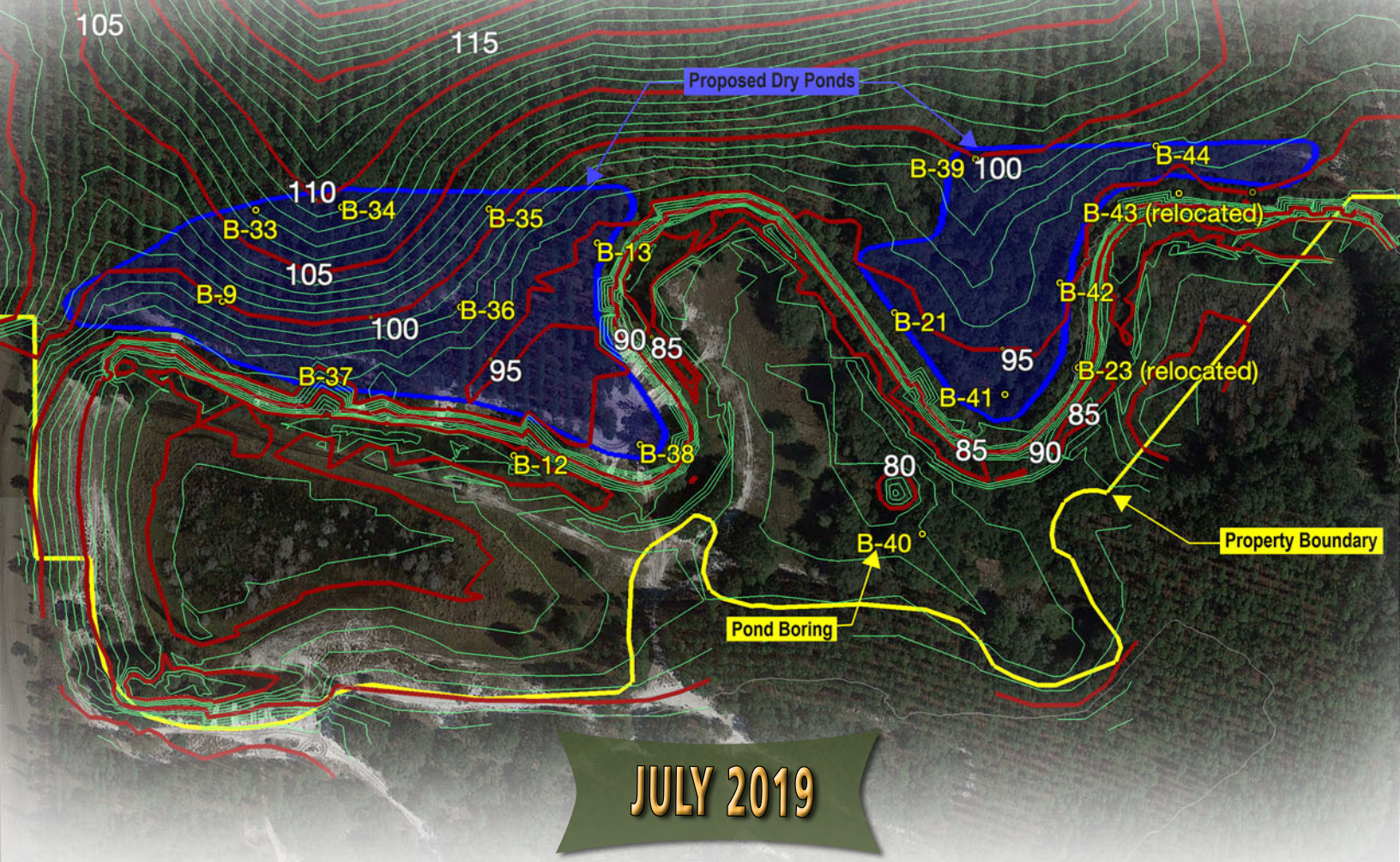
STORMWATER POND - GEOTECHNICAL ENGINEERING REPORT

HARTWOOD MARSH RESIDENTIAL

Proposed Single Family Residential Subdivision
120± Acres, Hartwood Marsh Road, off U.S. Highway 27
City of Clermont, Lake County, Florida
[Sections 9 & 16, Township 23 South, Range 26 East]



JULY 2019

Prepared by

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS

DEVO SEEREERAM, PH.D., P.E., LLC.
5500 ALHAMBRA DR., ORLANDO, FL-32808
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For

LAKE WEBSTER, LLC

401 Ferguson Drive
Orlando, FL 32805

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Date: July 8, 2019	*Devo's Project No:* 19-585.18

To:

LAKE WEBSTER, LLC
401 Ferguson Drive
Orlando, FL 32805
(407)-293-6562; jeff@amickinc.com

attention: **JEFF B. FUQUA, PH.D.**

Re:

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HARTWOOD MARSH RESIDENTIAL

Proposed Single Family Residential Subdivision
120± Acres, Hartwood Marsh Road, off U.S. Highway 27, City of Clermont, Lake County, Florida
[Sections 9 & 16, Township 23 South, Range 26 East]

Dear Mr. Fuqua:

The purpose of this report is to document the pond-specific geotechnical data, stormwater recovery analyses, grading recommendations, and berm stability analysis for the proposed dry retention pond at the above-captioned subdivision.

Note that we are still working on a more comprehensive geotechnical report for the non-pond portions of the subdivision and those data and recommendations will be presented in a separate report.

We trust that the geotechnical data, assessment, and recommendations in this report are responsive to the needs of the permitting agencies and the civil engineer at this phase of the design process. 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: July 8, 2019

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I.0 POND TYPE & LOCATION

A conventional, dry-bottom stormwater retention pond (no underdrains, etc.) is proposed for the proposed Hartwood Marsh single-family residential subdivision in Clermont, Lake County, Florida. Exhibit 1 shows the subdivision boundary of this undeveloped land which sits on a high sandy ridge (of the Lake Wales Ridge) with a deep water table.

The pond layout within the subdivision is in Exhibit 2 and is divided into a north and a south lobe, equalized by a pipe so the lobes function as a single pond. The specific purpose of this report is to document the geotechnical data within the pond area and to present the results of the stormwater recovery analyses which are required to check for compliance with SJRWMD recovery time criteria. Fill berm specifications are also provided since the downhill side of the ponds will be bermed above natural land surface.

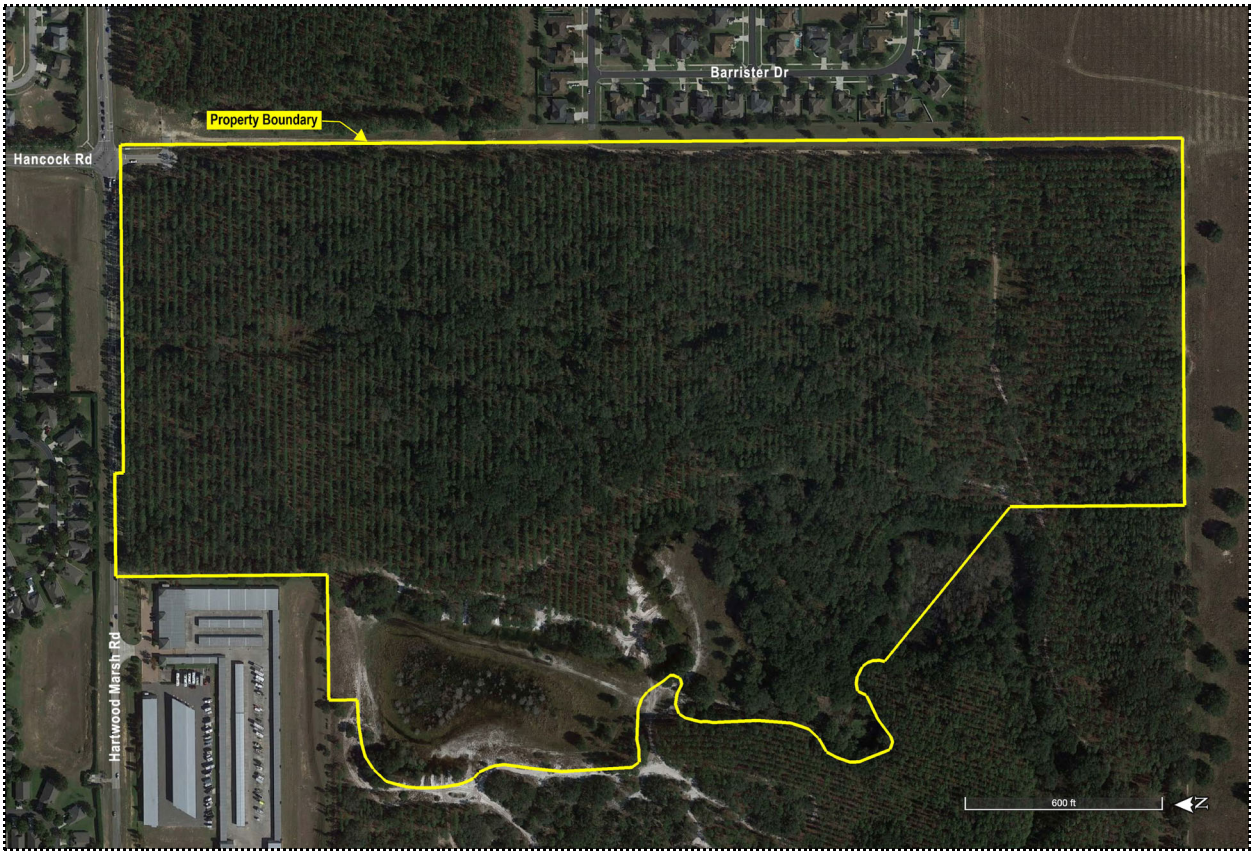


Exhibit 1. Subdivision Boundary

Exhibits 3.1 and 3.2 show the existing ground surface contours within the pond footprint and bear in mind the pond bottom elevation +92 ft NAVD when reviewing these contours. Within the bottom area of the south lobe, predevelopment ground surface is a high of about +100 ft to a low of about +94 ft. This compares to a high of +108 ft to a low of +94 ft within the bottom area of the north lobe.

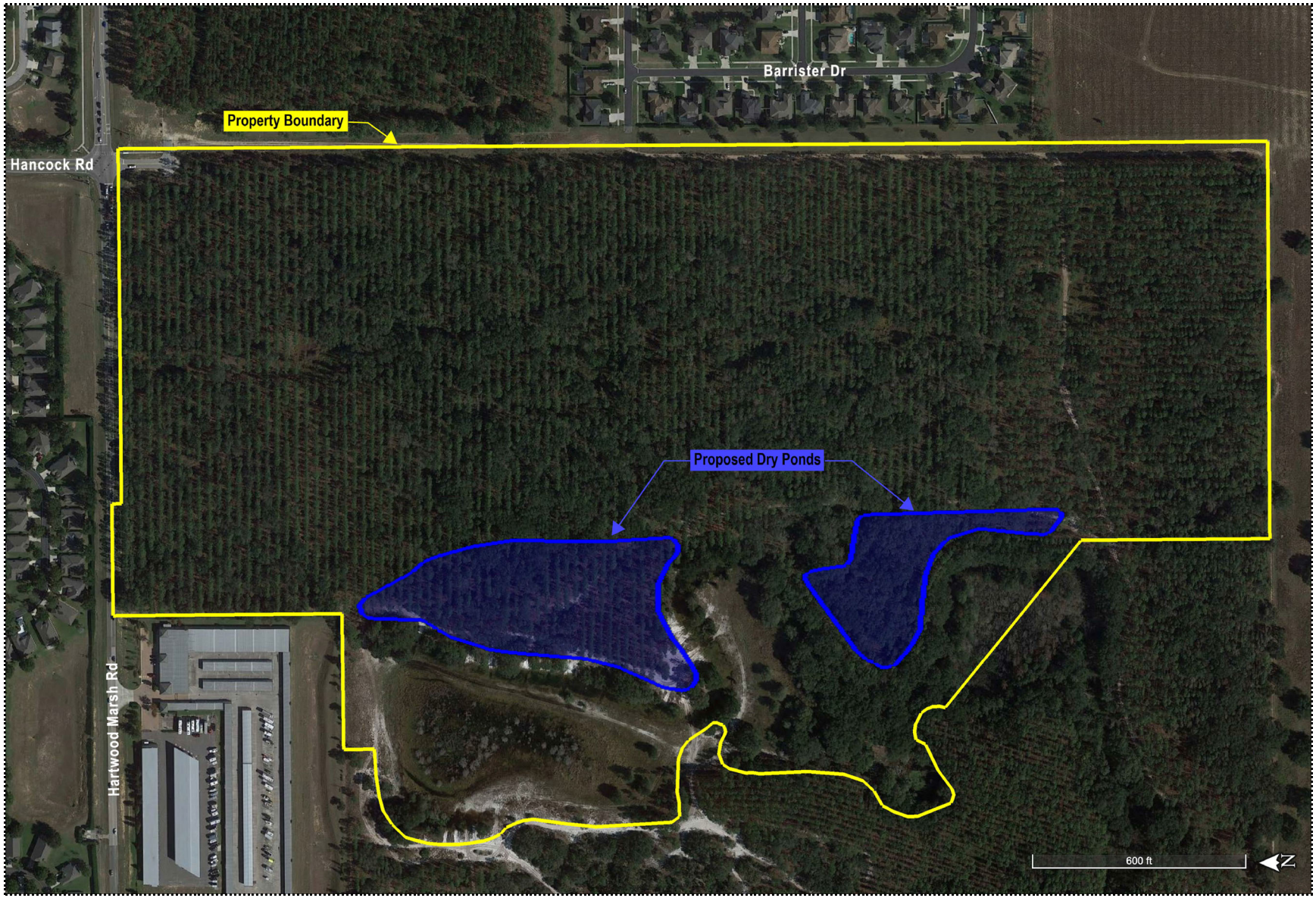


Exhibit 2. Pond Layout Within The Subdivision

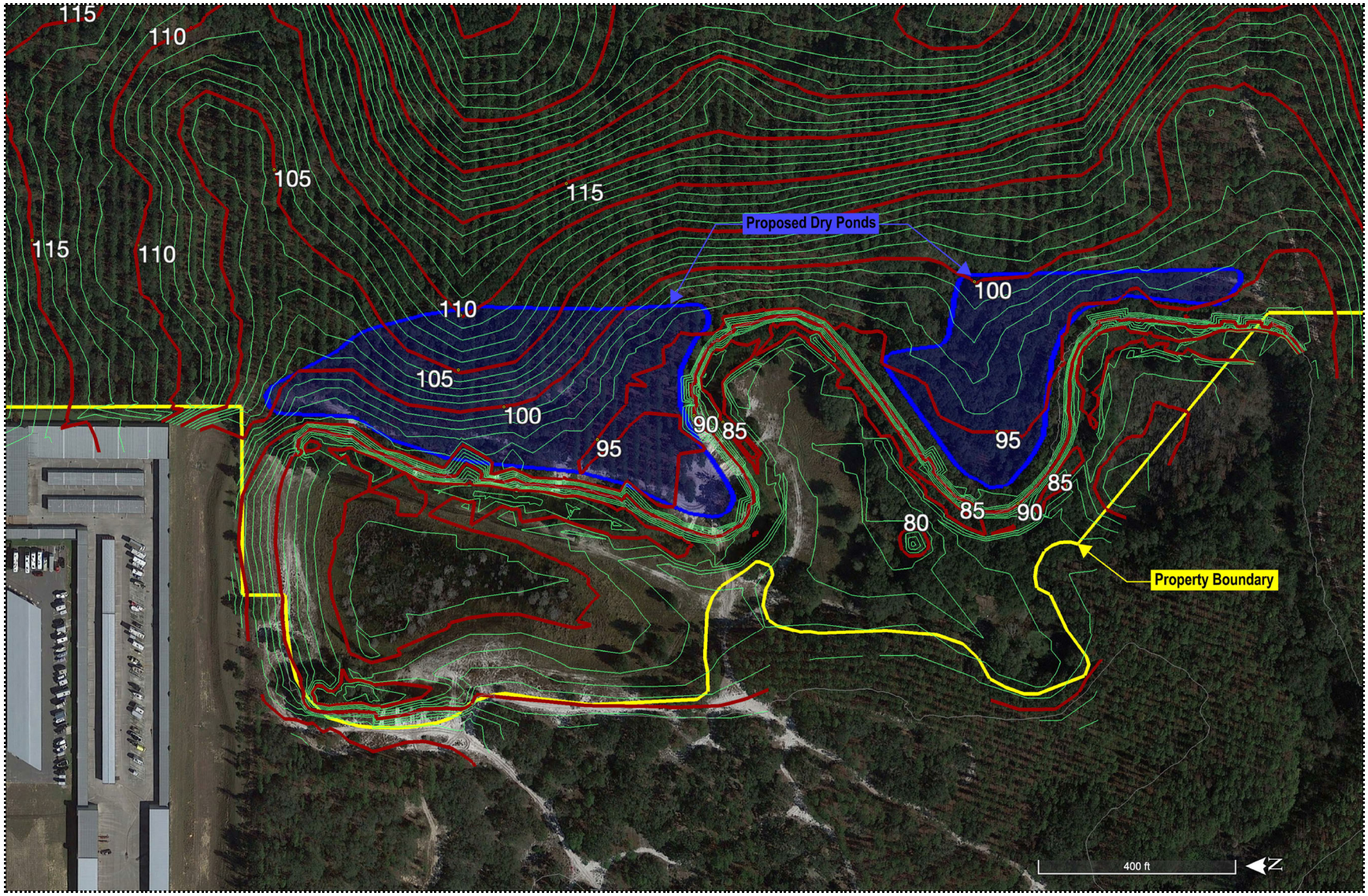


Exhibit 3.1. Pond footprint on predevelopment topography
note: pond bottom elevation at +92 ft NAVD

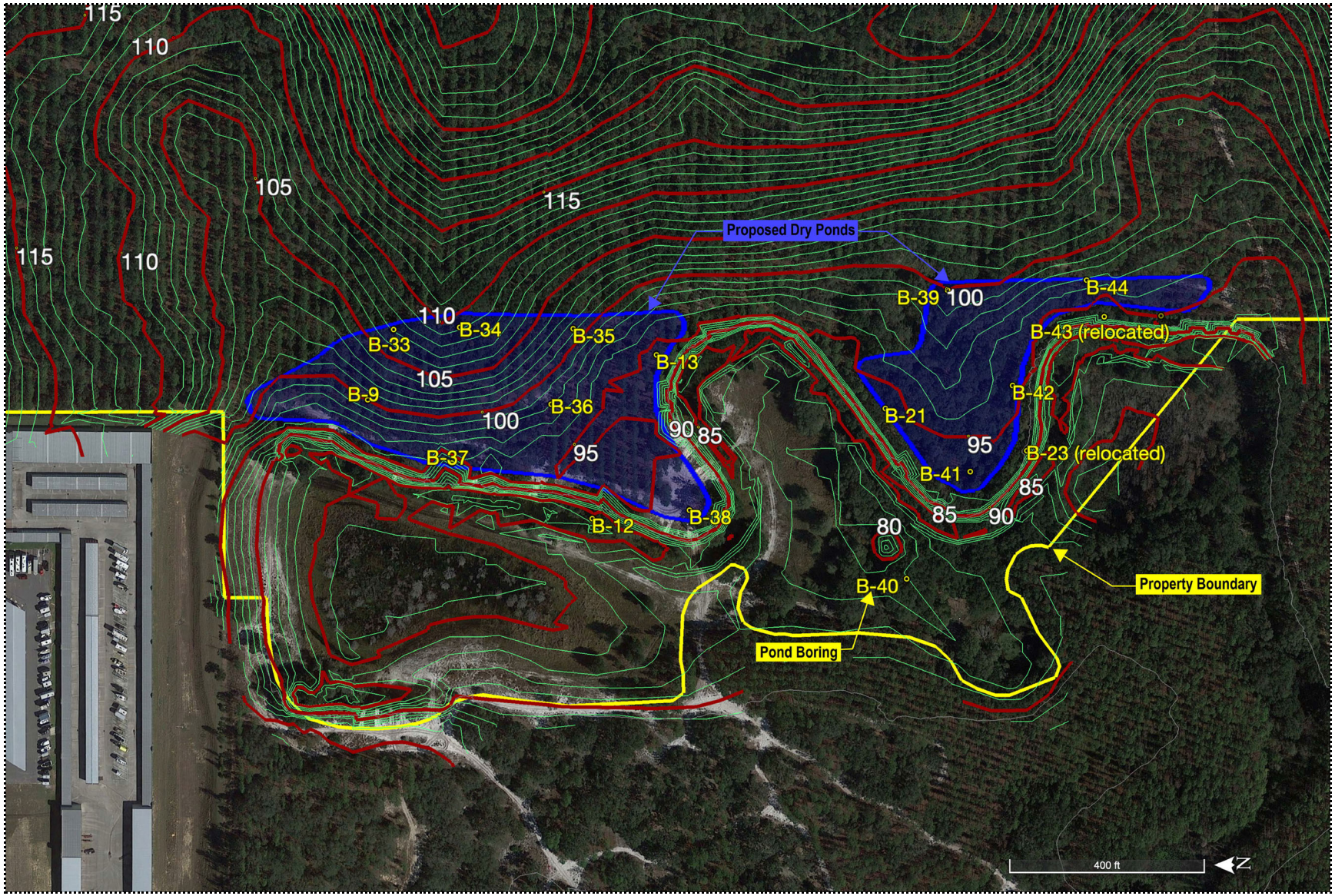


Exhibit 3.2. Predevelopment ground surface within ponds and surveyed borehole locations
note: pond bottom elevation at +92 ft NAVD

2.0 GEOTECHNICAL DATA

Eighteen (18) 30 ft deep borings were drilled within the pond footprint and these are labeled B-9, B-12, B-13, B-21, B-23, B-27 and B-33 to B-44 in Exhibit 4. Boring profiles are presented in Figures 1.1 to 1.6 (attached). Water table depth measurements and laboratory test results are annotated adjacent to these graphic soil profiles. All test locations were surveyed by the project surveyor except for B23 and B43 which were relocated due to site access. All borings show deep layers of permeable fine sands except for one small zone within the southern lobe. This zone is identified in Exhibit 5 where the base elevation of the permeable sand layer is above elevation +85 ft, compared to below elevation +65 ft in the other parts of the pond.

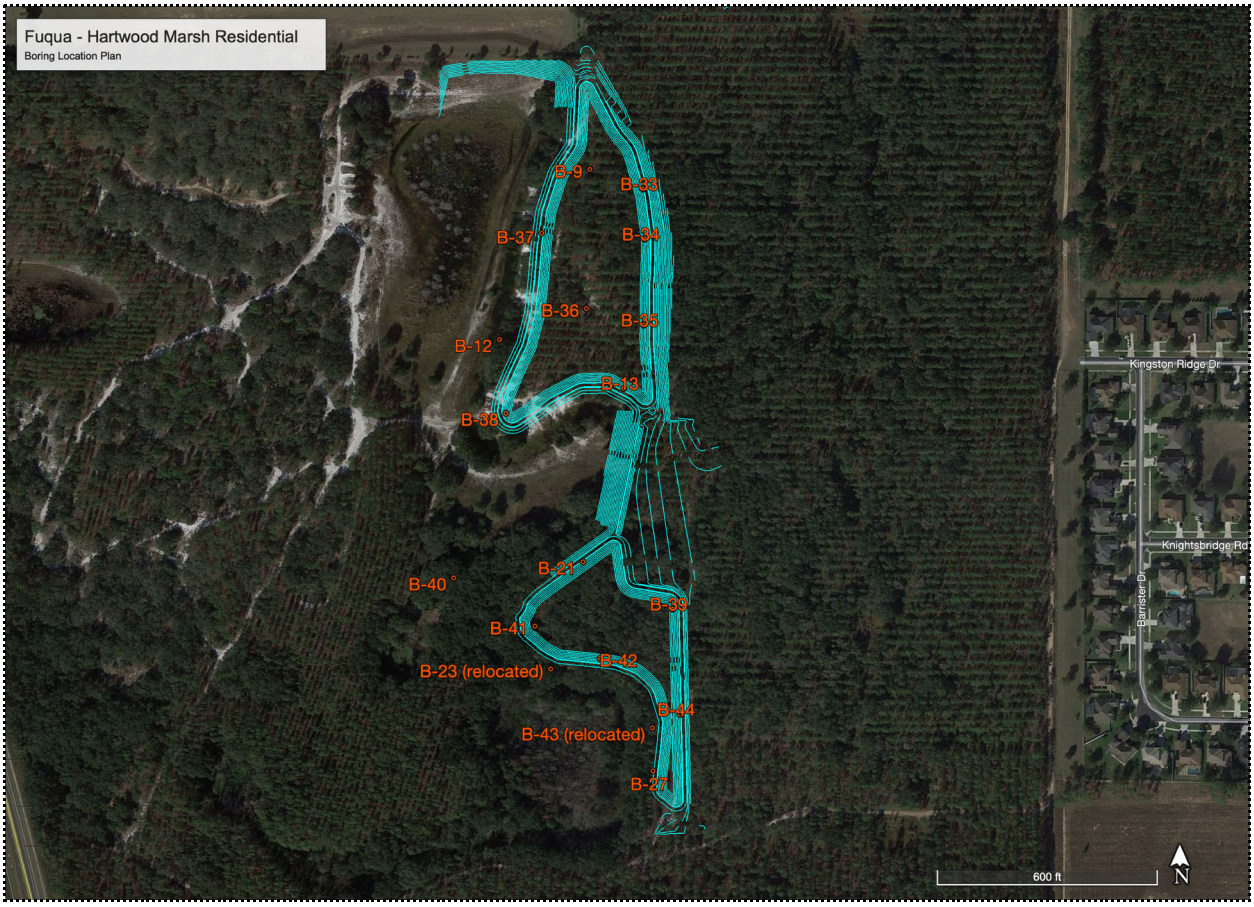


Exhibit 4. Boring Location Plan

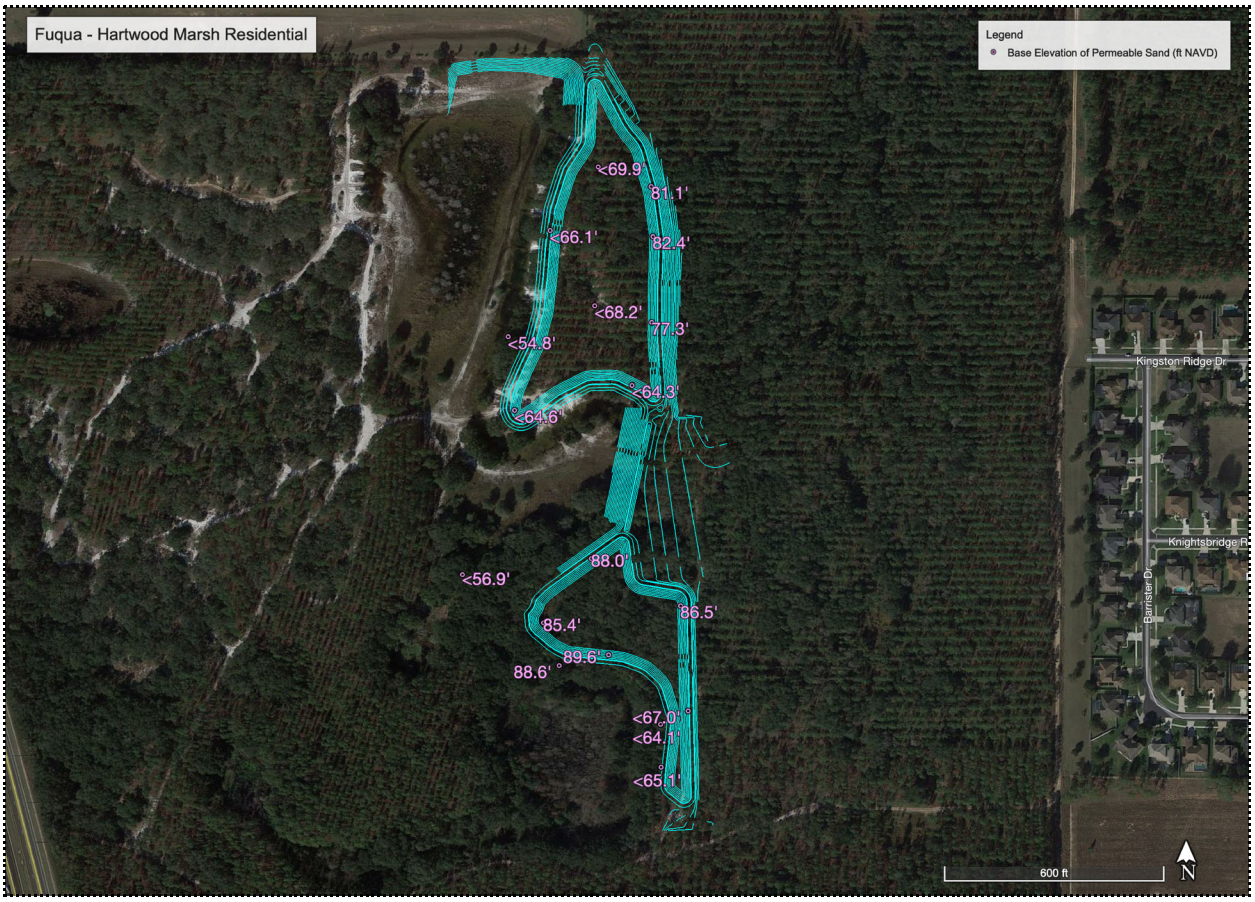


Exhibit 5. Base Elevation of Permeable Sand (ft NAVD)

Permeability tests on vertically oriented samples of the sand layer are in the general range 55 to 67 ft/day. These results are typical for the ridge areas of Clermont and are comparatively high when compared to sand permeability in other parts of Central Florida. Test results are summarized in Table 1 and are also annotated adjacent to the soil profiles in Figures 1.1 to 1.6.

Table 1. Summary of Permeability Test Results

Location	Sample Depth (ft)	Soil Description	Measured Vertical Permeability (ft/day)
SAND			
B-9	15.0 to 15.5	Very Light Brown Fine Sand	55.3
B-27	6.0 to 6.5	Light Brown Fine Sand	66.8
B-36	10.0 to 10.5	Very Light Brown Fine Sand	62.5
B-38	16.0 to 16.5	Light Brown Fine Sand	57.2
B-40	16.0 to 16.5	Brown Fine Sand	54.9
CLAYEY SAND			
B-42	12.0 to 12.5	Orange Clayey Fine Sand	26.8

Water table altitudes for measured and estimated seasonal high scenarios are shown in Exhibits 6 and 7 and these digital data are in Table 2. There was a fair amount of rainfall at Hartwood Marsh in June 2019 as a buildup to the wet season.

Table 2. Measured Water Table Elevations and Seasonal High Water Table (SHWT)

Boring No.	Ground Surface Elevation (ft NAVD)	Water Table Measured on June 26, 2019		Estimated SHWT	
		Depth Below Ground (ft)	Elevation (ft NAVD)	Depth Below Ground (ft)	Elevation (ft NAVD)
30 FT POND BORINGS					
B-9	99.9	16.40	83.5	13.4	86.5
B-12	84.8	1.20	83.6	-1.7	86.5
B-13	94.3	10.95	83.4	7.8	86.5
B-21	94.5	10.00	84.5	7.5	87.0
B-23	85.3	-0.70	86.0	-2.7	88.0
B-23A	94.1	9.65	84.5	6.7	87.5
B-27	95.1	9.10	86.0	9.1	86.0
B-33	108.1	24.73	83.4	21.6	86.5
B-34	110.4	26.75	83.7	23.4	87.0
B-35	101.3	17.25	84.1	14.3	87.0
B-36	98.2	14.85	83.4	11.7	86.5
B-37	96.1	12.75	83.4	9.6	86.5
B-38	94.6	11.45	83.2	8.1	86.5
B-39	100.5	16.45	84.1	13.6	87.0
B-40	86.9	2.60	84.3	-0.1	87.0
B-41	94.4	9.40	85.0	6.9	87.5
B-42	95.6	10.85	84.8	8.1	87.5
B-43	86.2	0.20	86.0	-1.8	88.0
B-43A	94.1	8.80	85.3	6.1	88.0
B-44	97.0	11.95	85.1	9.5	87.5

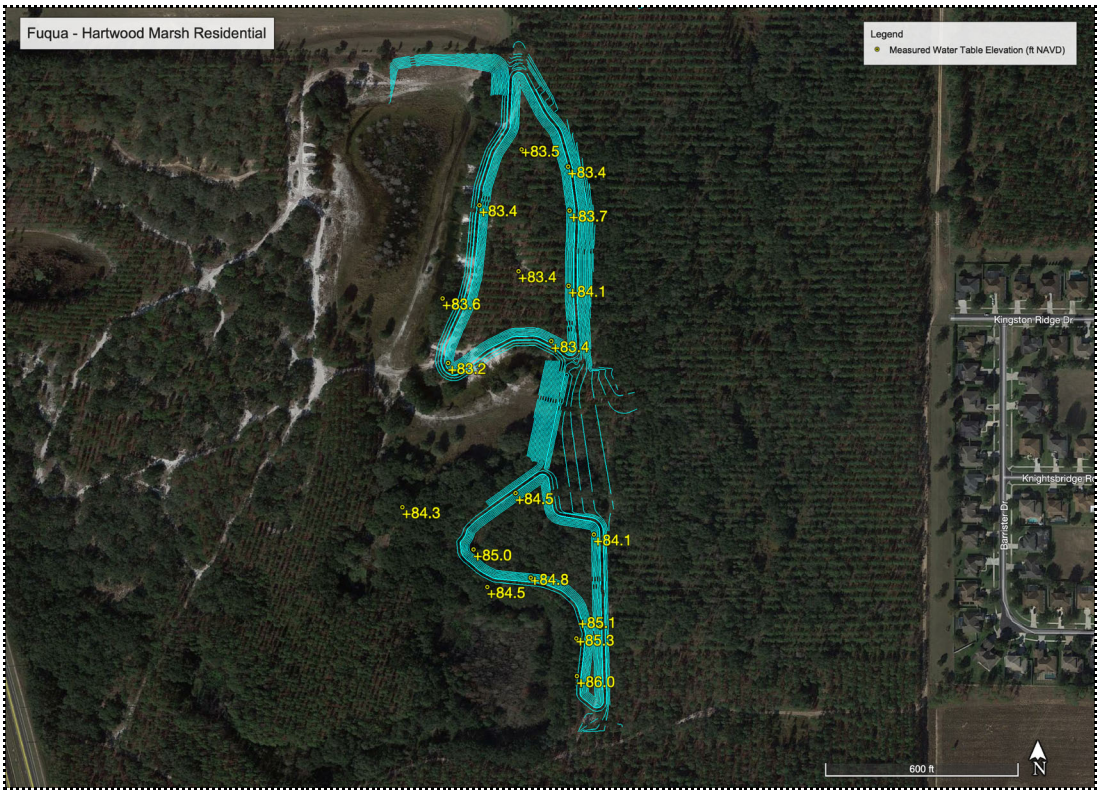


Exhibit 6. Measured Water Table Elevation (ft NAVD)

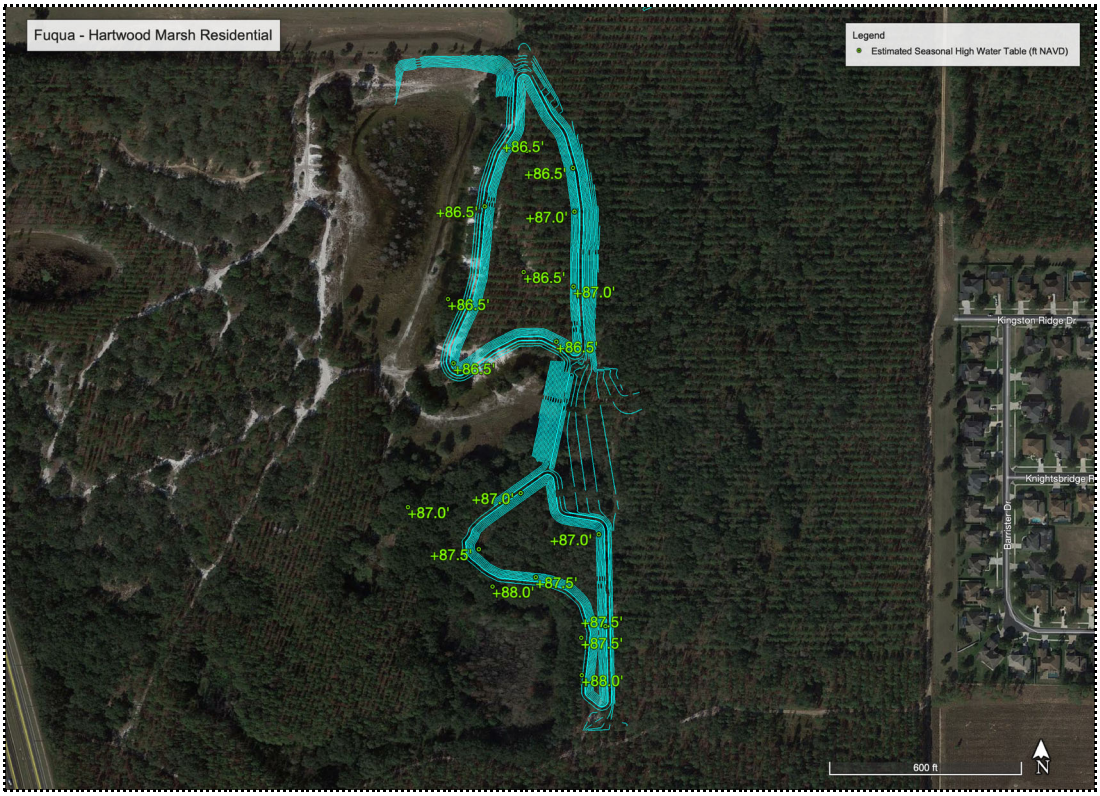


Exhibit 7. Estimated Seasonal High Water Table Elevation (ft NAVD)

3.0 RECOVERY ANALYSES

Table 3 summarizes the stage-area-volume relationship for the pond.

Table 3. Pond Stage / Storage Table				
Stage (FT)	Area (AC)	ft^2	Δ Vol. (AF)	Σ Vol. (AF)
92.0	8.68	378,101	0.000	0.000
93.0	9.05	394,218	8.870	8.870
94.0	9.43	410,771	9.240	18.110
95.0	9.82	427,759	9.630	27.730
96.0	10.21	444,748	10.020	37.750
96.5	10.41	453,460	5.160	42.900
97.5	11.40	496,584	10.910	53.810

Note that there is a high level overflow structure (5 ft weir) at an elevation of +97.7 ft NAVD. Pond fill berm side slopes are 4H:1V with a 10 ft width at the top of berm.

The idealized and other input parameters for this pond are listed in Table 4. Simulation results (PONDS Refined method Module) for the 25 yr/96 hr storm recovery is in Attachment A and the corresponding water quality volume recovery is in Attachment B. These results show that both SJRWMD criteria are satisfied for recovery.

The slope stability of the fill berm is also above 1.2 for full saturation of the slope which is an acceptable safety factor.

Table 4. Stormwater Pond {Key Parameters & Results}		
Parameter	**Unit**	**Magnitude**
Top of Bank Elevation	ft NAVD	98.5
Weir Elevation	ft NAVD	97.70
Pond Bottom Elevation	ft NAVD	92.0
Seasonal High Water Table (SHWT)	ft NAVD	87.0
Base of Aquifer (permeable sand)	ft NAVD	70.0
Horizontal Hydraulic Conductivity, Kh	ft/day	45.0
Fillable Porosity, n	%	30.0
Unsaturated vertical infiltration rate	ft/day	5.0
Projection area for unsaturated infiltration	ft^2	410,771
Separation between pond bottom & SHWT	ft	5.0
Water Quality Volume (72 hr recovery)	ac-ft	12.11
	ft^3	527,512
25 yr/96 hr volume (14 day recovery)	ac-ft	40.78
	ft^3	1,776,377
Equivalent pond length	ft	1430
Equivalent pond width	ft	290
KEY RESULTS OF COMPUTER RUNS		
Recovery time for water quality volume	hr	12
Recovery time for 25 yr/96 hr volume	days	10
COMPUTER PRINTOUTS OF RECOVERY ANALYSES		
Attachment containing PONDS computer printout	-	A, B
BERM STABILITY PARAMETERS		
Top of fill berm	ft NAVD	98.5
Predevelopment ground surface in fill berm	ft NAVD	93.0
Maximum height of fill berm (downhill)	ft	5.5
Weir Elevation	ft NAVD	97.70
Top width of berm	ft	10
Outside side slope for fill berm	?H:1V	4
Inside side slope for fill berm	?H:1V	4
Factor of safety for slope stability failure {FS≥ 1.2)	-	1.2

4.0 POND BERM FILL RECOMMENDATIONS

Where the pond's perimeter berm is to be constructed above natural grade, the following are the recommended specifications for berm construction. With the exception of the topsoil, the soils are of a type and consistency suitable for the support of the proposed earthen berms, provided that they are prepared as described hereunder. The following berm construction specifications have been prepared as a guide to the design engineer for the Hartwood Marsh residential subdivision in Clermont, FL. These recommendations should be incorporated into the general project specifications.

1. The berm footprint plus a minimum margin of 3 feet 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/or stockpiled onsite as directed by the owner/engineer.

2. Within the berm footprint, plus a minimum margin of 3 feet on either side, the resulting cleared surface and 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 below.

3. No construction dewatering is anticipated.

4. 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 operation.

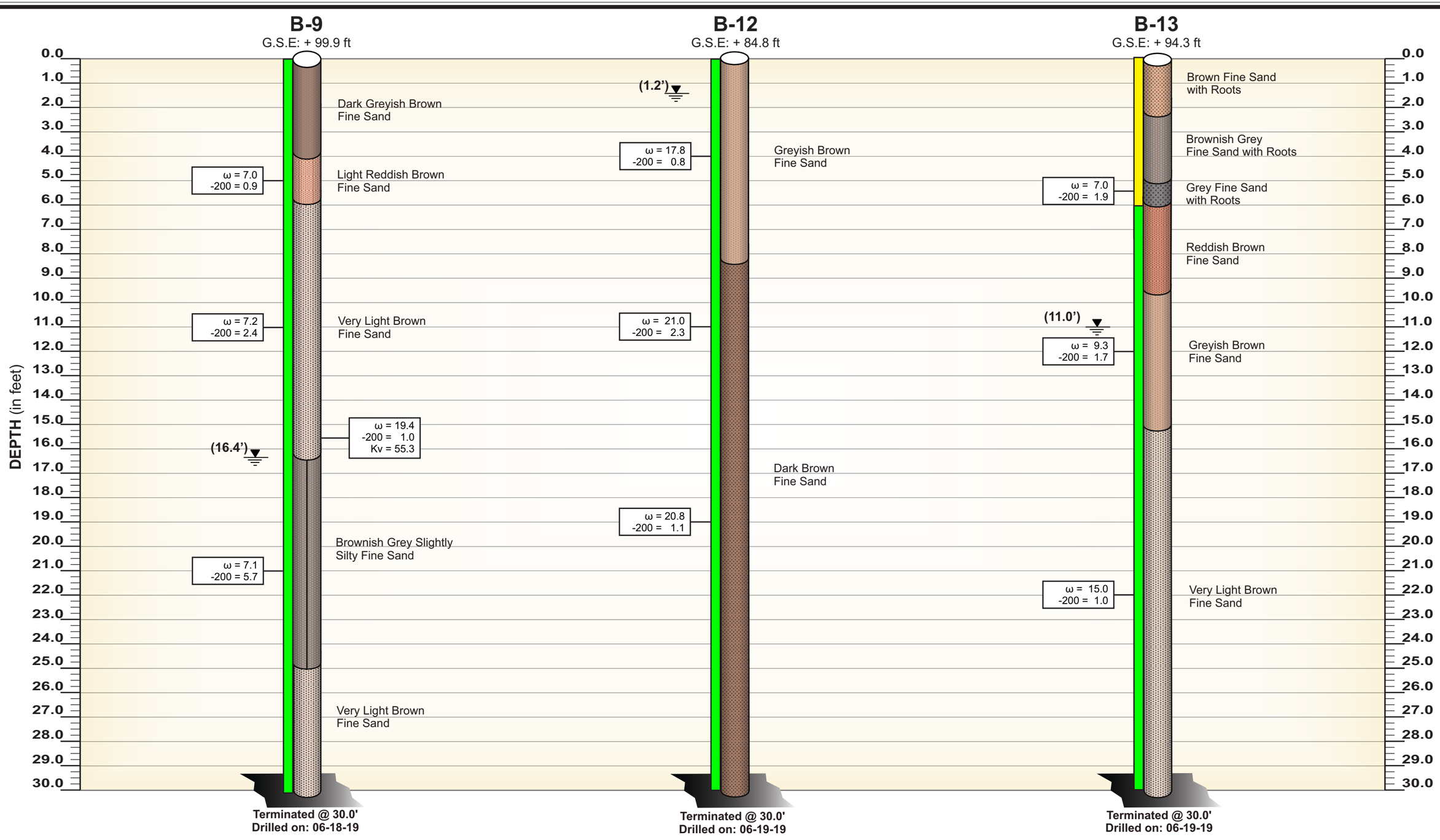
5. The compaction efforts should continue until the subsoils within the proposed berm footprint are compacted to a minimum density equivalent to 95 percent of the soils' Maximum Modified Proctor Density value (AASHTO T-180), as tested to a minimum depth of 1 foot below the bottom of the exposed subgrade.

6. Fill material required to attain finished grade should comprise the fine sands from the onsite excavation. The fill soils should be placed in lifts not exceeding 12 inches loose thickness and compacted to the minimum density specified above ($\geq$95% Modified Proctor). No tree limbs or other debris should be emplaced in the fill berm or pond bottom without the approval of the geotechnical engineer. Such inclusions in the fill berm can cause settlement and provide preferential pathways for seepage through the berm and result in berm failure. Do not bury trees or vegetation debris within the berm fill.

7. The intent of the compaction requirements outlined herein is to provide compacted soils to the top of the berm.

8. 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.

FIGURES



NOTES:

- Suitable fill for veneer (fine sands & slightly silty fine sands)
- Suitable but w/ limitations on placement/compaction (Silty fine sands & slightly clayey fine sands)
- Unsuitable for fill (Clayey fine sand, sandy clay, clays, muck)

LEGEND :

ω = Field moisture content (%)

-200 = Percent passing US#200 Sieve

Kv = Vertical Hydraulic Conductivity (ft/Day)

Typical Correlations between SPT "N" Values and Soil Properties

Granular Materials		Silt and Clay	
Relative Density	SPT (Blows/ft)	Consistency	SPT (Blows/ft)
Very Loose	Less than 4	Very Soft	Less than 2
Loose	4 to 10	Soft	2 to 4
Meduim Dense	10 to 30	Firm	4 to 8
Very	30 to 50	Stiff	8 to 15
Very Dense	Greater than 50	Very Stiff	15 to 30
		Hard	Greater than 30

NOTES:

Borings drilled on the date noted

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

Water level measured on June 26, 2019.

N Standard Penetration Test Resistance (blos/ft)

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Checked & Approved By:	Drawn By:	Date:
DS	RB	06.27.2019

Figure Name: **SOIL PROFILES FOR B-9, B-12 & B-13**

Project Name: **Fuqua - Hartwood Marsh Residential**

Scale:	Project #	
NOTED	19-585.18	Figure 1.1

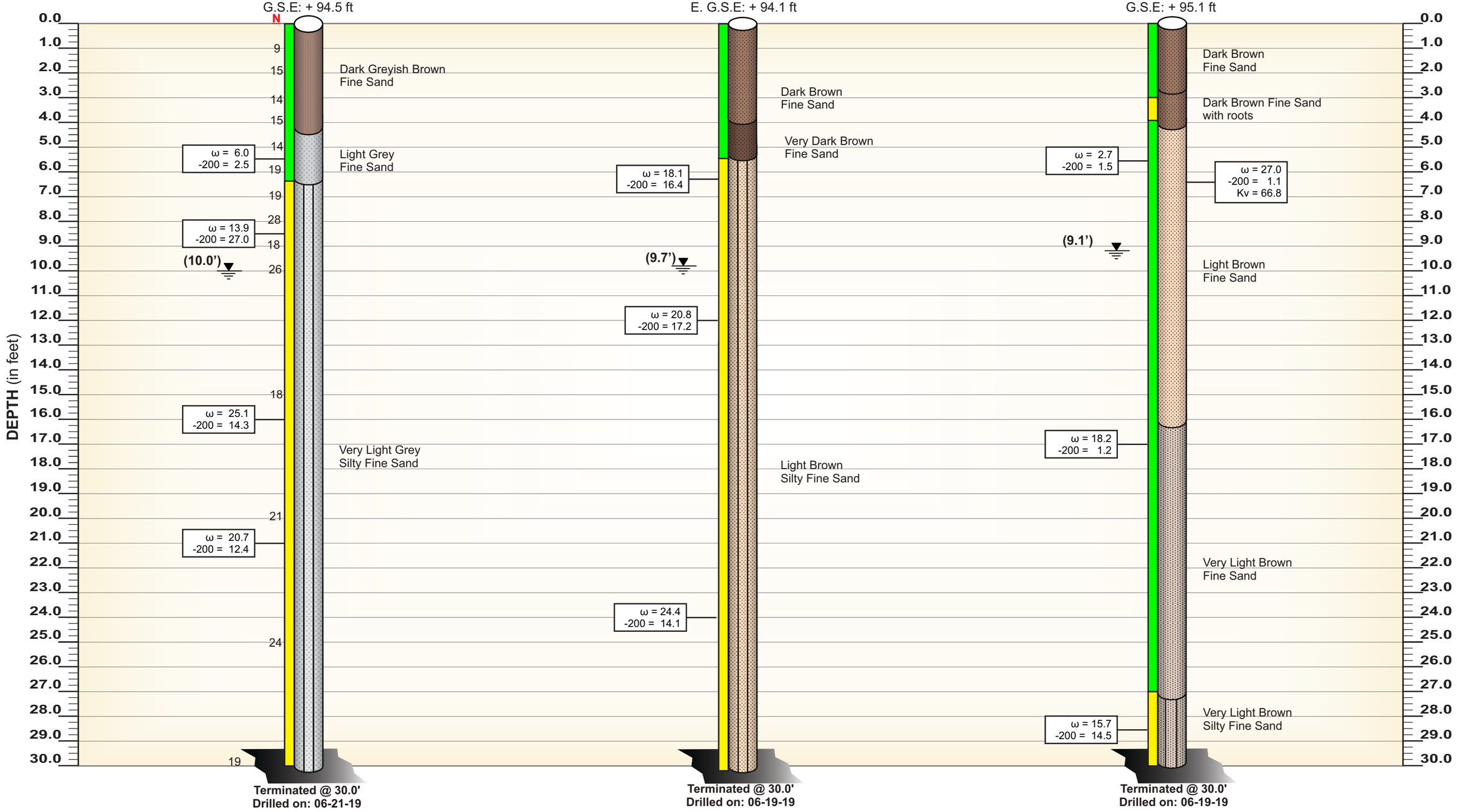

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Figure Name: **SOIL PROFILES FOR B-21, B-23 & B-27**

Project Name: **Fuqua - Hartwood Marsh Residential**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	RB	06.27.2019	NOTED	19-585.18	Figure 1.2

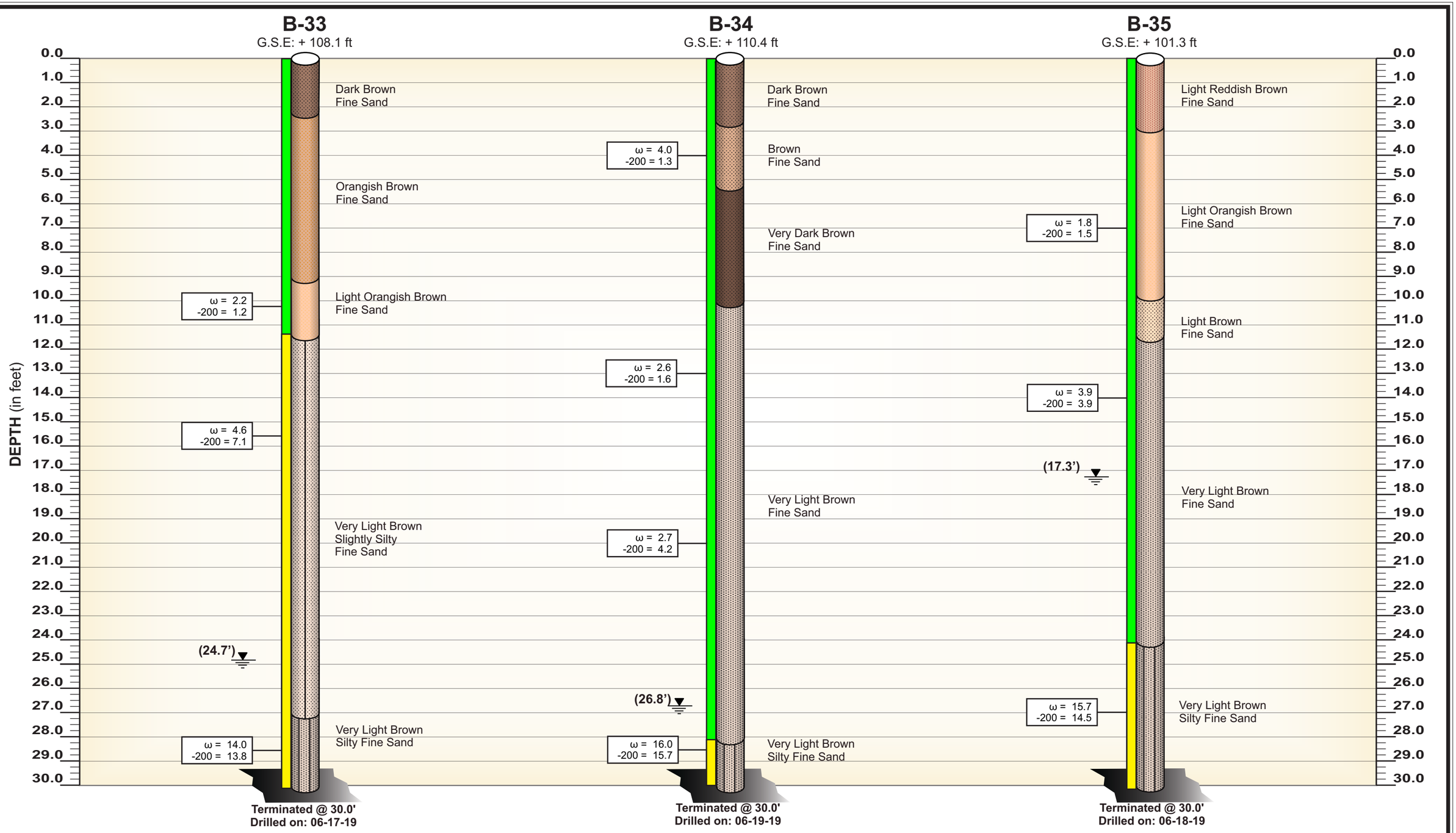

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Figure Name: **SOIL PROFILES FOR B-33, B-34 & B-35**

Project Name: **Fuqua - Hartwood Marsh Residential**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	RB	06.27.2019	NOTED	19-585.18	Figure 1.3

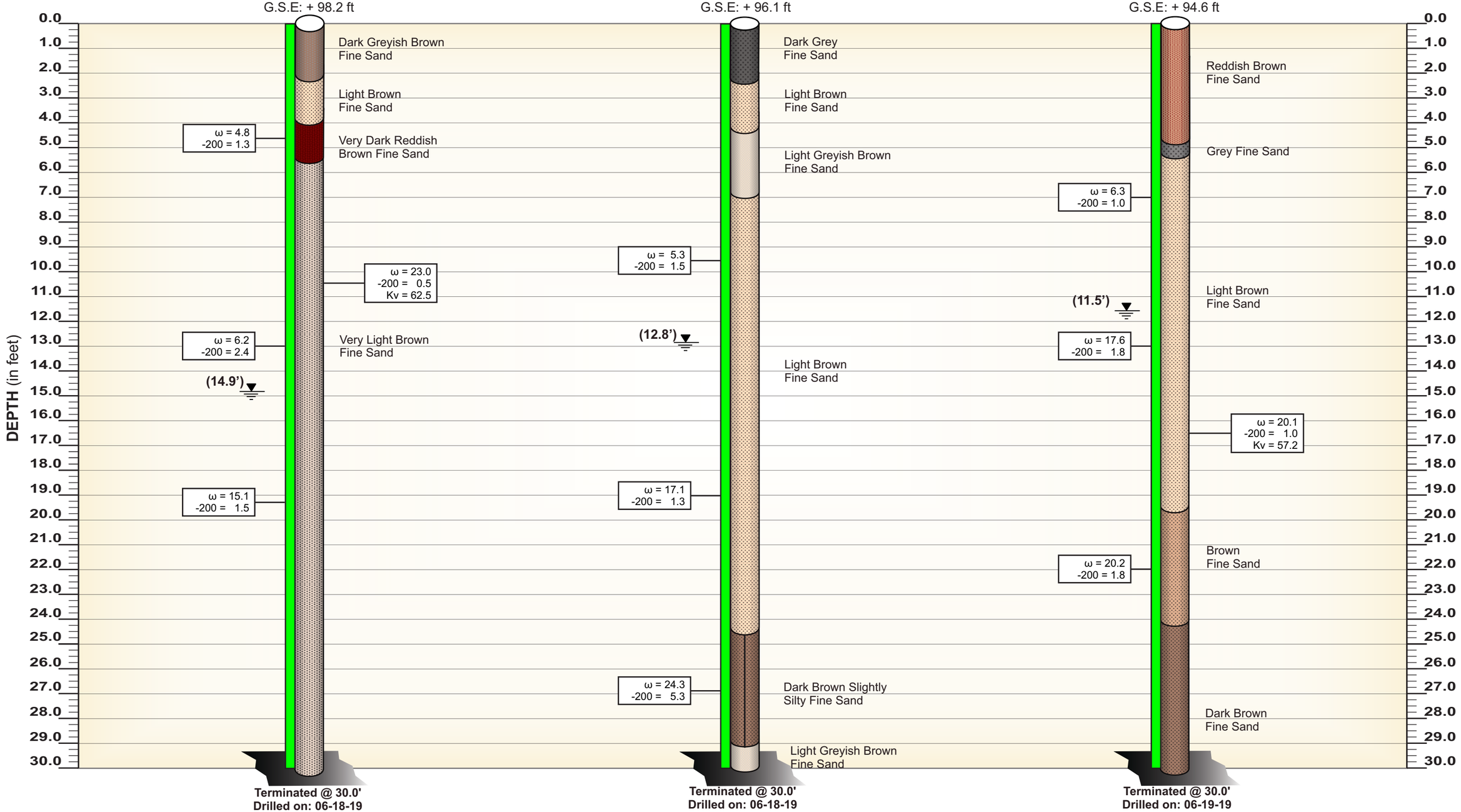

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Figure Name: **SOIL PROFILES FOR B-36, B-37 & B-38**

Project Name: **Fuqua - Hartwood Marsh Residential**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	RB	06.27.2019	NOTED	19-585.18	Figure 1.4

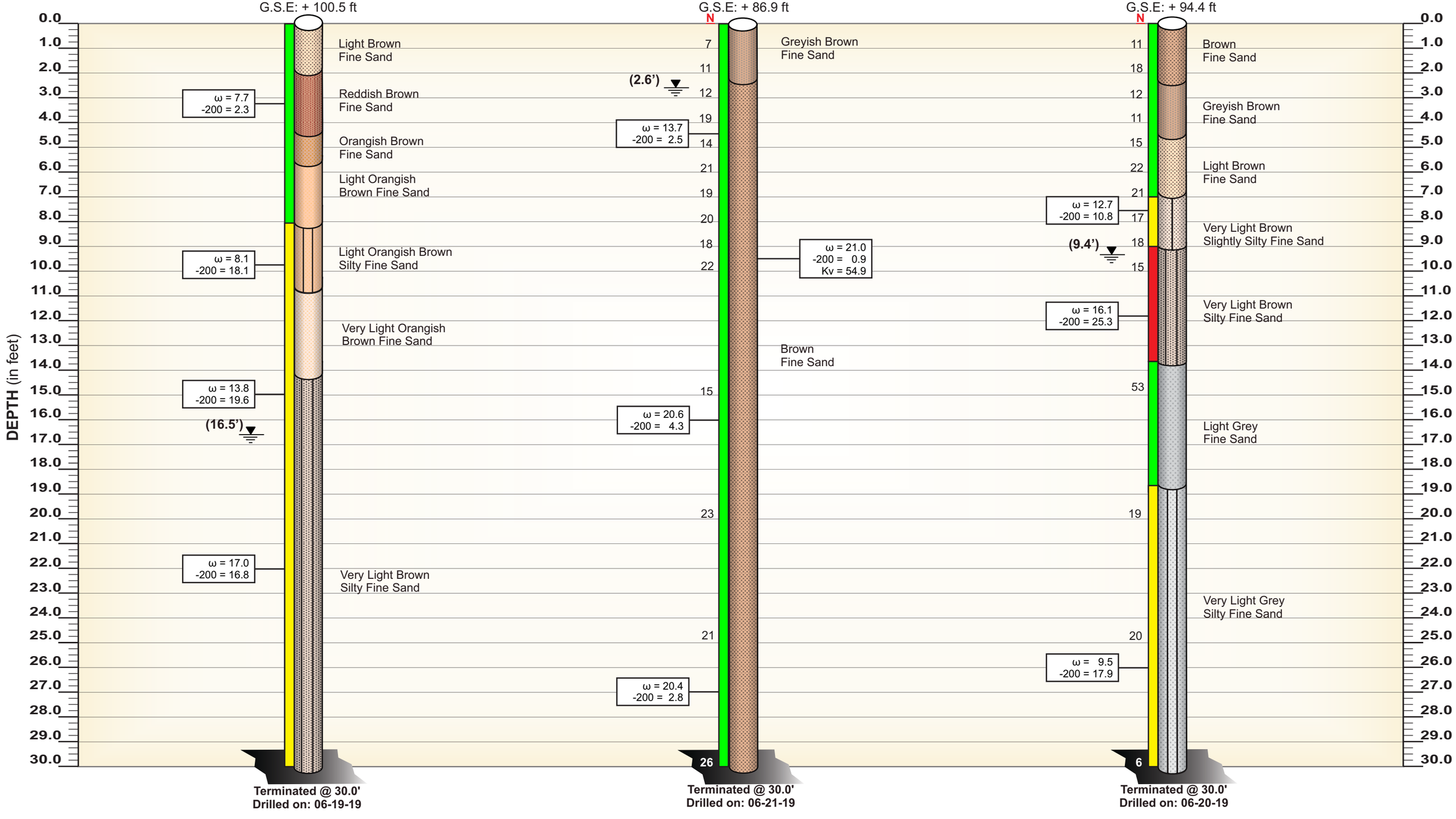

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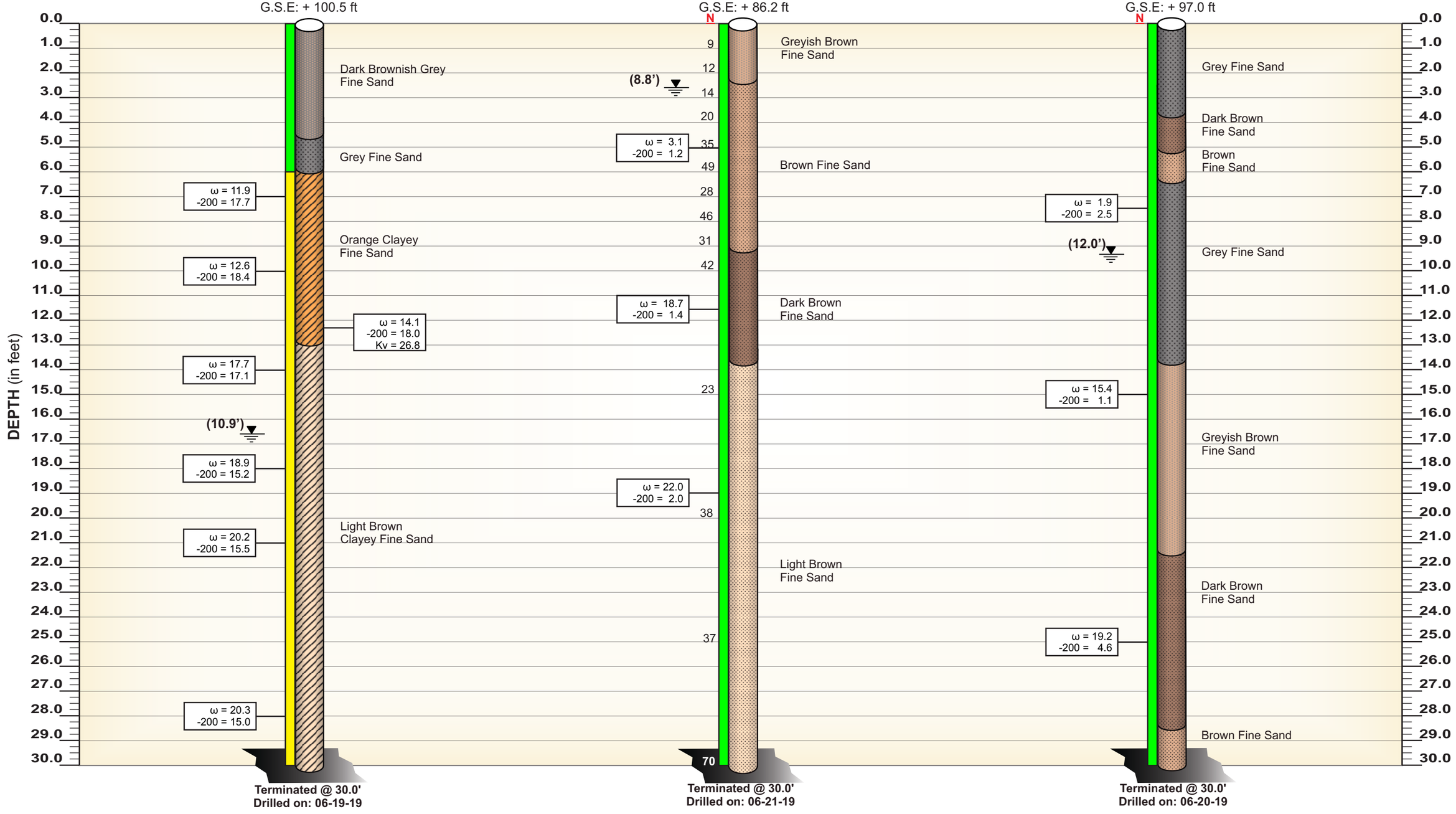
Figure Name: **SOIL PROFILES FOR B-39, B-40 & B-41**

Project Name: **Fuqua - Hartwood Marsh Residential**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	RB	06.27.2019	NOTED	19-585.18	Figure 1.5



NOTES:

- Suitable fill for veneer (fine sands & slightly silty fine sands)
- Suitable but w/ limitations on placement/compaction (Silty fine sands & slightly clayey fine sands)
- Unsuitable for fill (Clayey fine sand, sandy clay, clays, muck)

LEGEND :

ω = Field moisture content (%)

-200 = Percent passing US#200 Sieve

Kv = Vertical Hydraulic Conductivity (ft/Day)

Typical Correlations between SPT "N" Values and Soil Properties

Granular Materials		Silt and Clay	
Relative Density	SPT (Blows/ft)	Consistency	SPT (Blows/ft)
Very Loose	Less than 4	Very Soft	Less than 2
Loose	4 to 10	Soft	2 to 4
Meduim Dense	10 to 30	Firm	4 to 8
Very	30 to 50	Stiff	8 to 15
Very Dense	Greater than 50	Very Stiff	15 to 30
		Hard	Greater than 30

NOTES:

- Borings drilled on the date noted
- G.S.E Surveyed ground surface elevation (ft NAVD)
- Water level measured on June 26, 2019.
- N Standard Penetration Test Resistance (blos/ft)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Drive . Orlando, Florida 32808
Phone: (407) 290-2371 . Fax: (407) 298-9011
E-Mail addresss: devo@devoeng.com
Website: http://www.devoeng.com

Figure Name: **SOIL PROFILES FOR B-42, B-43 & B-44**

Project Name: **Fuqua - Hartwood Marsh Residential**

Checked & Approved By:	Drawn By:	Date:	Scale:	Project #	
DS	RB	06.27.2019	NOTED	19-585.18	Figure 1.6

ATTACHMENT A

25 YR/96 HR PRE-POST STORM VOLUME RECOVERY

PONDS Version 3.3.0278
Retention Pond Recovery - Refined Method
Copyright 2012
Devo Seereeram, Ph.D., P.E.

Project Data

Project Name:	Fuqua - Hartwood Marsh
Simulation Description:	Combined Pond - 25yr 96hr Volume Run
Project Number:	19-585.18
Engineer :	Reidel Gardon
Supervising Engineer:	Devo Seereeram
Date:	06-21-2019

Aquifer Data

Base Of Aquifer Elevation, [B] (ft datum):	70.00
Water Table Elevation, [WT] (ft datum):	87.00
Horizontal Saturated Hydraulic Conductivity, [Kh] (ft/day):	45.00
Fillable Porosity, [n] (%):	30.00
Unsaturated Vertical Infiltration Rate, [Iv] (ft/day):	5.0
Maximum Area For Unsaturated Infiltration, [Av] (ft^2):	410771.0

Geometry Data

Equivalent Pond Length, [L] (ft):	1430.0
Equivalent Pond Width, [W] (ft):	290.0

Ground water mound is expected to intersect the pond bottom

Stage vs Area Data

Stage (ft datum)	Area (ft^2)
92.00	378101.0
93.00	394218.0
94.00	410771.0
95.00	427759.0
96.00	444748.0
96.50	453460.0
97.50	496584.0

Ditch Data

Ditch (or interceptor trench) parallel to length axis is inactive

Ditch (or interceptor trench) parallel to width axis is inactive

Discharge Structures

Discharge Structure #1 is inactive

Discharge Structure #2 is inactive

Discharge Structure #3 is inactive

Scenario Input Data

Scenario 1 :: 1776377 ft³ slug load

Hydrograph Type: Slug Load
Modflow Routing: Routed with infiltration

Treatment Volume (ft³) 1776377

Initial ground water level (ft datum) 87.00 (default)

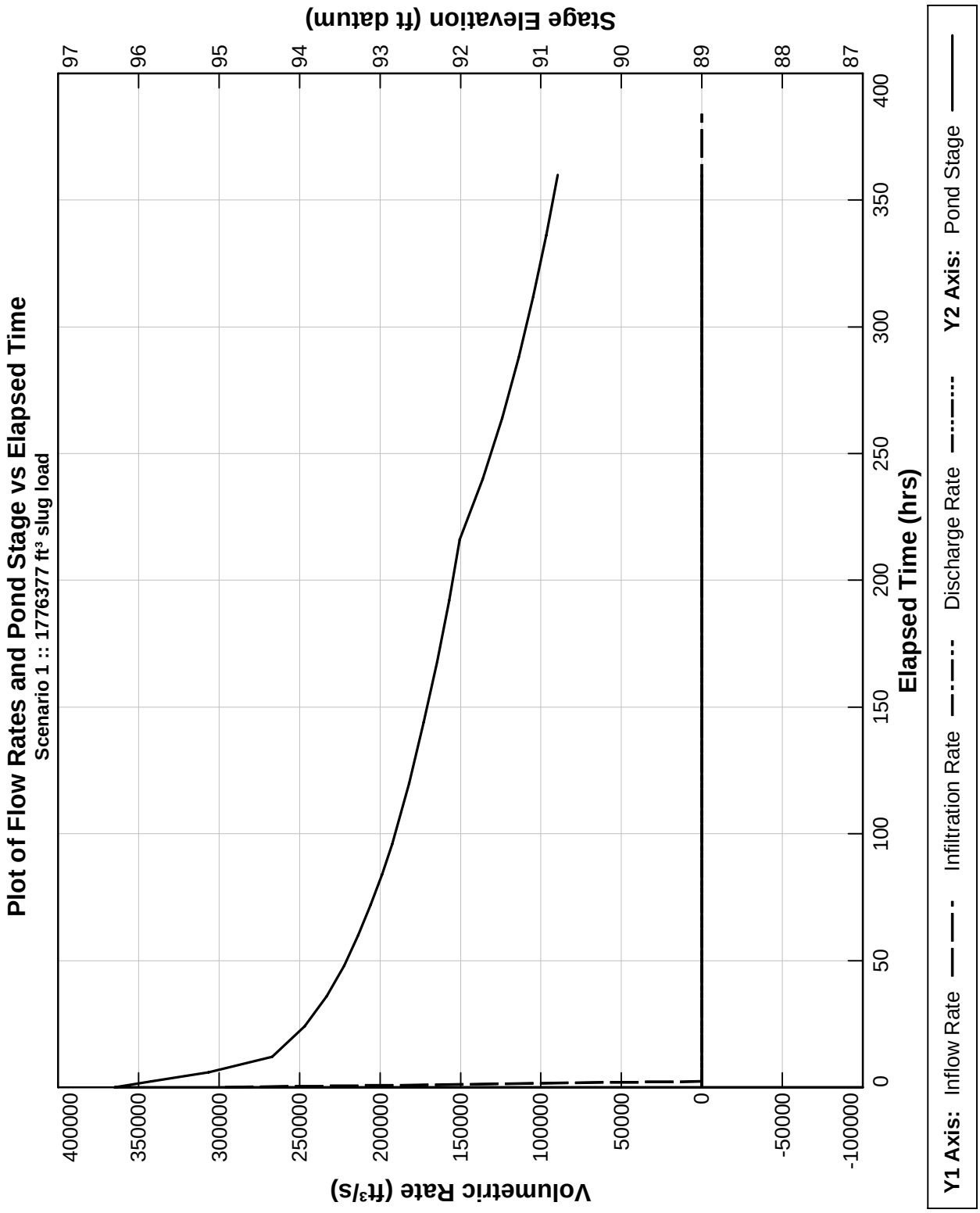
Time After Storm Event (days)	Time After Storm Event (days)	Time After Storm Event (days)	Time After Storm Event (days)	Time After Storm Event (days)
0.100	2.000	5.000	10.000	15.000
0.250	2.500	6.000	11.000	16.000
0.500	3.000	7.000	12.000	
1.000	3.500	8.000	13.000	
1.500	4.000	9.000	14.000	

Detailed Results *:: Scenario 1 :: 1776377 ft³ slug load*

Elapsed Time (hours)	Instantaneous Inflow Rate (ft³/s)	Outside Recharge (ft/day)	Stage Elevation (ft datum)	Infiltration Rate (ft³/s)	Combined Instantaneous Discharge Rate (ft³/s)	Cumulative Inflow Volume (ft³)	Cumulative Infiltration Volume (ft³)	Combined Cumulative Discharge (ft³)	Flow Type
0.000	296062.8000	0.00000	87.00000	0.00000	0	0.000	0.0	0	N.A.
0.002	296062.8000	0.00000	96.29523	23.77147	0	1776377.000	142.6	0	U/P
2.400	0.0000	0.00000	95.83494	23.77147	0	1776377.000	205385.5	0	U/P
6.000	0.0000	0.00000	95.12823	20.63968	0	1776377.000	513463.8	0	U/P
12.000	0.0000	0.00000	94.34130	11.57274	0	1776377.000	846536.2	0	U/S
24.000	0.0000	0.00000	93.93577	3.23237	0	1776377.000	1014074.0	0	S
36.000	0.0000	0.00000	93.66152	2.29446	0	1776377.000	1125813.0	0	S
48.000	0.0000	0.00000	93.44708	1.83042	0	1776377.000	1212315.0	0	S
60.000	0.0000	0.00000	93.26803	1.54292	0	1776377.000	1283961.0	0	S
72.000	0.0000	0.00000	93.11285	1.34329	0	1776377.000	1345624.0	0	S
84.000	0.0000	0.00000	92.97512	1.19474	0	1776377.000	1400022.0	0	S
96.000	0.0000	0.00000	92.85081	1.07178	0	1776377.000	1448849.0	0	S
120.000	0.0000	0.00000	92.63935	0.89110	0	1776377.000	1531344.0	0	S
144.000	0.0000	0.00000	92.45459	0.77890	0	1776377.000	1602830.0	0	S
168.000	0.0000	0.00000	92.29029	0.69221	0	1776377.000	1665939.0	0	S
192.000	0.0000	0.00000	92.14221	0.62305	0	1776377.000	1722444.0	0	S
216.000	0.0000	0.00000	92.00734	0.31211	0	1776377.000	1773601.0	0	S
240.000	0.0000	0.00000	91.72523	0.01607	0	1776377.000	1776377.0	0	S
264.000	0.0000	0.00000	91.48316	0.00000	0	1776377.000	1776377.0	0	S
288.000	0.0000	0.00000	91.27623	0.00000	0	1776377.000	1776377.0	0	S
312.000	0.0000	0.00000	91.09518	0.00000	0	1776377.000	1776377.0	0	S
336.000	0.0000	0.00000	90.93434	0.00000	0	1776377.000	1776377.0	0	S
360.000	0.0000	0.00000	90.78988	0.00000	0	1776377.000	1776377.0	0	S
384.000	0.0000	0.00000	90.65897	----	----	1776377.000	1776377.0	0	N.A.

Summary of Results *:: Scenario 1 :: 1776377 ft³ slug load*

	Time (hours)	Stage (ft datum)	Rate (ft³/s)	Volume (ft³)
Stage				
Minimum	0.000	87.00		
Maximum	0.002	96.30		
Inflow				
Rate - Maximum - Positive	0.002		296062.8000	
Rate - Maximum - Negative	None		None	
Cumulative Volume - Maximum Positive	0.002			1776377.0
Cumulative Volume - Maximum Negative	None			None
Cumulative Volume - End of Simulation	384.000			1776377.0
Infiltration				
Rate - Maximum - Positive	0.002		23.7715	
Rate - Maximum - Negative	None		None	
Cumulative Volume - Maximum Positive	240.000			1776377.0
Cumulative Volume - Maximum Negative	None			None
Cumulative Volume - End of Simulation	384.000			1776377.0
Combined Discharge				
Rate - Maximum - Positive	None		None	
Rate - Maximum - Negative	None		None	
Cumulative Volume - Maximum Positive	None			None
Cumulative Volume - Maximum Negative	None			None
Cumulative Volume - End of Simulation	384.000			0.0
Discharge Structure 1 - inactive				
Rate - Maximum - Positive	disabled		disabled	
Rate - Maximum - Negative	disabled		disabled	
Cumulative Volume - Maximum Positive	disabled			disabled
Cumulative Volume - Maximum Negative	disabled			disabled
Cumulative Volume - End of Simulation	disabled			disabled
Discharge Structure 2 - inactive				
Rate - Maximum - Positive	disabled		disabled	
Rate - Maximum - Negative	disabled		disabled	
Cumulative Volume - Maximum Positive	disabled			disabled
Cumulative Volume - Maximum Negative	disabled			disabled
Cumulative Volume - End of Simulation	disabled			disabled
Discharge Structure 3 - inactive				
Rate - Maximum - Positive	disabled		disabled	
Rate - Maximum - Negative	disabled		disabled	
Cumulative Volume - Maximum Positive	disabled			disabled
Cumulative Volume - Maximum Negative	disabled			disabled
Cumulative Volume - End of Simulation	disabled			disabled
Pollution Abatement:				
36 Hour Stage and Infiltration Volume	36.000	93.66		1125813.0
72 Hour Stage and Infiltration Volume	72.000	93.11		1345624.0


Plot of Flow Rates and Pond Stage vs Elapsed Time
Scenario 1 :: 1776377 ft³ slug load
Volumetric Rate (ft³/s)
400000
350000
300000
250000
200000
150000
100000
50000
0
-50000
-100000
Stage Elevation (ft datum)
97
96
95
94
93
92
91
90
89
88
87
Elapsed Time (hrs)
0
50
100
150
200
250
300
350
400
Y1 Axis: Inflow Rate
Infiltration Rate
Discharge Rate
Y2 Axis: Pond Stage

ATTACHMENT B

WATER QUALITY VOLUME RECOVERY

PONDS Version 3.3.0278
Retention Pond Recovery - Refined Method
Copyright 2012
Devo Seereeram, Ph.D., P.E.

Project Data

Project Name:	Fuqua - Hartwood Marsh
Simulation Description:	Combined Pond - Water Quality Treatment Volume Run
Project Number:	19-585.18
Engineer :	Reidel Gardon
Supervising Engineer:	Devo Seereeram
Date:	06-21-2019

Aquifer Data

Base Of Aquifer Elevation, [B] (ft datum):	70.00
Water Table Elevation, [WT] (ft datum):	87.00
Horizontal Saturated Hydraulic Conductivity, [Kh] (ft/day):	45.00
Fillable Porosity, [n] (%):	30.00
Unsaturated Vertical Infiltration Rate, [Iv] (ft/day):	5.0
Maximum Area For Unsaturated Infiltration, [Av] (ft^2):	410771.0

Geometry Data

Equivalent Pond Length, [L] (ft):	1430.0
Equivalent Pond Width, [W] (ft):	290.0

Ground water mound is expected to intersect the pond bottom

Stage vs Area Data

Stage (ft datum)	Area (ft^2)
92.00	378101.0
93.00	394218.0
94.00	410771.0
95.00	427759.0
96.00	444748.0
96.50	453460.0
97.50	496584.0

Ditch Data

Ditch (or interceptor trench) parallel to length axis is inactive

Ditch (or interceptor trench) parallel to width axis is inactive

Discharge Structures

Discharge Structure #1 is inactive

Discharge Structure #2 is inactive

Discharge Structure #3 is inactive

Scenario Input Data

Scenario 1 :: 527512 ft³ slug load

Hydrograph Type: Slug Load
Modflow Routing: Routed with infiltration

Treatment Volume (ft³) 527512

Initial ground water level (ft datum) 87.00 (default)

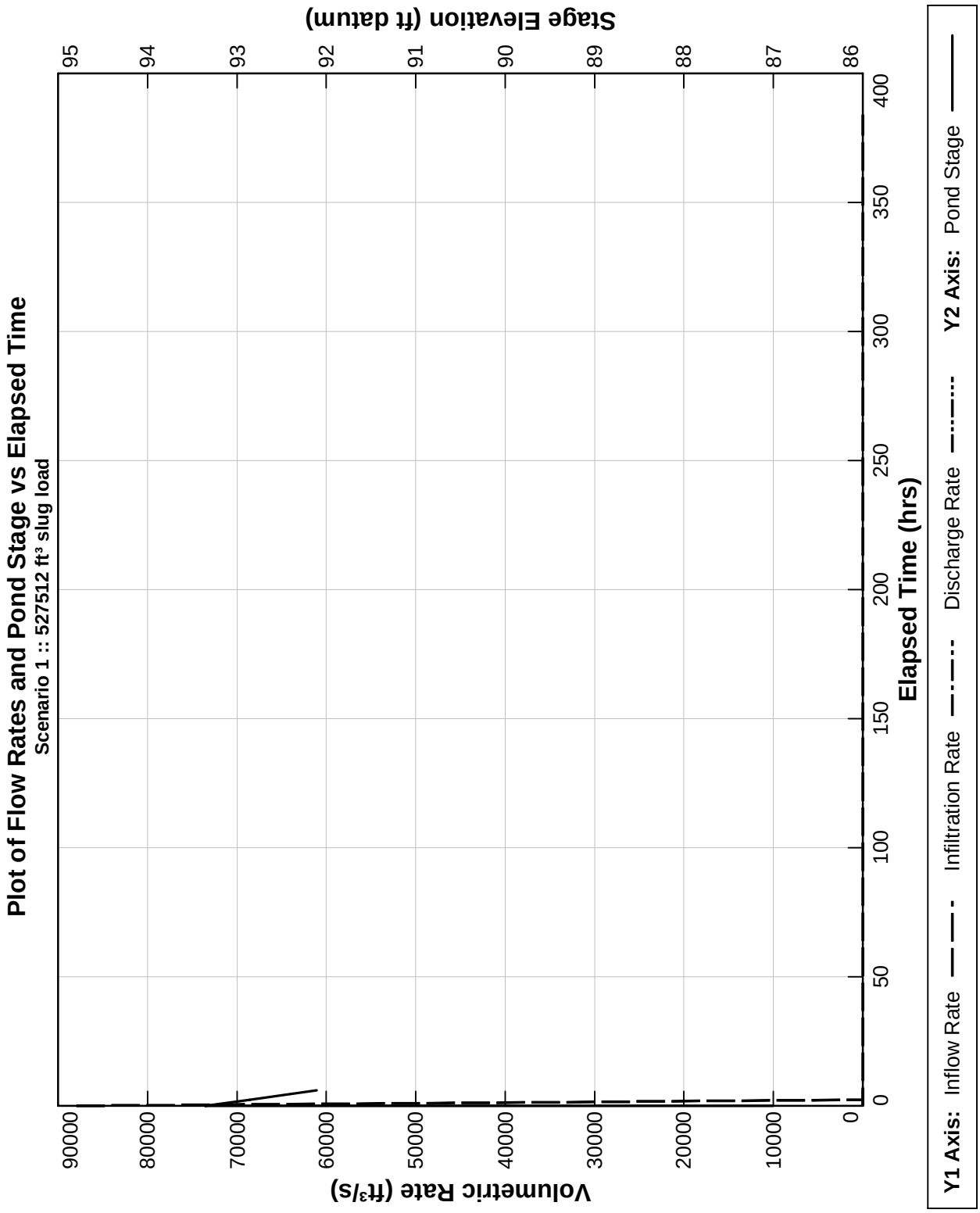
Time After Storm Event (days)	Time After Storm Event (days)	Time After Storm Event (days)	Time After Storm Event (days)	Time After Storm Event (days)
0.100	2.000	5.000	10.000	15.000
0.250	2.500	6.000	11.000	16.000
0.500	3.000	7.000	12.000	
1.000	3.500	8.000	13.000	
1.500	4.000	9.000	14.000	

Detailed Results *:: Scenario 1 :: 527512 ft³ slug load*

Elapsed Time (hours)	Instantaneous Inflow Rate (ft³/s)	Outside Recharge (ft/day)	Stage Elevation (ft datum)	Infiltration Rate (ft³/s)	Combined Instantaneous Discharge Rate (ft³/s)	Cumulative Inflow Volume (ft³)	Cumulative Infiltration Volume (ft³)	Combined Cumulative Discharge (ft³)	Flow Type
0.000	87918.6600	0.00000	87.00000	0.00000	0	0.000	0.0	0	N.A.
0.002	87918.6600	0.00000	93.35556	23.15431	0	527512.000	138.9	0	U/P
2.400	0.0000	0.00000	92.85569	22.69069	0	527512.000	198074.7	0	U/P
6.000	0.0000	0.00000	92.10536	13.96172	0	527512.000	487584.8	0	U/P
12.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
24.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
36.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
48.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
60.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
72.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
84.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
96.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
120.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
144.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
168.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
192.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
216.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
240.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
264.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
288.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
312.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
336.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
360.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry
384.000	0.0000	0.00000	----	----	----	527512.000	527512.0	0	dry

Summary of Results *:: Scenario 1 :: 527512 ft³ slug load*

	Time (hours)	Stage (ft datum)	Rate (ft³/s)	Volume (ft³)
Stage				
Minimum	0.000	87.00		
Maximum	0.002	93.36		
Inflow				
Rate - Maximum - Positive	0.002		87918.6600	
Rate - Maximum - Negative	None		None	
Cumulative Volume - Maximum Positive	0.002			527512.0
Cumulative Volume - Maximum Negative	None			None
Cumulative Volume - End of Simulation	384.000			527512.0
Infiltration				
Rate - Maximum - Positive	0.002		23.1543	
Rate - Maximum - Negative	None		None	
Cumulative Volume - Maximum Positive	6.000			487584.8
Cumulative Volume - Maximum Negative	None			None
Cumulative Volume - End of Simulation	384.000			527512.0
Combined Discharge				
Rate - Maximum - Positive	None		None	
Rate - Maximum - Negative	None		None	
Cumulative Volume - Maximum Positive	None			None
Cumulative Volume - Maximum Negative	None			None
Cumulative Volume - End of Simulation	384.000			0.0
Discharge Structure 1 - inactive				
Rate - Maximum - Positive	disabled		disabled	
Rate - Maximum - Negative	disabled		disabled	
Cumulative Volume - Maximum Positive	disabled			disabled
Cumulative Volume - Maximum Negative	disabled			disabled
Cumulative Volume - End of Simulation	disabled			disabled
Discharge Structure 2 - inactive				
Rate - Maximum - Positive	disabled		disabled	
Rate - Maximum - Negative	disabled		disabled	
Cumulative Volume - Maximum Positive	disabled			disabled
Cumulative Volume - Maximum Negative	disabled			disabled
Cumulative Volume - End of Simulation	disabled			disabled
Discharge Structure 3 - inactive				
Rate - Maximum - Positive	disabled		disabled	
Rate - Maximum - Negative	disabled		disabled	
Cumulative Volume - Maximum Positive	disabled			disabled
Cumulative Volume - Maximum Negative	disabled			disabled
Cumulative Volume - End of Simulation	disabled			disabled
Pollution Abatement:				
36 Hour Stage and Infiltration Volume	36.000	Dry		527512.0
72 Hour Stage and Infiltration Volume	72.000	Dry		527512.0


Plot of Flow Rates and Pond Stage vs Elapsed Time
Scenario 1 :: 527512 ft³ slug load
Volumetric Rate (ft³/s)
Stage Elevation (ft datum)
Elapsed Time (hrs)
0
10000
20000
30000
40000
50000
60000
70000
80000
90000
86
87
88
89
90
91
92
93
94
95
0
50
100
150
200
250
300
350
400
Y1 Axis: Inflow Rate
Infiltration Rate
Discharge Rate
Y2 Axis: Pond Stage