucky sand
SM	Sandy muck
DV	Decaying vegetation

Note:

The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.



KEY MAP:

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS

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Figure Name:
MUCK PROBE DATA
AREA #3

Project Name:
FONTANA

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	**KR/BM**	**05.04.2018**	**Noted**	**17-585.16**	**Figure 4.3**

LEGEND:

0.0'SW 1.5'S ●	Muck probes and augers performed in August 2017
SW	Standing water
S	Sand
M	Muck
MS	Mucky sand
SM	Sandy muck
DV	Decaying vegetation

Note:
The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.

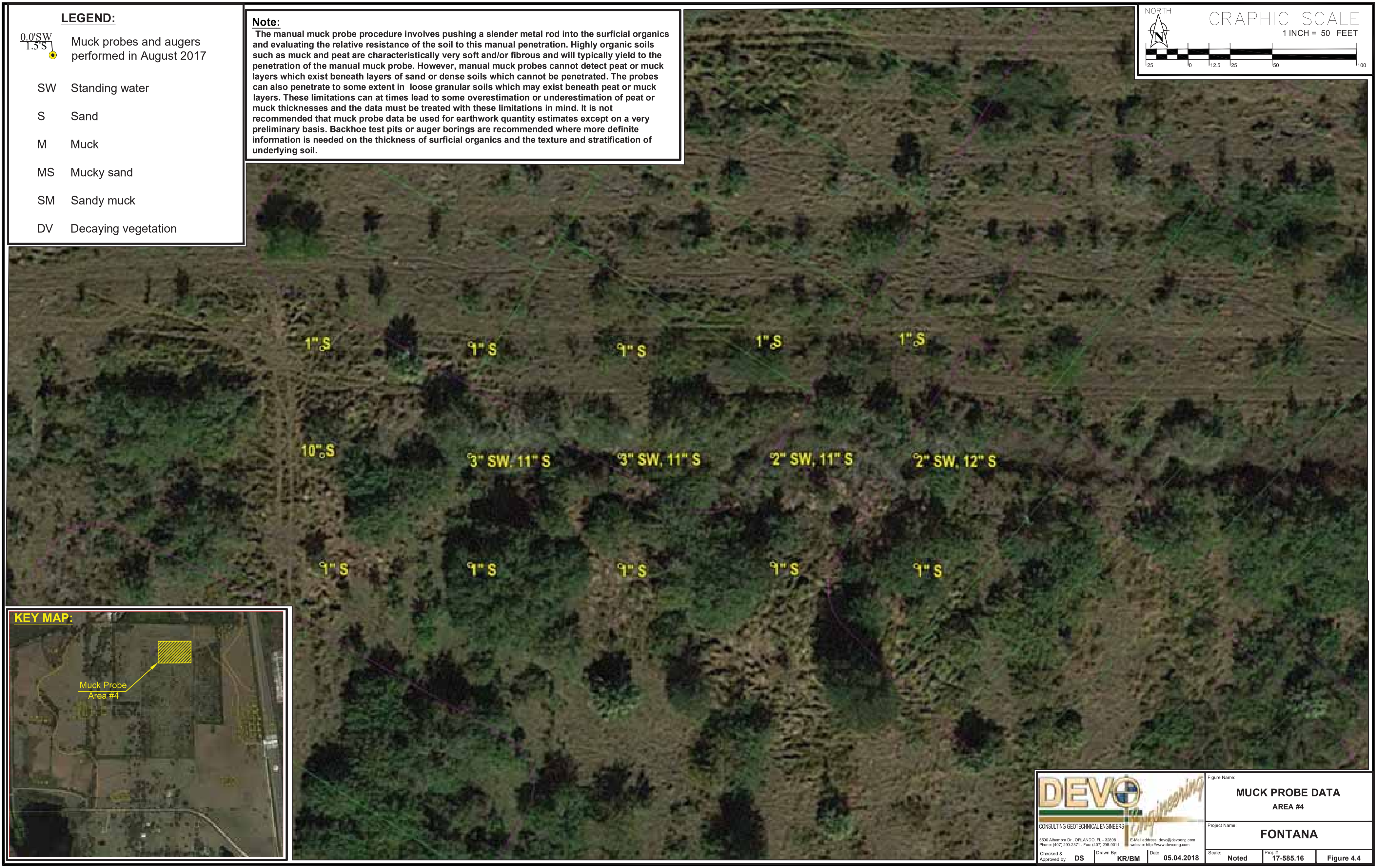

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Figure Name:
MUCK PROBE DATA
AREA #4

Project Name:
FONTANA

Checked & Approved by: **DS**	Drawn By: **KR/BM**	Date: **05.04.2018**	Scale: **Noted**	Proj. # **17-585.16**	**Figure 4.4**

LEGEND:

$\frac{0.0'SW}{1.5'S}$ ●	Muck probes and augers performed in August 2017
SW	Standing water
S	Sand
M	Muck
MS	Mucky sand
SM	Sandy muck
DV	Decaying vegetation

Note:

The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.

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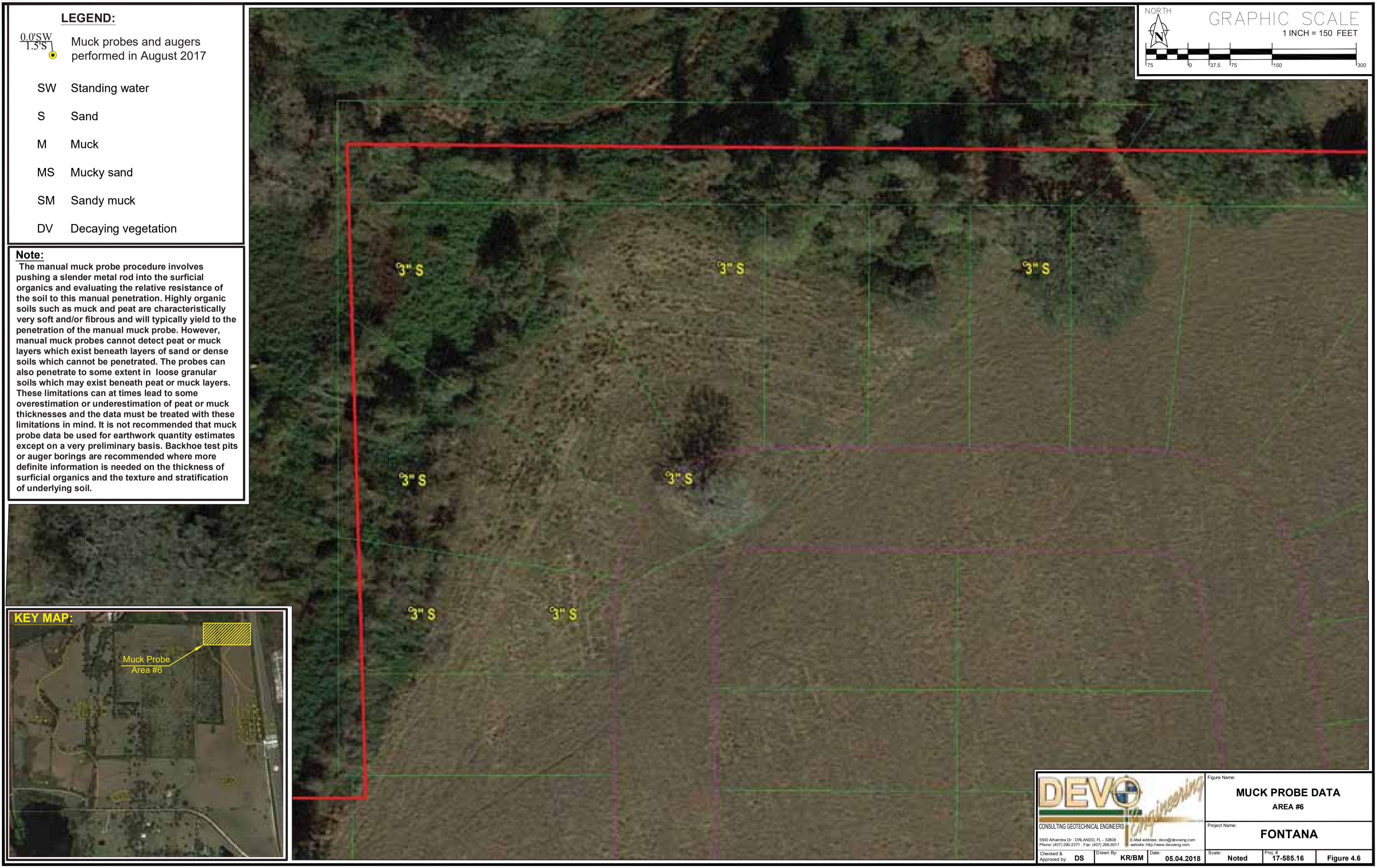
Figure Name:
MUCK PROBE DATA
AREA #5

Project Name:
FONTANA

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	KR/BM	05.04.2018	Noted	17-585.16	Figure 4.5



LEGEND:

$\frac{0.0'SW}{1.5'S}$ ●	Muck probes and augers performed in August 2017
SW	Standing water
S	Sand
M	Muck
MS	Mucky sand
SM	Sandy muck
DV	Decaying vegetation

Note:

The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.

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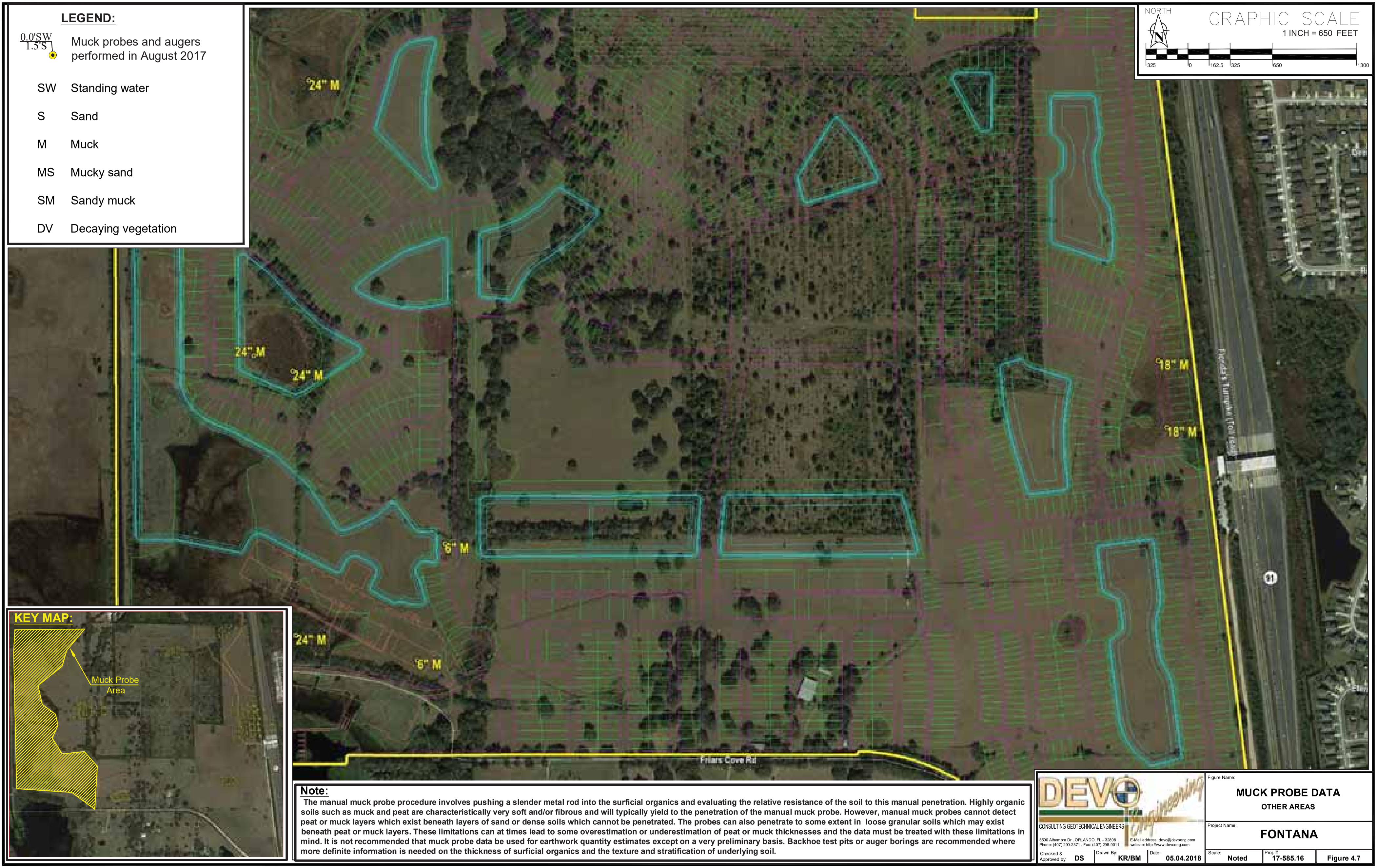
Figure Name:
MUCK PROBE DATA
AREA #6

Project Name:
FONTANA

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	KR/BM	05.04.2018	Noted	17-585.16	Figure 4.6



Note:
The manual muck probe procedure involves pushing a slender metal rod into the surficial organics and evaluating the relative resistance of the soil to this manual penetration. Highly organic soils such as muck and peat are characteristically very soft and/or fibrous and will typically yield to the penetration of the manual muck probe. However, manual muck probes cannot detect peat or muck layers which exist beneath layers of sand or dense soils which cannot be penetrated. The probes can also penetrate to some extent in loose granular soils which may exist beneath peat or muck layers. These limitations can at times lead to some overestimation or underestimation of peat or muck thicknesses and the data must be treated with these limitations in mind. It is not recommended that muck probe data be used for earthwork quantity estimates except on a very preliminary basis. Backhoe test pits or auger borings are recommended where more definite information is needed on the thickness of surficial organics and the texture and stratification of underlying soil.

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Figure Name:
MUCK PROBE DATA
OTHER AREAS

Project Name:
FONTANA

Checked & Approved by: **DS**	Drawn By: **KR/BM**	Date: **05.04.2018**	Scale: **Noted**	Proj. # **17-585.16**	**Figure 4.7**