****

IFB NO. Y16-7000-RM **ISSUED: July 22, 2016**

INVITATION FOR BIDS

FOR

PARK MANOR ESTATES SECTIONS 1-8 UNDERDRAIN IMPROVEMENTS

****

PART H
TECHNICAL SPECIFICATIONS

****

PART H

PART H

TECHNICAL PROVISIONS

for

PARK MANOR ESTATES SECTIONS 1-8
UNDERDRAIN IMPROVEMENTS
ORANGE COUNTY, FLORIDA

"**Standard Specifications**" shall mean the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction, dated 2016, and supplements thereto, and Orange County Road Construction Specifications. The project shall be constructed in accordance with these specifications and of the Florida Department of Transportation (FDOT) "**Standard Specifications for Road and Bridge Construction**" (dated 2016), and "**Supplemental Specifications for Road and Bridge Construction**" (dated 2016), hereafter referred to as the "Standard Specifications," and "**Orange County Road Construction Specifications**" (latest edition). "**Additional Specifications**" (if any) may also be provided herein by the Engineer in an effort to more clearly define the Work under this Contract.

When reference is made to a Division, Section, or Article, it shall mean a Division, Section, or Article of said "**Standard Specification**". Wherever the Standard Specifications indicate a mailing address for a State office or Agency, the office or agency and the address shown area hereby deleted and replaced by the following:

Orange County Roads and Drainage	4200 South John Young Parkway
Division – Public Works Department	Orlando, Florida 32839

Where duplication of specifications occur, the Florida Department of Transportation (FDOT) "Standard Specifications for Road and Bridge Construction (latest edition)" shall apply unless reference is made to a material or equipment specification as required by Orange County. Where discrepancies occur between the "Standard Specifications", "Supplemental Specifications", "Orange County Specifications" and the Engineer's "Additional Specifications", provisions of Section 5-2 of the Standard Specifications for Road and Bridge Construction (latest edition) shall apply.

Each reference to Basis of Payment in said "Standard Specifications" is superseded by the conditions contained in the Technical Provisions and all other conditions related to Basis of Payment contained in these specifications.

The work specified in this contract represents the type of services to be accomplished. Work under this contract is limited to specified areas as listed in the scope of work. Areas have been inventoried and calculated as to quantities. Any discrepancies or disagreements concerning quantities and limits of work shall be immediately reported in writing (shall reflect the new measurements taken by the Contractor and the contract measurements) to the County representative. Discrepancies or disagreements will be mutually resolved prior to beginning work in any area in question. The County will make the final determination on any unresolved matters.

The plans/drawings depict the general layout for work to be performed under this contract. The Contractor shall layout the work from benchmarks, control points and construction base lines established at the site, or supplied by County. All work of every description shall be laid out and checked by the Contractor who shall be held solely responsible for its correctness. A detailed quote including quantities and materials needed for requested projects (linear foot underdrain, PVC pipe, square yards of concrete (sidewalk, driveways, curb), asphalt, etc.), conflicts (utilities, structures, trees, mailboxes, etc.) and recommendations shall be submitted to the County's Representative for review no later than five (5) days after request from the County. The Contractor shall be responsible for direction of flow, high points, etc. The County's Representative must review submitted quote and authorize the Contractor to proceed with the layout of the project. The detailed layout for the project shall be submitted for review prior to starting operations and no later than three (3) days after notification, unless otherwise authorized by the County.

All measurement for payment shall be based on the completed and accepted work performed in strict accordance with drawings and specifications. All work completed under this contract shall be measured by the Contractor in the presence of the County's Representative. The quantities listed in the summary of Pay Items are estimated.

Unless otherwise specified herein, the Contractor shall be responsible for any testing and densities required as per Orange County and FDOT specifications at no cost to the County.

TECHNICAL PROVISIONS

TP 101 - Mobilization

MOBILIZATION

Mobilization shall include all items detailed in Article 101 of the Standard Specifications, the Special Provisions and on the plans, except as directed by the Engineer.

Preservation of Property Corners including all items detailed in Section 7-11 of the Standard Specifications shall be included in the contract price for mobilization.

Basis of Payment

The work and incidental costs covered under Mobilization will be paid for at the contract lump sum price and will be paid in partial payments in accordance with the following:

Percent of Original Contract Amount Earned	Allowable Percent of the Lump Sum Price for the Items*
5	25
10	50
25	75
50	100

*Partial payments as detailed above will be limited to 5% of the original Contract amount for the roadway pay items. Any amount of mobilization in excess of 5% of the roadway pay items will be paid upon completion of all work.

No special compensation will be made to the Contractor to defray costs of any of the work or delays by making surveys and measurements, tests or inspections, but such costs shall be considered as having been included in the price stipulated for the several items of work to be done under this contract. The Contractor shall bear all costs of relocating and/or re-establishing damaged or lost monuments/control structures. Any claims for extras based on substrata or ground water table conditions shall not be allowed.

Payment shall be made under:

Pay Item:

101-1	Mobilization (5% of all other items)	Lump Sum

Pay Item Footnote No. 101-1
Includes all applicable survey costs and costs necessary for a video survey. The work site/area shall be videoed (CD) prior to work commencement and after work is completed. This video will be taken by the Contractor, and shall be submitted on CD to the County with the final pay request. Includes all efforts necessary to construct and dismantle a temporary staging area as needed to accommodate typical wet season rainfall events occurring during construction.

TECHNICAL PROVISIONS

TP 102 – Maintenance of Traffic

MAINTENANCE OF TRAFFIC

All Maintenance of Traffic work shall conform to the requirements of Section 102 of the Standard Specifications, Index 600 of the FDOT Design Standards, the plans, and/or as herein modified, except as directed by the Engineer.

The road shall be kept open to two-way traffic on a paved surface during construction except when full closures are allowed by the plans or by the Engineer. The Contractor shall not be permitted to isolate residences or places of business. Access shall be provided to all residences and all places of business whenever construction interferes with the existing means of access.

The Contractor shall furnish, erect and maintain all necessary traffic control devices, including flagmen, pilot cars and variable message boards, in accordance with the *Manual on Uniform Traffic Control Devices for Streets and Highways*, published by the U.S. Department of Transportation, Federal Highway Administration. The Contractor shall provide and maintain in a safe condition the entire project limits included, but not limited to pre existing conditions, driving lanes, temporary approaches, crossings, and intersections with trails, roads, streets, business parking lots, residences, garages and completed work. Contractor shall coordinate with Orange County to notify residents of this closure. The Contractor shall take all necessary precautions for the protection of the work and the safety of the public in accordance with Section 102.

The Contractor shall present his signed and sealed Maintenance of Traffic Plan to the Engineer at the preconstruction conference, and shall be fully and solely responsible for the adequacy of the Maintenance of Traffic plan regardless of the source. The plan shall be signed and sealed by a professional engineer licensed in the State of Florida.

The Contractor shall be responsible for installation of signs for all business along the project corridor. Signs should be manufactured and installed in accordance with FDOT design standards. No special compensation will be made to the contractor to defray costs of any of the work or delays for complying with the requirements of installing business signs, but such costs shall be considered as having been included in the price stipulated for the Maintenance of Traffic pay item.

A safe pedestrian way shall be maintained at all times during construction.

Basis of Payment

All materials, work and incidental costs related to Maintenance of Traffic will be paid for at the contract lump sum price. All material, labor and equipment necessary for the construction and maintenance of the entire project limits included, but not limited to pre-existing conditions, driving lanes, temporary approaches, crossings, intersections with trails, roads, streets, business

parking lots, residences, garages, temporary driving lanes, side streets, driveway connections, temporary fencing, and completed work, as may be directed by the Engineer shall be included in the contract price.

Payment will be made under:

Pay Item:

102-1	Maintenance of Traffic (5% of all other pay items)	Lump Sum

Pay Item Footnote No. 102-1
Includes all necessary traffic control devices including flagmen, pilot cars and variable message boards, in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways (latest edition). Contractor shall secure construction site (i.e. temporary pedestrian safety fencing, barricades, signs, etc.) in order to prevent pedestrians from accessing work areas.

TECHNICAL PROVISIONS

TP 104 – Prevention, Control and Abatement of Erosion and Water Pollution

PREVENTION, CONTROL AND ABATEMENT OF EROSION AND WATER POLLUTION

Prevention, control and abatement of erosion and water pollution shall conform to the requirements of Section 104 of the Standard Specifications, National Pollution Discharge Elimination System (NPDES) requirements, except as modified by these Technical Provisions or as directed by the Engineer.

The Contractor shall present at the Preconstruction Conference its Storm Water Pollution Prevention Plan (SWPPP) and a separate schedule to manage erosion and water pollution. This schedule shall include a complete outline of the proposed construction of all erosion and pollution control and abatement items required.

The Contractor shall be responsible for the preparation and submittal of the Notice of Intent (NOI) and Notice of Termination (NOT) to the Florida Department of Environmental Protection (FDEP) and shall obtain the FDEP Generic Permit for Stormwater Discharge from Large and Small Construction Activities.

All roadways, driveways etc., must be kept clean and hazard free at all times. **Roadways must be swept daily to ensure the safety of the motoring public and protect existing drainage systems.** This operation shall be conducted in such a manner that shall minimize the potential of creating a traffic hazard and minimize air pollution.

Basis of Payment

All work and incidental costs required to comply with the articles of this specification will be paid at the contract lump sum price for Prevention, Control and Abatement of Erosion and Water Pollution.

Payment will be made under:

Pay Item:		
104-1	Prevention, Control and Abatement of Erosion and Water Pollution	Lump Sum

Pay Item Footnote No. 104-1
Includes the cost of all items required for erosion control including, but not limited to, synthetic bales, turbidity barriers, silt fence, and temporary grassing, as shown in the plans or as directed by the County.

TECHNICAL PROVISIONS

TP 110 – Clearing and Grubbing

CLEARING AND GRUBBING

All clearing and grubbing shall be performed in accordance with the requirements of Section 110 of the Standard Specifications, except as directed by the Engineer.

Scope of work to include but not be limited to, the removal of all rigid, asphalt pavement, Portland cement concrete pavement, curb, curb and gutter, ditch pavement, sidewalk, driveway aprons, concrete slabs, concrete structures, brick, fences, gravity walls, retaining walls, pipes, etc.

Clearing and Grubbing shall also include the removal of existing pavement and base course and backfilling with suitable material, as shown in the construction plans. Removal of the existing roadway shall also include the proper disposal of the removed materials as specified above.

All personal property, within the right of way and drainage easement not relocated by the property owner shall be removed by the Contractor as necessary to construct the project in accordance with the plans. It is the Contractor's responsibility to replace in-kind or better any damaged fencing identified to remain, damaged mailboxes or any other private property disturbed during construction and notify resident prior to commencement of work.

All existing functional and nonfunctional drainage structures and pipes within the right-of-way shall be evaluated and discussed with the County's Representative prior to removal, unless otherwise directed.

Basis of Payment

All work and incidental costs required to perform clearing and grubbing as herein specified will be paid for at the contract lump sum price.

Payment shall be made under:

Pay Item:

110-1-1	Clearing and Grubbing	Lump Sum

Pay Item Footnote No. 110-1-1
Includes, but is not limited to, the sawcut, removal and disposal of existing pavement, driveway concrete, curb and base required to construct the project. Includes the transport and disposal of all removed materials to an approved Orange County disposal site yard or as directed by the County. It is the Contractor's responsibility to replace in-kind or better any damaged fencing identified to remain, damaged mailboxes or any other private property disturbed during construction. Includes the cost of resident notification prior to the commencement of work. The Contractor shall notify all residents within the work area as to when the work will take place and explain the level of inconvenience that will be involved. This notification shall take place five (5) days prior to commencement of any work in that area. The notification will be by an approved door hanger to be placed on each house and any vehicles parked on the roadways.

TECHNICAL PROVISIONS

TP 270 – Soil Cement Base (Primed)

SOIL CEMENT BASE (PRIMED)

Construction of a Soil Cement Base shall consist of soil, water, and portland cement uniformly mixed, moistened, compacted, finished and cured in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross-sections shown on the plans. Soil cement base that is not finished and cured within (36) hours after compaction has been achieved may be rejected and subject to removal and replacement if so directed by the Engineer.

Testing

A. The Contractor shall submit a mix design prepared by an independent Geotechnical Engineer to the Engineer for acceptance before using the material for road construction. Processing of the base shall proceed after the design mix is accepted by the Engineer. A modified Portland Cement Association (PCA) Short Cut Procedure for sand soil test method may be used in lieu of the wet dry/freeze thaw test method. However, a 7 day minimum laboratory compressive strength of 300 psi shall be used to determine the cement content when using the modified PCA test method.

B. Construction of the soil cement base shall proceed only after 48 hours prior notice has been received by the Engineer and the County's geotechnical engineer. The geotechnical engineer shall be present during construction. The following is the minimum information/test data to be obtained during construction:

1. Area & Date of Construction
2. Average Cement Content
3. Uniformity of Mix
4. Moisture Content at Time of Compaction
5. Percent Compaction
6. Compacted Thickness
7. 7 Day Compressive Strength Tests

The geotechnical engineer will prepare and submit to the Engineer a signed report documenting all field tests and observations.

Materials

A. Portland Cement

Portland Cement shall be Type I, II, III, or Type I-S or Type I-P and shall comply with FDOT Standard Specification Section 921. Portland Cement shall also comply with ASTM C-150 and/or AASHTO M-85 and be produced in the United States. Cement which is partially set, lumpy or caked shall not be used. One cubic foot of Portland Cement shall be considered to weigh 94 lbs.

TECHNICAL PROVISIONS

TP 270 – Soil Cement Base (Primed)

B. Water

Water shall be clean and free from substances deleterious to the hardening of the soil cement mixture.

C. Soil

Only soils which have proven themselves to produce a high quality soil cement base shall be acceptable. New sources of soil cement material shall be accepted by the County prior to use.

Specific Requirements for Soil:

Organic Material (As per FM 1-T267)	Maximum 5%
Total Clay and Silt Content (minus No. 200 [75µm sieve) (As per AASHTO T 88, no hydrometer test)	Maximum 25%
Plastic Index (As per AASHTO T 90)	Maximum 10%
Liquid Limit (As per AASHTO T 89)	Maximum 25%

Gradation: (As per AASHTO T 88)

Passing 2 inch [50 mm] sieve	Minimum 100%
Passing No. 4 [4.75 mm] sieve	Minimum 55%
Passing No. 10 [2.00 mm] sieve	Minimum 37%

As an exception to the above requirements, the Contractor may use any material meeting the requirements for Limerock in Section 911 of the FDOT Standard Specifications.

D. Prime Coat

The prime coat shall be emulsified Asphalt Grades SS l or SS lH, or Special MS-Emulsion, diluted per the manufacturer's recommendations.

Equipment

Soil Cement may be constructed with any machine, combination of machines or equipment that will produce the results meeting the requirements for soil pulverization, cement application, mixing, uniform depth control, water application, incorporation of materials, compaction, finishing and curing as required to comply with these specifications.

TECHNICAL PROVISIONS

TP 270 – Soil Cement Base (Primed)

Construction Methods

A. General

The Soil-Cement base shall be placed under the supervision of a competent superintendent having a minimum of two (2) years experience in the construction of soil-cement base courses. Soil-Cement base proportioning and construction shall only be performed when ambient temperatures measured in the shade are at 45°F and rising and that temperatures are not forecast to fall below 35°F for 48 hours following placement of the material. All mixing, shaping, finishing and compaction shall be completed within four hours starting from the time mixing commences.

B. Mix Proportioning

The Soil-Cement base shall be proportioned using Strength Design criteria. Proportioning of the soil, cement and water shall be performed in a pugmill at a central mix plant. Mixing shall be sufficiently achieved to prevent cement balls from forming when water is added. The Contractor shall continuously monitor plant batching and mixing of the materials and submit to the Engineer reports of the gradation, cement content and moisture content prepared by the independent Geotechnical Engineer. The County's Geotechnical Engineer shall monitor the installation and conduct applicable tests and inspections as outlined in this Section.

C. Preparation

Before construction operations are begun, the area to be paved shall be graded and shaped as required to receive the spread of soil-cement mixture delivered from the plant and allow construction in conformance with the grades, lines, thicknesses and typical cross sections shown on the plans. Additional soil needed, if any, shall be placed as directed. Unsuitable soil or materials shall be removed and replaced with acceptable soil. The subgrade shall be compacted to the density, thickness, lines, grades, and typical sections shown on the plans. The contractor shall maintain the required density until the base is placed on the subgrade.

D. Pulverization

The soil to be used in mixing shall be so pulverized that, at the completion of moist mixing, 100 percent by dry weight passes a 1" sieve, and a minimum of 80% passes a No. 4 sieve, exclusive of gravel or stone retained on these sieves.

TECHNICAL PROVISIONS

TP 270 – Soil Cement Base (Primed)

E. Application of Cement

The specified quantity of Portland Cement required for full depth treatment shall be metered out at the plant in accurate proportion in accordance with the mix design. The percentage of moisture in the soil, at the time of cement application at the plant, shall not exceed the quantity that will permit a uniform and intimate mixture of soil and cement during proportioning and shall not exceed 2% below the optimum moisture content for the soil cement mixture.

F. Mixing

After the cement has been applied, it shall be thoroughly mixed with the soil at the pugmill. Mixing shall continue until the cement has been thoroughly blended with the soil in order to prevent the formation of cement balls when water is applied. Any uncompacted soil and cement mixture that has not been compacted and finished shall not remain undisturbed for more than thirty (30) minutes.

G. Application of Water and Moist Mixing

Immediately after and/or during the mixing of soil and cement, the moisture content of the soil cement mixture shall be determined by the laboratory. Water shall be applied uniformly in quantities required to obtain the proper design moisture content within the range provided by the contractor's geotechnical engineer. After the final application of water, mixing shall continue until a uniform and intimate mixture of soil, cement and water is obtained.

When water application and mixing have been completed, the percentage of moisture in the mixture, based on oven dry weights, shall be no more than two percentage points above the specified optimum moisture content, and shall be less than that quantity which will cause the soil cement mixture to become unstable during compaction and finishing.

H. Spreading

The mixed base material shall be hauled to the placement site in trucks equipped with protective covers and immediately placed on top of the prepared subgrade. The material shall be graded to conform to the lines and grades of the finished pavement section as shown on the project drawings and shall be placed in a sufficient thickness to assure the minimum required compacted thickness free from high and low spots. No more than 60 minutes will be allowed between placement of adjacent passes of the spreader at any location, except at construction joints.

I. Compaction

The material shall be placed in a single, uniformly thick, loose layer and evenly compacted to a density not less than 97% of the modified maximum density determined by AASHTO T 134 on representative samples of soil cement mixture obtained from the roadway at the time compaction

begins. Not more than four hours shall elapse from the time of batching to final compaction and the material shall not remain undisturbed for more than two hours. The surface of the base course may require the addition of water during the final rolling and shaping operation to prevent excessive surface moisture losses prior to sealing the base.

J. Finishing

After the mixture has been initially compacted, the surface of the soil cement shall be shaped to the required lines, grades and cross section. During the shaping operations, the surface shall be lightly scarified to loosen any imprints left by the compacting or shaping equipment, when deemed necessary. The resulting surface shall then be compacted to the specified density with a pneumatic tire roller. Rolling shall be supplemented by broom dragging, if required.

The moisture content of the surface material must be maintained at not less than its specified optimum moisture content during finishing operations. Surface compaction and finishing shall be done in such a manner as to produce a smooth, dense surface, free of surface compaction planes, cracks, ridges, or loose material. Surface finishing methods may vary, provided a smooth, dense surface free of surface compaction planes is produced. The moisture and density requirements shall be determined by the methods prescribed in AASHTO T 134.

K. Surface Requirements (Scalping or Hard Planing)

After completing compaction and finishing but not later than the beginning of the next calendar day after constructing any section of the base, the surface shall be tested with a template cut to the required crown and/or with a 15 foot straight edge laid parallel to the centerline. All irregularities greater than 1/4 inch shall be immediately corrected with a blade adjusted to the lightest cut which will insure a surface that does not contain depressions greater than 1/4 inch under the template or the straight edge. The material removed shall be wasted. Additional wetting during and after that final shaping operation shall be provided to keep the base continuously moist.

L. Prime/Curing

After finishing the soil cement it shall be protected against drying for 7 days by applying a bituminous curing material as soon as possible after completing finishing operations. The finished soil cement shall be kept continuously wet until the curing material is placed. Curing material shall consist of a mixture of 60% grade SS 1 and 40% water applied at the rate of 0.15 to 0.20 gallons per square yard.

The prime coat bituminous material specified shall be uniformly applied to the surface of the completed soil cement. The exact rate and temperature of application to give complete coverage without excessive runoff will be accepted by the Engineer. At the time the bituminous material is applied, the soil cement surface shall be dense, free of all loose and extraneous material, and

contain sufficient moisture to prevent penetration of the bituminous material. Water shall be applied in sufficient quantity to fill the surface voids of the soil cement immediately before the bituminous curing material is applied. The bituminous material shall be sanded using a sufficient amount of clean sand to prevent bleeding or traffic pick up.

M. Construction Joints

Prior to the beginning of each day's construction, a straight transverse construction joint shall be formed by cutting back into the completed work to form a true vertical face.

N. Thickness

During various stages of construction test holes or trenches shall be dug in the mixture to determine the thickness. After completing the base, test holes shall be dug or drilled at intervals of not more than 300 feet (closer intervals if necessary) and the thickness of the base shall be determined from measurements made in these test holes.

Where the base is deficient in thickness by more than 1/2 inch, the area of deficient base shall be removed and replaced with base of the required thickness at the Contractor's sole expense. At the Engineer's option such deficient thickness base may be left in place, provided the deficiency is not more than one inch. This deficiency shall be made up in asphaltic concrete, provided the control grades can be maintained. Payment will be made on the basis of full depth soil cement. No additional payment will be made for asphaltic concrete required to make up deficiencies in soil cement base thicknesses.

Opening To Traffic

The Contractor will not be permitted to drive heavy equipment over the completed sections, but light weight pneumatic-tired equipment may be permitted after 24 hours, provided the surface has hardened sufficiently to prevent the equipment's marking the surface and provided the protection and curing specified are not impaired.

Maintenance

The Contractor shall maintain the base to a true and satisfactory surface until the wearing surface is constructed. Should any repairs or patching be necessary, they shall extend to the full depth of the base and shall be made in a manner that will assure restoration of a uniform base course conforming to the requirements of these specifications. The bituminous curing coating shall be maintained until the wearing surface is constructed.

TECHNICAL PROVISIONS

TP 270 – Soil Cement Base (Primed)

Inspection

The Engineer, Geotechnical Engineer and Contractor shall inspect the base for deficiencies after a minimum of seven 7 days have elapsed and prior to applying the asphalt wearing surface. All deficiencies shall be corrected and accepted by the Engineer 48 hours prior to commencing paving operations.

Method of Measurement

Quantities measured for payment under this Section shall be the actual area in square yards of soil cement base constructed to limits, thicknesses, lines and grades shown on the plans, completed and accepted.

Basis of Payment

Soil Cement Base will be paid for at the contract unit price per square yard completed and accepted. The cost of the cement, prime coat and cover material, including the spreading of each, shall be included in the contract unit price.

Payment shall be made under:

Pay Item:		
270-9	Soil Cement Base (Primed) (9”) (350 psi)	Per Square Yard

TECHNICAL PROVISIONS

TP 334 – Superpave Asphaltic Concrete Pavement

SUPERPAVE ASPHALTIC CONCRETE PAVEMENT

334-1 GENERAL

Work specified in this Provision consists of the application of Asphaltic Concrete structural courses properly produced and laid upon a prepared and accepted base in accordance with these specifications and in conformity with the lines, grades, thicknesses and cross-sections provided in the plans. Base preparation and Asphaltic Concrete Friction Courses are covered under separate provisions.

This Provision is intended to stand alone for the production and placement of structural course asphalt and replaces Sections 330 and 334 of the FDOT Standard Specifications for Road and Bridge Construction except when specific references are made to these or other Sections. Any references to FDOT Specification Sections shall mean the latest FDOT Standard Specifications for Road and Bridge Construction, including Supplements. Any incorrect references to or conflicts with the FDOT specifications, test methods, or standards shall be brought to the attention of the Engineer for clarification.

The Engineer will have the right to disapprove of any material or process that does not conform to these specifications.

The Contractor shall document all QC procedures, Process Control, inspection, and all test results and make them available for review by the Engineer throughout the Contract duration.

All test methods designated as FM refer to the FDOT Florida Sampling and Testing Methods.

Trench restorations, asphalt overlaps or lane width overlay will be affected by overall resurfacing schedules for areas where underdrains are installed and other field conditions. The County's Representative shall make the final determination on the final restoration of the open cuts. The Contractor shall be responsible to mill specified areas of asphalt overlaps and lane width overlays to a 1.5" depth, unless otherwise authorized by the County's Representative, prior to overlay. Asphalt restoration must be completed no later than forty-eight (48) hours after removal. Under no circumstance shall the Contractor leave open areas unattended for more than the specified time frame, unless otherwise authorized in writing by the County's Representative.

Asphalt repairs shall be made in kind and in accordance to all applicable FDOT standards and County regulations. A copy of asphalt tickets shall be provided to the County's Representative on a daily basis.

TECHNICAL PROVISIONS

TP 334 – Superpave Asphaltic Concrete Pavement

334-2 CONTRACTOR QUALITY CONTROL REQUIREMENTS

334-2.1 GENERAL: The Contractor shall be responsible for the overall quality of the materials and workmanship of the work covered under this Provision.

Ensure that the qualifications and certifications of personnel and laboratories are maintained throughout the Contract duration. Provide proof of qualifications and all applicable certifications to the County prior to construction operations commencing. Notify the County immediately when there is a change in any qualification or certification during the Contract duration.

334-2.2 PERSONNEL: Provide personnel who are both qualified and certified in all activities related to asphalt mix production at the plant and placement on the roadway, especially for the sampling, testing and inspection of materials and construction activities. At a minimum, a certified Paving Level II technician shall be present on site at all times during paving operations. Provide documentation to the Engineer that the personnel responsible for the production and placement of asphalt products under the Contract are qualified and certified.

334-2.3 TESTING LABORATORY: Furnish or have furnished a fully equipped asphalt laboratory (permanent or portable) at the production site. Provide documentation to the Engineer that any Laboratory used is FDOT qualified and certified.

334-2.4 EQUIPMENT: Provide equipment and methods conforming to Section 320 of the FDOT Standard Specifications for Road and Bridge Construction. Provide a sufficient number of trucks to transport the asphalt mixture from the plant to the job site such that paving of each lane can proceed in one smooth uninterrupted operation. In determining the number of trucks required the Contractor shall consider the capacity of the trucks, the length of the approved haul route from the plant to the job site, traffic conditions, weather conditions, and any other factors that could impact the round trip travel time. Stopping the paver to wait for trucks bringing the asphalt mixture will not be acceptable. In addition to meeting the requirements in Section 320-5, the paving machine shall be capable of pushing the asphalt truck as it dumps the asphalt mixture into the hopper. Stopping the paving machine to allow the next asphalt truck to back up to it to fill the hopper is not an acceptable procedure, and shall not be allowed.

Unless otherwise approved by the Engineer, the paving machine shall weigh a minimum of 26,000 pounds.

334-2.5 MINIMUM QUALITY CONTROL REQUIREMENTS: Perform the following activities necessary to maintain quality and process control and meet specification requirements:

Stockpiles: Ensure each aggregate component is placed in an individual stockpile, and separated from adjacent stockpiles, either by space or by a system of bulkheads. Prevent the intermingling of different materials in stockpiles. Form and maintain stockpiles in a manner that will prevent separation, contamination, segregation, etc. Identify each individual stockpile, including RAP, as shown on the mix design.

Incoming Aggregate: Obtain gradations and bulk specific gravity (Gsb) values from aggregate supplier for reference; determine the gradation of all component materials; routinely compare gradations and Gsb values to mix design.

Cold Bins: Calibrate the cold gate/feeder belt for each material; determine cold gate/feeder belt settings; observe operation of cold feeder for uniformity.

Dryer: Observe pyrometer for aggregate temperature control; observe efficiency of the burner.

For Batch Plants: Determine percent used and weight to be pulled from each bin to assure compliance with Mix Design, check mixing time, and check operations of weigh bucket and scales.

For Drum Mixer Plants: Determine aggregate moisture content, and calibrate the weigh bridge on the charging conveyor.

Control Charts: Plot and keep charts updated daily for all Quality Control Sampling and Testing and post in the asphalt lab where they can be seen. Maintain the following charts:

1. Sample test results for the following: No. 8 sieve, No. 200 sieve, asphalt binder content, air voids, and density.

2. Gradation of incoming aggregate.

3. Gradation and asphalt content of RAP.

4. Any other test result or material characteristic (as determined by the Contractor) necessary for process control.

The above listed minimum activities are to be considered normal activities necessary to control the production of hot mix asphalt at an acceptable quality level. It is recognized, however, that depending on the type of process or materials, some of the activities listed may

not be necessary and in other cases, additional activities may be required. The frequency of these activities will also vary with the process and the materials. When the process varies from the defined process average and variability targets, the frequency of these activities will be increased until the proper conditions have been restored.

334-2.6 MINIMUM PROCESS CONTROL TESTING REQUIREMENTS:

Asphalt Plant

1. Hot Mix Asphalt: Determine the asphalt binder content; mix gradation and volumetric properties at a minimum frequency of one per day. In the event that the daily production exceeds 1,000 tons, perform these tests a minimum of two times per day.

2. Aggregate (Including RAP): One sample per 1,000 tons of incoming material as it is stockpiled for gradation. The testing of RAP material shall include the determination of asphalt binder content and gradation of extracted aggregate.

3. Monitor the mix temperature for the first five loads and every fifth load thereafter.

4. Monitor the aggregate moisture content from stockpiles or combined cold feed aggregate - one per day.

5. Other tests (as determined necessary by the Contractor) for process control.

Roadway

1. Monitor the mix temperature for the first five loads and every fifth load thereafter.

2. Monitor the prime/tack spread rate as needed to control operations and ensure that it meets or exceeds the target spread rate.

3. Monitor the pavement cross slope at a frequency necessary to fulfill the requirements of the plans and section 334-3.10.3 below, and identify a system to control the cross slope of each pavement layer during construction.

4. Monitor the mix spread rate at the beginning of each day’s production, and as needed to control the operations, at a minimum of once per 200 tons placed to ensure that the spread rate meets or exceeds the target spread rate. When determining the spread rate, use an average of five truckloads of mix.

5. Monitor mat placement thickness every 25’ to ensure the minimum design thickness is met.

6. Monitor the pavement temperature with an infrared temperature device. Monitor the roadway density with either 6 inch diameter roadway cores, a nuclear density gauge, or other density measuring device, at a minimum frequency of once per 1,500 feet of pavement. When the layer thickness is greater than or equal to 1 inch (or the spread rate is greater than or equal to 105 lb/yd2) and an approved rolling pattern may be used in lieu of density testing, monitor the density (for informational purposes only) by cutting and testing a 6 inch diameter core at a minimum frequency of three cores per day. Maintain daily records of the testing results and make them available for review by the Engineer throughout the life of the Contract.

7. Monitor the pavement smoothness with a 15-foot rolling straightedge as required by section 334-3.10.4 below.

334-3 GENERAL CONSTRUCTION REQUIREMENTS

334-3.1 DESCRIPTION

Construct plant-mixed hot bituminous pavements. Establish and maintain a quality control system in accordance with section 334-2 above that provides assurance that all materials, products and completed construction submitted for acceptance meet Contract requirements.

334-3.2 LIMITATIONS OF OPERATIONS

334-3.2.1 Weather Limitations: Do not transport asphalt mix from the plant to the roadway unless all weather conditions are suitable for the laying operations.

334-3.2.2 Limitations of Laying Operations:

334-3.2.2.1 General: Spread the mixture only when the surface upon which it is to be laid has been previously prepared, is intact, firm, and properly cured, and is substantially dry. Do not place friction course until the adjacent shoulder area has been dressed and grassed.

334-3.2.2.2 Temperature: Spread the mixture only when the air temperature in the shade and away from artificial heat is at least 40ºF and rising for layers greater than 1 inch in thickness and at least 45ºF and rising for layers 1 inch or less in thickness (including leveling courses). The minimum temperature requirement for leveling courses with a spread rate of 50 lb/yd2 or less is 50ºF and rising.

334-3.2.2.3 Wind: Do not spread the mixture when the wind is blowing to such an extent that proper and adequate compaction cannot be maintained or when sand, dust, etc., are being deposited on the surface being paved to the extent that the bond between layers will be diminished.

334-3.2.2.4 Night Paving: Provide sufficient lighting for night operations.

334-3.3 ROADWAY SURFACE PREPARATION

334-3.3.1 Cleaning: Prior to the laying of the mixture, clean the surface of the base or pavement to be covered of all loose and deleterious material by the use of a vacuum truck. Power brooms or blowers may be used when the use of a vacuum truck is impractical, supplemented by hand brooming where necessary.

334-3.3.2 Patching and Leveling Courses: Where an asphalt mix is to be placed on an existing pavement or old base which is irregular, or wherever the plans indicate, bring the existing surface to proper grade and cross-section by the application of patching or leveling courses. Wherever a patch is required, the width shall be taken out to the full width of each lane affected and the length shall extend far enough longitudinally to fully encompass the affected area. The existing pavement receiving a patch or leveling course shall be milled as shown on the plans or as required by the Engineer.

334-3.3.3 Application Over Surface Treatment: Where an asphalt mix is to be placed over a newly constructed surface treatment, sweep and dispose of all loose material from the paving area.

334-3.3.4 Coating Surfaces of Contacting Structures: Paint all structures which will be in actual contact with the asphalt mixture, with the exception of the vertical faces of existing pavements and curbs or curb and gutter, with a uniform coating of asphalt cement to provide a closely bonded, watertight joint.

334-3.3.5 Tack Coat:

334-3.3.5.1 Tack Coat Required: Apply a tack coat, meeting the requirements of Section 300 in the FDOT Standard Specifications for Road and Bridge Construction, on existing pavement structures that are to be overlaid with an asphalt mix and between successive layers of all asphalt mixes. The use of Trackless Polymer Modified Asphalt Emulsion Tack Coat (MTSS-1HM) is not allowed unless approved by the Engineer.

334-3.3.5.2 Tack Coat at Engineer's Option: Apply a tack coat on the following surfaces only when so directed by the Engineer:

1. Freshly primed bases.
2. Surface treatment.

334-3.4 ASPHALT PLANT PREPARATION

Ensure the following requirements are met at the asphalt plant:

Asphalt Cement

- Asphalt cement is delivered to the asphalt plant at a temperature not to exceed 370ºF.
- Asphalt cement is maintained in storage within a range of 230 to 370ºF in advance of mixing operations.
- Constant heating is maintained within these limits, and that high fluctuations in temperature during a day's production is avoided.

Aggregate Blending:

- All aggregates to be blended or proportioned are placed in separate bins at the cold hopper.
- Proportioning is performed by means of securely positioned calibrated gates or other approved devices.

Aggregate Cold Bins:

- Bin compartments are constructed to prevent any spilling or leakage of aggregate from one bin to another.
- Bin compartments have the capacity and design to permit a uniform flow of aggregates.
- Bin compartments are mounted over a feeder of uniform speed, which will deliver the specified proportions of aggregate to the drier.
- Bins are equipped with vibrators to ensure a uniform flow of aggregate at all times.
- Each bin compartment is provided with a gate which is adjustable in the vertical direction.
- Gates can be held securely at any specified vertical opening.
- Gates are equipped with a measuring device for measuring the vertical opening of the gates from a horizontal plane level with the bottom of the feeder.

Mineral Filler:

Mineral filler (if required in the mix design) is fed or weighed in separately from the other aggregates.

Aggregate Heating and Drying:

- Aggregates are heated and dried before screening.
- The temperature of the aggregates is controlled so that the temperature of the completed mixture at the plant falls within the permissible range allowed by this Section.

Aggregate Screening:

- Oversized pieces of aggregate are removed by the use of a scalping screen.
- Oversized material is not returned to the stockpile for reuse unless it has been crushed and reprocessed into sizes that will pass the scalping screen.
- The quantity of aggregates being discharged onto the screens does not exceed the capacity of the screens to actually separate the aggregates into the required sizes.
- A maximum of 10% plus-10 material in the minus-10 bin is maintained.

334-3.5 MIXTURE PREPARATION

Ensure the following requirements are met:

334-3.5.1 Batch Mixing: The dried aggregates and mineral filler (if required), prepared as specified and proportioned to meet the verified mix design, shall be conveyed to the empty mixer. The accurately measured hot asphalt binder shall be introduced into the mixer simultaneously with, or after, the hot aggregates. The blended materials shall be continuously mixed until thoroughly uniform with all particles fully coated. The mixing time begins when the measuring devices for both the asphalt and the aggregates indicate that all the material is in the mixer, and continues until the material begins to leave the mixing unit. In no case will the mixing time be less than 35 seconds.

334-3.5.2 Continuous Mixing: The dried aggregates and mineral filler (if required), prepared as specified and proportioned to meet the verified mix design, shall be introduced into the mixer in synchronization with the accurate feeding of the hot asphalt cement. The blended materials shall be sufficiently mixed until thoroughly uniform with all particles fully coated.

334-3.5.3 Mix Temperature: The ingredients of the mix shall be heated and combined in such a manner as to produce a mixture with a temperature, when discharged from the pugmill or surge bin, which is within the master range as defined below.

The temperature of the completed mixture shall be determined using a quick-reading thermometer through a hole in the side of the loaded truck immediately after loading. A 1/4 inch hole on both sides of the truck body within the middle third of the length of the body, and at a distance from 6 to 10 inches above the surface supporting the mixture shall be provided.

The normal frequency for taking asphalt mix temperatures will be for each day, for each design mix on the first five loads and once every five loads thereafter. The temperature of the asphalt mix at the plant and at the roadway shall be taken at the normal frequency before the mix is placed. The temperature shall be recorded on the front of the respective delivery ticket. The Engineer shall review the plant and roadway temperature readings and may take additional temperature measurements at any time.

The master range for all mix designs will be the established temperature from the mix design ±30ºF. Reject for use on the project any load or portion of a load of asphalt mix at

the plant or at the roadway with a temperature outside of this master range. The Engineer will be immediately notified of the rejection.

If any single load at the plant or at the roadway is within the master range but differs from the established mix temperature by more than ±25ºF or if the average difference of

the temperature measurements from the established mix temperature for five loads exceeds ±15ºF, the temperature of every load will be monitored until the temperature falls within the specified tolerance range in Table 334-1; at this time the normal frequency may be resumed.

Table 334-1 Temperature Tolerance From Verified Mix Design	
Any Single Measurement	±25ºF
Average of Any Five Consecutive Measurements	±15ºF

334-3.5.4 Maximum Period of Storage: The maximum time that any mix may be kept in a hot storage or surge bin shall be 72 hours.

334-3.5.5 Contractor's Responsibility for Mixture Requirements: Produce a homogeneous mixture, free from moisture and with no segregated materials, that meets all specification requirements. Also apply these requirements to all mixes produced by the drum mixer process and all mixes processed through a hot storage or surge bin, both before and after storage.

334-3.6 MIXTURE TRANSPORT

Transport the mixture in tight vehicles previously cleaned of all foreign material. After cleaning, thinly coat the inside surface of the truck bodies with soapy water or an asphalt release agent as needed to prevent the mixture from adhering to the beds. Do not allow excess liquid to pond in the truck body. Do not use diesel fuel or any other hazardous or environmentally detrimental material as a coating for the inside surface of the truck body. Cover each load during cool and cloudy weather and at any time there is a probability of rain.

334-3.7 MIXTURE PLACEMENT

334-3.7.1 Requirements Applicable to All Mixture Types:

334-3.7.1.1 Alignment of Edges: Lay all asphalt concrete mixtures, including leveling courses, other than the pavement edge just adjacent to curb and gutter or other true edges, by the stringline method to obtain an accurate, uniform alignment of the pavement edge. Control the unsupported pavement edge to ensure that it will not deviate more than ±1.5 inches from the stringline.

334-3.7.1.2 Temperature of Spreading: Maintain the temperature of the mix at the time of spreading within the master range as defined in 334-3.5.3.

334-3.7.1.3 Rain and Surface Conditions: Immediately cease transportation of asphalt mixtures from the plant when rain begins at the roadway. Do not place asphalt mixtures while rain is falling, or when there is standing water on the surface to be covered. Once the rain has stopped and water has been removed from the tacked surface to the satisfaction of the Engineer and the temperature of the mixture caught in transit still meets the requirements as specified in 334-3.7.1.2, the Contractor may then place the mixture caught in transit.

334-3.7.1.4 Speed of Paver: Establish the forward speed of the asphalt paver based on the rate of delivery of the mix to the roadway but not faster than the optimum speed needed to adequately compact the pavement.

334-3.7.1.5 Number of Crews Required: For each paving machine operated, use a separate crew, each crew operating as a full unit. The technician who will be in charge of all paving operations shall be state approved and properly certified as deemed appropriate by the Engineer. The Contractor's technician in charge of the paving operations may be responsible for more than one crew but must be physically accessible to the Engineer at all times when placing mix.

334-3.7.1.6 Checking Depth of Layer: Check the depth of each layer at frequent intervals, and make adjustments when the thickness deviates from the design thickness. When making an adjustment, allow the paving machine to travel a minimum distance of 32 feet to stabilize before the second check is made to determine the effects of the adjustment.

334-3.7.1.7 Hand Spreading: In limited areas where the use of the spreader is impossible or impracticable, the Contractor may spread and finish the mixture by hand.

334-3.7.1.8 Straightedging and Back-patching: Straightedge and backpatch after obtaining initial compaction and while the material is still hot.

334-3.7.2 Requirements Applicable to Courses Other Than Leveling:

334-3.7.2.1 Spreading and Finishing: Upon arrival, dump the mixture in the approved mechanical spreader, and immediately spread and strike-off the mixture to the full width required, and to such loose depth for each course that, when the work is completed, the required specified thickness is placed. Carry a uniform amount of mixture ahead of the screed at all times.

334-3.7.2.2 Thickness of Layers: Construct each course of Type SP mixture in layers of thickness as shown in Section 334-4.1.3.

334-3.7.2.3 Laying Width: For regular roadways, pave to the full lane width, except in areas where physically constrained. For other applications such as sidewalks, provide a spreader capable of placing and screeding to the plan width. If necessary due to the traffic requirements, lay the mixture in strips in such a manner as to provide for the passage of traffic. As an option, where the road is closed to traffic, lay the mixture to the full width with machines traveling in echelon. Plan longitudinal joints such that they are not placed where a permanent wheel path will occur.

334-3.7.2.4 Correcting Defects: Before starting any rolling, check the surface. Correct any irregularities; remove all drippings, fat sandy accumulations from the screed, and fat spots from any source; and replace them with satisfactory material. Do not skin patch. When correcting a depression while the mixture is hot, scarify the surface and add fresh mixture.

334-3.7.3 Requirements Applicable Only to Leveling Courses:

334-3.7.3.1 Patching Depressions: Before spreading any leveling course, fill all depressions in the existing surface more than 1 inch deep by spot patching with leveling course mixture, and then compact them thoroughly.

334-3.7.3.2 Spreading Leveling Courses: Place all courses of leveling by the use of two motor graders, equip one with a spreader box. Other types of leveling devices may be used if approved by the Engineer.

334-3.7.3.3 Rate of Application: When using Type SP-9.5 (fine graded) for leveling, do not allow the average spread of a layer to be less than 50 lb/yd2 or more than 75 lb/yd2. The quantity of mix for leveling shown in the plans represents the average for the entire project.

334-3.8 MIXTURE COMPACTION

334-3.8.1 Equipment and Sequence: For each paving or leveling train in operation, furnish a separate set of rollers, with their operators.

Select equipment, sequence, and coverage of rolling to meet the specified mix design density. The coverage is the number of times the roller passes over a given area of pavement.

Regardless of the rolling procedure used, complete the final rolling before the surface temperature of the pavement drops to the extent that effective compaction may not be achieved or the rollers begin to damage the pavement.

334-3.8.2 Standard Rolling Procedure: Meet the following equipment, sequence, and coverage requirements:

1. Seal Rolling: Provide two coverages with a tandem steel-wheeled roller, weighing 5 to 12 tons, following as close behind the spreader as possible without pick-up, undue displacement, or blistering of the material. Use static mode only for all compaction. No vibration will be allowed.

2. Intermediate rolling: Provide five coverages with a self-propelled pneumatic-tired roller, following as close behind the seal rolling operation as the mix will permit.

3. Final rolling: Provide one coverage with a tandem steel-wheeled roller (static mode only), weighing 5 to 12 tons, after completing the seal rolling and intermediate rolling, but before the surface pavement temperature drops to the extent that effective compaction may not be achieved or the rollers begin to damage the pavement.

For patching and leveling courses, the first structural layer placed on a milled surface, and on the first overbuild course, use only a self-propelled pneumatic-tired roller.

The Contractor may use equipment, sequences, or coverages other than those specified in the standard rolling procedure if so authorized by the Engineer.

334-3.8.3 Compaction at Crossovers, Intersections, etc.: When using a separate paving machine to pave the crossovers, compact the crossovers with one, 8 to 12 ton tandem steel roller (static mode only). If placing crossovers, intersections, and acceleration and deceleration lanes with the main run of paving, also use a traffic roller to compact these areas.

334-3.8.4 Rolling Procedures: Ensure that the initial rolling is longitudinal.

Where the lane being placed is adjacent to a previously placed lane, pinch or roll the center joint prior to the rolling of the rest of the lane.

Roll across the mat, overlapping the adjacent pass by at least 6 inches. Roll slowly enough to avoid displacement of the mixture, and correct any displacement at once by the use of rakes and the addition of fresh mixture if required.

Continue final rolling to eliminate all roller marks.

334-3.8.5 Number of Pneumatic-tired Rollers Required: Use a sufficient number of self-propelled pneumatic-tired rollers to ensure that the rolling of the surface for the required number of passes does not delay any other phase of the laying operation and does not result in excessive cooling of the mixture before completing the rolling. In the event that the rolling falls behind, discontinue the laying operation until the rolling operations are sufficiently caught up.

334-3.8.6 Compaction of Areas Inaccessible to Rollers: Use hand tamps or other satisfactory means to compact areas which are inaccessible to a roller, such as areas adjacent to curbs, headers, gutters, bridges, manholes, etc.

334-3.8.7 Correcting Defects: Do not allow the rollers to deposit gasoline, oil, or grease onto the pavement. Remove and replace any areas damaged by such deposits as directed by the Engineer. While rolling is in progress, test the surface continuously, and correct all discrepancies to comply with the surface requirements.

Remove and replace all drippings, fat or lean areas, and defective construction of any description. Remedy depressions that develop before completing the rolling by loosening the mixture and adding new mixture to bring the depressions to a true surface. Should any depression remain after obtaining the final compaction, remove the full depth of the mixture, and replace it with sufficient new mixture to form a true and even surface.

Correct all high spots, high joints, and honeycombing as directed by the Engineer.

Remove and replace any mixture remaining unbonded after rolling. Correct all defects prior to laying the subsequent course.

334-3.9 JOINTS

334-3.9.1 General: When laying fresh mixture against the exposed edges of joints (trimmed or formed as provided below), place it in close contact with the exposed edge to produce an even, well-compacted joint after rolling.

334-3.9.2 Transverse Joints: Place the mixture as continuously as possible. Do not pass the roller over the unprotected end of the freshly laid mixture except when discontinuing the laying operation long enough to permit the mixture to become chilled.

When thus interrupting the laying operation, construct a transverse joint by cutting back on the previous run to expose the full depth of the mat.

334-3.9.3 Longitudinal Joints: For all layers of pavement except the leveling course, place each layer so that longitudinal construction joints are offset 6 to 12 inches laterally between successive layers. The Engineer may waive this requirement where offsetting is not feasible due to the sequence of construction.

TECHNICAL PROVISIONS

TP 334 – Superpave Asphaltic Concrete Pavement

334-3.10 SURFACE REQUIREMENTS

334-3.10.1 General: Construct a smooth pavement with good surface texture and the proper cross-slope.

334-3.10.2 Texture of the Finished Surface of Paving Layers: Produce a finished surface of uniform texture and compaction with no pulled, torn, raveled, crushed or loosened portions and free of segregation, bleeding, flushing, sand streaks, sand spots, or ripples. Correct any area of the surface that does not meet the foregoing requirements in accordance with 334-3.10.5.

Do not use asphalt concrete mixtures containing aggregates that cause a different color appearance in the final wearing surface in sections less than 1 mile in length and across the full width of the roadway unless approved by the Engineer.

334-3.10.3 Cross Slope: Construct a pavement surface with cross slopes in compliance with the requirements of the Contract Documents. Furnish a level with a minimum length of 4 feet or a digital measuring device approved by the Engineer for the control of cross slope. Make this level or measuring device available at the jobsite at all times during paving operations. Utilize electronic transverse screed controls on the paving machine (unless directed otherwise by the Engineer) to obtain an accurate transverse slope of the pavement surface.

The Contractor shall be responsible to ensure that cross slope and positive drainage is maintained at all times during paving operations. Areas determined not to be in compliance with this requirement shall be removed and replaced by the Contractor at no cost to the County.

334-3.10.3.1 Quality Control Checks: Measure the cross slope of the pavement surface by placing the measuring device perpendicular to the roadway centerline. Report the cross slope to the nearest 0.1%. Record all the measurements on an approved form and submit to the Engineer for documentation.

Measure the cross slope at a minimum frequency of one measurement every 100 feet during paving operations to ensure that the cross slope is uniform and in compliance with the design cross slope. When the difference between the measured cross slope and the design cross slope exceeds ±0.2% for travel lanes (including turn lanes) or ±0.5% for shoulders, make all corrections immediately to bring the cross slope into the acceptable range.

When the cross slope is consistently within the acceptable range, upon the approval of the Engineer, the frequency of the cross slope measurements can be reduced to one measurement every 250 feet during paving operations.

For intersections, tapers, crossovers, transitions at beginning and end of project and similar areas, adjust the cross slope to match the actual site conditions or as directed by the Engineer.

334-3.10.4 Pavement Smoothness: Construct a smooth pavement meeting the requirements of this Specification. The County will provide a representative to be present when smoothness testing is performed.

334-3.10.4.1 General: Furnish a 15 foot manual and a 15 foot rolling straightedge meeting the requirements of FM 5-509. Make them available at the job site at all times during paving operations. Obtain a smooth surface on all pavement courses placed, and then straightedge all final structural and friction course layers in accordance with 334-3.10.4.5.

334-3.10.4.2 Test Method: Perform all straightedge testing in accordance with FM 5-509 with one pass of the rolling straightedge operated along the outside wheel path of each lane being tested. The Engineer may require additional testing at other locations within the lane.

334-3.10.4.3 Traffic Control: Provide traffic control in accordance with 334-3.2 and FDOT Design Standard Indices (600 series as applicable) during all testing. When traffic control cannot be provided in accordance with the applicable indices, submit an alternative Traffic Control Plan. The cost of this traffic control is included in the Contract bid prices for other pay items.

334-3.10.4.5 Quality Control Checks:

334-3.10.4.5.1 General: Straightedge the final Type SP structural layer and friction course layer with a rolling straightedge. Test all pavement lanes and ramps where the width is constant using a rolling straightedge and document all deficiencies on a form approved by the Engineer. Notify the Engineer of the location and time of all straightedge checks a minimum of 48 hours before beginning. Testing shall be conducted by a certified Paving Level I or higher technician. Maintain a field record during testing on a form approved by the Engineer identifying the areas tested and listing the location and degree of all deficiencies found. The field record shall be signed by the technician conducting the test and the Engineer or Engineer's Representative observing the test.

334-3.10.4.5.2 Rolling Straightedge Exceptions: Testing with the rolling straightedge will not be required in the following areas: intersections, tapers, crossovers, parking lots and similar areas. In addition, testing with the rolling straightedge will not be performed on the following areas when they are less than 50 feet in length: turn lanes, acceleration/deceleration lanes and side streets.

However, correct any individual surface irregularity in these areas that deviates from the plan grade in excess of 3/8 inch as determined by a 15 foot manual straightedge, and that the Engineer deems to be objectionable, in accordance with 334-3.10.5.

In addition, the Engineer may also waive the straightedging requirements on ramps and superelevated sections where the geometrical orientation of the pavement results in an inaccurate measurement with the rolling straightedge.

334-3.10.4.5.3 Intermediate Layers: Straightedge all intermediate Type SP layers (structural and overbuild) as necessary to construct a smooth pavement.

On roadways with a design speed 50 miles per hour or greater, when an intermediate Type SP layer will be opened to traffic, straightedge the pavement with a rolling straightedge and correct all deficiencies in excess of 3/8 inch within 72 hours of placement, unless directed otherwise by the Engineer. Correct all deficiencies in accordance with 334-3.10.5.

334-3.10.4.5.4 Final Type SP Structural Layer: Straightedge the final Type SP structural layer with a rolling straightedge, either behind the final roller of the paving train or as a separate operation. The Engineer will verify the straightedge testing by observing the Quality Control straightedging operations. Correct all deficiencies in excess of 3/16 inch in accordance with 334-3.10.5, and retest the corrected areas prior to placing the friction course.

For bicycle paths, straightedge the final structural layer with a rolling straightedge, either behind the final roller of the paving train or as a separate operation. Correct all deficiencies in excess of 5/16 inch in accordance with 334-3.10.5. Retest all corrected areas. If the Engineer determines that the deficiencies on the bicycle path are due to field geometrical conditions, the Engineer will waive corrections.

334-3.10.4.5.5 Friction Course Layer: Acceptance for pavement smoothness will be based on verified Quality Control measurements using the rolling straightedge. The Engineer will verify the straightedge testing by observing the Quality Control straightedging operations.

At the completion of all paving operations, straightedge the friction course as a separate operation. As an exception, if approved by the Engineer, straightedge the friction course behind the final roller of the paving train. Correct all deficiencies in excess of 3/16 inch in accordance with 334-3.10.5. Recheck all corrected areas.

334-3.10.5 Correcting Unacceptable Pavement: Correct all areas of unacceptable pavement at no cost to the County. Correct deficiencies in the Type SP structural layers or in the friction course by removing and replacing the full depth of the layer, extending for a distance on either side of the defective area as determined by the Engineer, but in no

case less than 50 feet on either side of the defective area for the full width of the paving lane. At the discretion of the Engineer, removal and replacement of the entire limits of the new pavement may be required.

334-3.11 FINISHED SURFACE PROTECTION

Keep sections of newly compacted asphalt concrete, which are to be covered by additional courses, clean until the successive course is laid.

Do not dump embankment or base material directly on the pavement. Dress shoulders before placing the friction course on adjacent pavement.

Equip blade graders operating adjacent to the pavement during shoulder construction with a 2 by 8 inch or larger board, or other attachment providing essentially the same results, attached to their blades in such manner that it extends below the blade edge in order to protect the pavement surface from damage by the grader blade.

To prevent rutting or other distortion, protect sections of newly finished dense graded friction course and the last structural layer prior to the friction course from traffic until the surface temperature has cooled below 160ºF.

The Contractor may use artificial methods to cool the pavement to expedite paving operations. The County may direct the Contractor to use artificial cooling methods when maintenance of traffic requires opening the pavement to traffic at the earliest possible time.

334-3.12 STRIPING

Following final cooling and compaction of the mat and prior to opening to traffic, place temporary painted traffic stripes in accordance with TP-710 and Standard Specification 710 on each paved surface that will receive traffic, including intermediate structural courses, final structural courses that will serve as the surface course, and friction courses. Following thirty (30) days after placement of the final surface course, structural or friction, place thermoplastic striping in accordance with TP-711 and Standard Specification 711 and place raised reflective pavement markers. Final pavement markings are subject to a 180 day observation period under normal traffic. The observation period shall begin with the satisfactory completion and acceptance of the work. The pavement markings shall show no signs of failure due to blistering, excessive cracking, chipping, discoloration, poor adhesion to the pavement, loss of reflectivity or vehicular damage. The County reserves the right to check the color and retroreflectivity within 30 days prior to the end of the observation period. Replace, at no additional expense to the County, any pavement markings that do not perform satisfactorily under traffic during the 180 day observation period.

334-4 SUPERPAVE ASPHALTIC CONCRETE

334-4.1 DESCRIPTION

334-4.1.1 General: Construct a Superpave Asphaltic Concrete pavement using the type of mixture specified in the Contract on a properly prepared and accepted base. Superpave mixes are identified as Type SP-9.5, Type SP-12.5 or Type SP-19.0.

Meet the requirements of 334-2 for personnel, plant, methods and equipment. Meet the general construction requirements of 334-3.

334-4.1.2 Traffic Levels: The requirements for Type SP Asphaltic Concrete mixtures are based on the design traffic level of the project, expressed in 18-Kip Equivalent Single Axle Loads (ESAL's). The traffic levels applicable for this specification are as shown in Table 1.

Table 1
Superpave Traffic Levels

Traffic Level	Million ESAL's	Typical Applications
A	<0.3	Local roads, county roads, and city streets where truck traffic is light or prohibited
B	0.3 to <3	Arterial roads, Collector roads, access streets, medium duty city streets and the majority of county roadways
C	3 to < 10	

The traffic level(s) for the project are as specified in the Contract. A Type SP mix one traffic level higher than the traffic level specified in the Contract, up to a Traffic Level C mix, may be substituted at no cost to the County. In situations where the design traffic level is not specified in the Contract, a Traffic Level C mix shall be used.

334-4.1.3 Layers: Use only fine graded Superpave mixes.

334-4.1.3.1 Layer Thickness: The allowable structural layer thicknesses for fine Type SP Asphaltic Concrete mixtures are as follows:

Type SP-9.5..... 3/4 – 1 1/2 inches
Type SP-12.5..... 1 1/2 – 2 1/2 inches
Type SP-19.0..... 2- 3 inches

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on fine mixes when used as a structural course:

Type SP-9.5 - Limited to the top two structural layers, two layers maximum.
Type SP-12.5 - May not be used in the first layer of courses over 3 1/2 inches thick, nor in the first layer of courses over 2 3/4 inches thick on limited access facilities.
Type SP-19.0 - May not be used in the final (top) structural layer.

334-4.1.3.2 Additional Requirements: The following requirements also apply to fine Type SP Asphaltic Concrete mixtures:

334-4.1.3.2.1 When construction includes the paving of adjacent shoulders (≤5 feet wide), the layer thickness for the upper pavement layer and shoulder shall be the same and paved in a single pass, unless called for differently in the contract documents.

334-4.1.3.2.2 All overbuild layers shall be Type SP Asphalt Concrete designed at the traffic level as stated in the Contract. Use the minimum and maximum layer thicknesses as specified above unless called for differently in the contract documents. On variable thickness overbuild layers, the minimum allowable thickness may be reduced by 1/4 inch, and the maximum allowable thickness may be increased 1/2 inch, unless called for differently in the contract documents.

334-4.2 MIX COMPOSITION

334-4.2.1 General: Compose the asphalt mixture using a combination of aggregates (coarse, fine or mixtures thereof), mineral filler, if required, and asphalt binder material. Size, grade and combine the aggregate proportions to meet the grading and physical properties of the approved mix design. Aggregates from various sources may be combined.

334-4.2.2 Mix Design: Submit to the Engineer the proposed mix design and proof that this mix design is on the FDOT District 5 accepted list. The Engineer will verify with the FDOT District 5 Bituminous Engineer that the mix is on the approved list. No mix design revisions will be allowed. A new design mix will be required for any substitution of an aggregate product, binder, or other design component unless approved by the Engineer. The Engineer will consider any marked variations from mix design parameters or any evidence of inadequate field performance of a mix design as sufficient evidence that the properties of the mix design have changed, and the Engineer will no longer allow the use of that mix design. Provide certification from the plant (either in a statement on the delivery ticket or on a separate sheet) that the mix provided is in conformance with the design mix.

334-4.2.3 Additional Information: Provide the following information to the Engineer with each FDOT approved mix design submitted for use:

- The approved FDOT Mix Design Number.
- The design traffic level and the design number of gyrations (N_{design}).
- The source and description of the materials to be used.
- The FDOT source number product code of the aggregate components furnished from an FDOT approved source.
- The gradation and proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use. Compensate for any change in aggregate gradation in handling and processing as necessary.
- A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly -No. 200 [-75 µm]) should be accounted for and identified for the applicable sieves.
- The bulk specific gravity value for each individual aggregate (and RAP) component, as identified in the FDOT aggregate control program.
- A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%.
- A target temperature at which the mixture is to be discharged from the plant and a target roadway temperature. Do not exceed a target temperature of 340°F for modified asphalts and 315°F for unmodified asphalts.
- The physical properties achieved at four different asphalt binder contents, one of which shall be at the optimum asphalt content, and must conform to all specified physical requirements.
- The ignition oven calibration factor.

334-4.3 MATERIALS

334-4.3.1 General Requirements: Meet the material requirements specified in Division III of the FDOT Standard Specifications for Road and Bridge Construction. Specific references are as follows:

Coarse Aggregate: Stone, Slag, Crushed Gravel, Crushed Reclaimed Portland Cement Concrete Pavement, Crushed Glass.....Section 901
Fine Aggregate.....Section 902
Superpave PG Asphalt Binder ..... Section 916-1

334-4.3.2 Superpave Asphalt Binder: Unless specified otherwise in the Contract, use a PG 67-22 asphalt binder unless the use of a different binder or recycling agent has been approved by the Florida Department of Transportation and the Engineer for a particular mix design.

334-4.3.3 Use of Reclaimed Asphalt Pavement (RAP) Material:

334-4.3.3.1 General Requirements: Reclaimed Asphalt Pavement (RAP) may be used as a component material of the asphalt mixture, with the exception of Friction Course mixes, subject to the following requirements:

- Assume responsibility for the production and placement of asphalt mixes which incorporate RAP as a component material.
- Use only RAP that has been approved by the FDOT. Provide documentation of the FDOT approval.
- Limit the amount of RAP material used in the mix to less than 20% by weight of total aggregate, unless otherwise approved the Engineer.
- Use any suitable means to prevent oversized RAP material from showing up in the completed recycled mixture. Take immediate corrective action if oversized RAP material appears in the completed recycled mix.
- Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.
- Provide RAP having a minimum average asphalt content of 4.0% by weight. The Engineer may sample the stockpile to verify that this requirement is met.

334-4.4 ACCEPTANCE

334-4.4.1 General: The asphalt mixture will be accepted based on one of the following methods as determined by the Engineer and/or the Contract Documents:

1) Certification, Contractor Process Control Testing, and Acceptance Testing by the Engineer
2) Other method(s) as determined by the Contract

334-4.4.2 Certification by the Contractor: Submit a Notarized Certification of Specification Compliance letter by an officer of the company who is in responsible charge of paving operations. The letter shall be submitted on company letterhead to the Engineer and shall state that all material produced and placed on the project was in substantial compliance with the Specifications.

334-4.4.3 Contractor Process Control Testing: Provide supporting test data documenting all quality and process control testing as described in 334-2 above. A pre-qualified Independent Laboratory as approved by the Engineer may be utilized for the Process Control testing.

334-4.4.4 Acceptance Testing by the Engineer: The Engineer may employ the use of a pre-qualified Independent Geotechnical Engineering firm and/or Laboratory to perform acceptance testing. For every 500 feet of pavement placed per lane per day, take a set of three (3) randomly placed cores, at least two (6") inches in diameter, for determining density and thickness. A minimum of two sets of three cores will be taken per roadway. Acceptance will be based on the following:

334-4.4.4.1 Density: The minimum acceptable average density for each course of asphaltic concrete placed shall be ninety-two (92%) percent of the design unit weight (G_{mm}) of the job mix, with no test lower than ninety and eight tenths (90.8%) percent or higher than ninety-five (95%) percent.

334-4.4.4.2 Thickness: Meet the minimum design thickness on all cores. When a deficiency in thickness is found, the Engineer may require additional cores to be taken to determine the extent of the thickness deficiency. For any thickness that is less than the design thickness, remove and replace the full depth of the layer, extending for a distance on either side of the defective area as determined by the Engineer, but in no case less than 50 feet on either side of the defective area for the full width of the paving lane. At the discretion of the Engineer, removal and replacement of the entire limits of the new pavement may be required. For any thickness that is greater than the design thickness, the Engineer will make a determination about acceptance.

334-4.4.4.3 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 334-3.10.

334-4.4.4.4 Additional Tests: The County reserves the right to run any test at any time for informational purposes and for determining the effectiveness of the Contractor's quality control and process control.

334-4.5 METHOD OF MEASUREMENT

For the work specified under this Section the quantity to be paid for shall be the actual area in Square Yards (SY) of asphaltic concrete placed and accepted within the limits of the contract.

334-4.6 BASIS OF PAYMENT

Type SP Asphaltic Concrete will be paid for at the contract unit price per square yard, completed and accepted. No additional payment will be made for thickness of asphalt greater than the design thickness.

The bid price for the asphalt mix will include the cost of the liquid asphalt or the asphalt recycling agent. There will be no separate payment for the asphalt binder material in the asphalt mix.

Payment shall be made under:

Pay Item:		
334-1-12A	Superpave Asphaltic Concrete (Traffic B)(SP-9.5) (1 1/2”)	Per Square Yard
334-1-12B	Superpave Asphaltic Concrete (Traffic B)(SP-12.5) (1 1/2”)	Per Square Yard

TECHNICAL PROVISIONS

TP 440 – Underdrains

UNDERDRAINS

Roadway underdrain and underdrain cleanout structures shall be constructed in the locations indicated on the plans or as directed by the Engineer. Construction of the roadway underdrain and underdrain cleanout structures shall conform to the requirements of the latest editions of the FDOT Road and Traffic Design Standard Index No. 286 and FDOT standard specifications for Road and Bridge Construction (specifically section 440), as well as the requirements provided herein. It is the Contractor's responsibility to acquire, read, and understand these documents. Roadway underdrain pipe shall have a diameter of eight (8) inches, unless indicated otherwise on the plans. Construct underdrain inspection boxes in accordance with the Design Standards, Index No. 245 and the Plans.

The Contractor shall be responsible for connecting the drains to outlet structures. Private drains shall not be connected to underdrains or outlet structures unless otherwise authorized by the County's Representative. All inlet/manhole pipe joints (internal and external) shall be filled with non-shrink grout.

Materials

Materials used for this Section shall conform to the following requirements:

A. Filter Fabric:

In accordance with the Geotechnical Report recommendations, the filter fabric shall be a Type D woven geotextile, polypropylene monofilament with fiber diameter 700 µm, and shall conform to the requirements of FDOT Standard Specification 985. No woven slit film fabric is allowed.

The following filter fabrics are approved for use:
Terratex EP-10, or similar
Geotex 2 x 2 HF, or similar

B. Pipe Wrap:

No filter fabric sock or pipe wrap shall be utilized for this project.

C. Filter Aggregate (Fine Aggregate):

Sand: Fine sand with less than 7% passing the US#200 sieve and minimum remolded permeability of 7 ft/day.

Stone: Granite #57 stone shall be used for the trench backfill material.

D. Pipe

Perforated Underdrain Pipe: 8” diameter PVC pipe with perforations (not slots which are more prone to clog).

Underdrain Outlet Pipe: 8” diameter non-perforated PVC pipe. All bends shall be made using 1/8 (45 degree) elbows. All 90 degree bends shall be constructed with two 1/8 elbows separated by at least 1' of straight pipe. Outlet pipes stubbed into inlets or other

drainage structures shall be not less than 6" above the structure flow line. Outlet pipes discharging to grassed areas shall have concrete aprons, hardware cloth, and bordering sod as shown in Index No. 287 for edgedrain outlets.

In addition to the requirements specified herein, the materials used for this Section shall also conform to the requirements specified in the Plans and the Geotechnical Report.

Procedures

Construction procedures shall conform to the following:

Excavation Trench:

The trench shall be excavated carefully to such depth as is required to permit the pipe to be laid to the grade designed and to the dimensions shown in the plans.

The underdrain trench shall be constructed in a dry condition. This shall be accomplished by the use of a positive dewatering method.

Sprinkler systems must be removed before and restored immediately after the installation of the underdrain and must be coordinated with the homeowner. Sprinkler systems shall be restored for each residence or every 75’ on open lots.

Placing Filter Fabric:

After the trench has been excavated, the filter fabric shall be rolled out over the trench and walked into the trench. Care shall be taken to prevent the excavated material from entering the trench after the fabric has been installed.

Laying Pipe:

After the filter fabric has been placed in the trench, approximately six (6) inches of filter aggregate shall be placed in the trench. The pipe shall be bedded firmly in the filter in the aggregate to the correct line and grade. The upper end of the run of roadway underdrain pipe shall terminate at the underdrain cleanout to prevent any filter aggregate from entering the pipe.

Construct underdrain cleanout structures of in-line wye fittings and stub for access where called for in the Plans.

Line and grade shall be maintained by the Contractor at all times during construction installation to ensure proper flow.

Placing and Compacting Filter Aggregate:

After the pipe has been laid to grade, the pipe shall be firmly held in place by mechanical means while the filter aggregate is placed to a maximum height of five (5) inches plus one (1) inch (compacted) above the top of the pipe. After the first lift is placed and compacted to the satisfaction of the Engineer, the remainder of the filter aggregate shall be placed. The excavation of the trench, the placement of the filter fabric, the installation of the pipe, and the placement and compaction of the first lift of filter aggregate shall be accomplished in a single continuous operation.

TECHNICAL PROVISIONS

TP 440 – Underdrains

Special care shall be taken to avoid displacement or damage to the pipe or filter fabric.

Backfill above Filter Aggregate:

The Contractor shall be responsible for all clean (free of deleterious material, trash, clay, muck, etc.) backfill material necessary to complete the installation of drains and restoration of the areas affected by the underdrain installation.

After the filter aggregate has been placed to the required height above the pipe, as shown on the plans, the filter fabric shall be lapped full width of trench from both sides. The portion of the trench above the filter aggregate shall be filled with fine filter aggregate which shall be placed and tamped in layers not thicker than twelve (12) inches to the proposed grade.

Cleanouts:

Cleanouts shall be installed evenly spaced no more than 300 feet apart depending on the length of the underdrain. Concrete pads (4" thick) shall be constructed around cleanouts for protection. These square pads shall extend six (6) inches from the edge of the pipe (the clean out pipe shall be located in the center of the pad) and flush with pad. Double cleanouts shall follow the same standards in only one pad; pipes can be placed six (6) inches apart (outside edge to outside edge).

Cleanout pipes shall have inverted standard pipe covers for easy access. All clean out locations shall be identified with embedded concrete curb cuts with minimum of 4" lettering, 1/4" width and 1/4" depth ("UD" is to be used for this purpose). The lettering must be legible. GPS coordinates shall be provided as part of the as-built drawings. Deviations from these standards shall be previously discussed with the County's Representative for approval.

Method of Measurement

Quantities measured for payment under this Section shall be the length in feet of underdrains measured in place, along the center line and gradient of the underdrain, completed and accepted. The measurement shall include the portion of the pipe extending into the walls or junction boxes, etc.

Basis of Payment

Underdrains will be paid for at the contract unit price per linear foot of underdrain and underdrain outlet pipe, completed and accepted. Payment shall be full compensation for all work described herein, including dewatering, excavation, perforated and non-perforated pipe and fittings, filter aggregate, filter fabric, underdrain cleanouts and concrete apron, hardware cloth for concrete aprons, junction boxes, pipe, backfilling, compacting, disposal of surplus material, stubbing into drainage structures, and removal and restoration of sprinklers.

The measurements for payment will be from outside of structure to outside of structure, cleanout to cleanout, or cleanout to outside of structure, installed and accepted as determined by the County Representative. Underdrains included in the contract price of other pay items will not be included in this Section for payment.

TECHNICAL PROVISIONS

TP 440 – Underdrains

Payment shall be made under:

Pay Item:		
440-1-60	Underdrain, Special, Perforated (8” Dia.)	Per Linear Foot

Pay Item Footnote No. 440-1-60
Payment for underdrains includes, but is not limited to, the cost for pipe, perforated and non-perforated fittings, aggregate, filter fabric, underdrain cleanouts, underdrain outlet pipe, junction boxes, concrete aprons, and stubbing into drainage structures. Also includes the cost to coordinate with utility owners and field adjust underdrain to avoid impacts with utilities and private property.

CONCRETE GUTTER, CURB ELEMENTS, AND TRAFFIC SEPARATOR

Construction of concrete curb and gutter, concrete traffic separator, and concrete valley gutter shall conform to the requirements of Section 520 of the Standard Specifications, except as directed by the Engineer.

Foundation

Foundation material upon which the concrete is to be placed shall be compacted to a minimum QC density of 100% of the standard Proctor maximum density as determined by AASHTO T-99, Method C, per FDOT Standard Specification 120-10.2. The foundation material shall also be thoroughly wetted but free of standing water just prior to placing concrete.

Contraction Joints

Contraction joints shall be sawed to a minimum depth of 1 1/2 inches. Sawing shall begin as soon as the concrete has hardened to the degree that excessive raveling will not occur. Sawing shall progress in the same direction and sequence as the concrete placement. Every third joint shall be sawed first, then saw intermediate joints.

For concrete placed before noon, all joints shall be sawed the same day of placement. For concrete placed after noon, all third joints shall be sawed the day of placement; all other joints prior to noon the following day.

Curing

Concrete shall be cured as provided in Section 520-8, except as modified herein or as approved by the Engineer. Curing material shall be applied to the concrete surfaces after finishing as soon as the concrete has hardened sufficiently to prevent marring the surface or within one hour after finishing is completed, whichever occurs first. Applying curing materials shall not be held up due to other activities on the project. Contractor shall schedule and provide manpower necessary to conform to these requirements.

Spraying equipment, including spray tip and nozzle, shall be as recommended by manufacturer's printed literature, or an acceptable equal. Suggested equivalent spraying equipment is:

Pump Sprayer: Model No. 1949, Chapin Mfg., (800) 444-3140
Drum Pump Sprayer: 12 Volt DC # 6061, Chapin Mfg.

Equipment shall be maintained and nozzles replaced as required to provide consistent uniform spray pattern.

A uniform coating meeting the manufacturer's recommended minimum application rate shall be applied. Areas appearing to have insufficient curing compound, as determined solely by the Engineer, shall be re-coated immediately to provide required uniform coverage.

Storage containers having greater than a five gallon capacity may be utilized only with prior approval by the Engineer. The contractor shall submit the manufacturer's descriptive literature describing the placement, storage and mixing requirements for storage containers exceeding five gallons. The contractor shall provide and utilize mechanical mixers for all containers larger than five gallons. The mixers shall be equivalent to the manufacture's requirements. The contractor shall conform to all storage, mixing and application requirements.

Repairs

Where replacement is necessary, complete sections between existing contraction joints shall be removed and replaced.

Method of Measurement

For curb or curb and gutter, the quantity to be paid will be plan quantity, in linear feet, measured along the face of the completed and accepted curb or curb and gutter.

For valley gutter or shoulder gutter, the quantity to be paid will be plan quantity, in linear feet, measured along the gutter line of the completed and accepted valley gutter or shoulder gutter.

For concrete traffic separator of constant width, the quantity to be paid will be plan quantity, in linear feet, measured along the center of its width, completed and accepted, including the length of the nose.

For concrete traffic separator of varying width, the quantity to be paid will be plan quantity, in square yards, completed and accepted.

Basis of Payment

Items covered by this Section will be paid for at the contract unit price. Payment shall constitute full compensation for all work described herein, including all labor, equipment, materials and incidentals necessary to complete each item of work.

Payment shall be made under:

Pay Item:

520-1-10	Concrete Curb and Gutter, Drop Curb	Linear Feet

Pay Item Footnote No. 520-1-10
Includes the cost of all materials, labor and equipment required for construction of curb and gutter.

TECHNICAL PROVISIONS

TP 522 – Concrete Sidewalks, 4 Inch and 6 Inch Thickness

CONCRETE SIDEWALKS, 4 INCH AND 6 INCH THICKNESS

Construction of 4-inch and 6-inch concrete sidewalk (and driveways) shall conform to the requirements of Section 522 of the Standard Specifications, and Indexes 304 and 310 of the FDOT Design Standards, except as directed by the Engineer.

Foundation

Foundation material shall be compacted to a minimum of 95% of AASHTO T-99 density per FDOT Standard Specification 522 and shall be thoroughly wetted but free of standing water just prior to placing concrete.

Contraction Joints

Contraction joints shall be sawed. All joints shall be straight lines oriented at 90 degrees to the edge of sidewalk, radially if in a curve, or as directed otherwise. The minimum depth of joints shall be 1 1/2 inches or 1/4 the nominal thickness of concrete placed, whichever is greater.

Joint installation shall proceed in the same direction and sequence as the concrete placement. Sawing shall begin as soon as the concrete has hardened to the degree that excessive raveling will not occur. Every third transverse joint and all longitudinal joints shall be sawcut within 8 hours after finishing. Remaining transverse joints, shall be sawcut by noon the following day.

Construction Joints

Construction joints shall be constructed at the end of all pours and at other locations where the concrete placement operations are stopped for as long as 30 minutes. They shall be placed at least 10 feet from any other transverse construction joint or end of pavement section.

Metal keyways shall be installed at all construction joints 6-inches and greater in thickness. Concrete thickness shall be increased by 2-inches for a minimum distance of 6-inches either side of construction joints.

Curing

Concrete shall be cured as provided in Section 520-8, except as modified herein. Curing material shall be applied to the concrete surfaces after finishing as soon as the concrete has hardened sufficiently to prevent marring the surface or within one hour after finishing is completed, whichever occurs first. Applying curing materials shall not be held up due to other activities on the project. Contractor shall schedule and provide manpower necessary to conform to these requirements.

TECHNICAL PROVISIONS

TP 522 – Concrete Sidewalks, 4 Inch and 6 Inch Thickness

Spraying equipment, including spray tip and nozzle, shall be as recommended by the manufacturers' printed literature, or an acceptable equal. Suggested equivalent spraying equipment is as follows:

Pump Sprayer:	Model No. 1949, Chapin Mfg., (800) 444-3140
Drum Pump Sprayer:	12 Volt DC # 6061, Chapin Mfg.

Equipment shall be maintained and nozzles replaced as required to provide a consistently uniform spray pattern.

A uniform coating meeting the manufacturer's recommended minimum application rate shall be applied. Areas appearing to have insufficient curing compound, as determined solely by the County, shall be re-coated immediately to provide the required uniform coverage.

Storage containers having greater than a five gallon capacity may be utilized only with prior approval of the Engineer. The Contractor shall submit the manufacturer's descriptive literature describing the placement, storage and mixing requirements for storage exceeding five gallons. The Contractor shall provide and utilize mechanical mixers for all containers larger than five gallons. The mixers shall be equivalent to or exceed the manufacture's requirements.

The Contractor shall conform to all storage, mixing and application requirements.

Replacement

Driveway approaches and sidewalk portions of driveways must be re-poured within 24 hours after removal. Residents at any driveway work location must have 24 hours notice prior to removing existing concrete. Residents must have reasonable access to the driveway area at all times.

Regular sidewalk panels that have been removed must be properly secured and re-poured within three (3) business days after removal. Sidewalk panels within one (1) mile of any school must be re-poured within 24 hours. All opened areas including areas with debris shall be barricaded at all times. No sidewalk panels shall be left open during Holidays or Holiday weekends.

Provide the new concrete with a neat broom finish and protect the new panels/sections from traffic and environmental effects until the area is suitable for traffic. Panels identified by the County's Representative not to be in compliance with the required broom-finish shall be removed and replaced at no additional cost to the County. Concrete edges must be straight and smooth, no sharp or rugged edges shall be allowed. No graffiti, coating, overlaying, exposed aggregates or surface repairs shall be allowed at any time.

TECHNICAL PROVISIONS

TP 522 – Concrete Sidewalks, 4 Inch and 6 Inch Thickness

When pedestrian traffic is impeded by work operations; barricades, restrictive tape or other approved restraints will be used to keep pedestrians from the work site.

Pedestrian ramps shall be constructed per F.D.O.T. "Standard Specifications for Road and Bridge Construction", latest edition unless otherwise specified on this contract or where authorized by the County's Representative.

Removal and construction of concrete curbs affected by ramp replacement or removed and replaced at the request of the County shall conform to the requirements of the FDOT "Standards Specifications", latest edition, except as authorized by the County Representative. Curb transitions (not associated to pedestrian ramps as specified above) and reconstructed curbs, regardless of type, will be paid as a separate line item.

Detectable surface mats shall be installed flush to the concrete; no gaps, lips or other defects shall be accepted. Deficiencies found shall be immediately corrected at no additional cost to the County.

No under-tolerances shall apply to the thickness of the required concrete for work to be performed under this contract. Areas determined not to be in compliance with the required uniform thickness shall be removed and replaced by the Contractor at no cost to the County.

Where 6-inch concrete has to be replaced due to cracks, it shall be replaced with a uniform thickness of 8-inch concrete covering no less than 40 square feet and extending to existing sawed contraction joints. Replacement concrete shall extend at least 3-inches beneath existing concrete at a minimum thickness of 3-inches.

Method of Measurement

Quantities measured for payment under this Section shall be the actual area in square yards of concrete constructed in place.

Basis of Payment

Concrete sidewalks including ramps, reconstructed sidewalks, walk around sidewalks, sidewalk landings, sidewalk curbs, detectable warning surfaces (armor tiled domes) and driveways will be paid for at the contract unit prices, completed and accepted. Payment shall constitute full compensation for all work described herein, and shall include all labor, equipment, materials, clearing and grubbing, excavation, grading, compaction, expansion material (asphalt impregnated), root removal, disposal of excess or waste, and all incidentals necessary to complete the work to the lines, grades, and thickness indicated on the plans. Includes construction of concrete curb cut ramps.

TECHNICAL PROVISIONS

TP 522 – Concrete Sidewalks, 4 Inch and 6 Inch Thickness

Subgrade preparation and additional concrete required for thickened slabs as indicated on the plans or as directed by the Engineer shall be included in the contract unit price for 6-inch Concrete Sidewalk.

Payment shall be made under:

Pay Item:

522-1	Concrete Sidewalk, 4" Thick	Per Square Yard
522-2	Concrete Sidewalk and Driveway, 6" Thick (for Driveways)	Per Square Yard

TECHNICAL PROVISIONS

TP 570 – Performance Turf

PERFORMANCE TURF

The Contractor shall establish a stand of grass in all areas designated on the plans and disturbed by construction in accordance with Chapter 15, Environmental Control, Article XVII, Fertilizer Management Ordinance of the Orange County Code; Sections 162 and 570 of the Standard Specifications, except as directed by the Engineer.

Work under this Section shall include all seeding, mulching, sodding, fertilizing and watering necessary to provide routine maintenance of the grassed area until the work is accepted by the Engineer.

There must be at least 90% coverage of healthy grass prior to acceptance by the Engineer. The Engineer, at any time, may require replanting of any areas in which the establishment of the grass stand does not appear to be developing satisfactorily.

The Contractor shall mow grassed areas twice monthly, or as required by the Engineer, until final acceptance of the work.

Seeding and Mulching

Grass seed shall be common Bermuda and Bahia. In addition, brown top-millet will be included during summer months and annual rye in the winter months. All seed shall meet the requirements of the State Department of Agriculture.

Sodding

Sodding shall be Bahia. It may be placed in rolls or as individual pieces. In established areas, replacement sod shall be of the same type as the existing sod, unless otherwise approved by the Engineer.

Fertilizers

Fertilize as necessary based on soil testing performed in accordance with Section 162. For fertilizer rates and application times follow Chapter 15 Environmental Control, Article XVII Fertilizer Management Ordinance of the Orange County Code.

Method of Measurement

Payment shall be calculated based on the quantity in square yards as specified in the completed and accepted plans. The cost of establishing grass in other areas disturbed by construction activities shall be borne by the Contractor.

TECHNICAL PROVISIONS

TP 570 – Performance Turf

Basis of Payment

Payment shall be paid for at the contract unit price per square yard. Payment shall constitute full compensation for furnishing all materials and completing all the work specified herein, including ground preparation, fertilizing, seeding, mulching, sodding, watering, mowing and complete maintenance of the grassed area until final completion and acceptance by the Engineer.

Payment shall be made under:

Pay Item:

570-1	Performance Turf, Sod	Per Square Yard

Pay Item Footnote No. 570-1
Includes the cost of pegging, fertilizer and water as required for establishment of permanent sodding. Sod placed on all slopes 1:3 or steeper shall be pegged. Also includes the cost of topsoil treatment on all permanent grass areas and mowing until the final project acceptance by the County.

TECHNICAL PROVISIONS

TP 900-1 – As-Built Plans

AS-BUILT PLANS

The As-Built Plans shall incorporate all the changes made to the red line As-Built plans. They shall show locations and elevations of paving, swales, ditches, pipe inverts and structures constructed and all relocated or reset property corners, section corners and 1/4 section corners.

Upon the completion of the project, the Contractor shall submit to the County the As-Built Plans as an electronic file in PDF format and three (3) sets of 11”x17” paper drawings with Statement of Certifications, certifying that the project was constructed according to the Construction Plans and Specifications, and that the AS BUILT PLANS are correct representation of what was constructed. The plans shall delineate all red line information contained on the As-Built Plans, and shall include a detailed sketch of the installed system including location of clean outs, measurement, GPS coordinates, locations of base repairs, etc. for the completed and accepted project.

The Contractor shall include the Statement of Certification on either the cover sheet certifying all of the sheets or certify each individual sheet. The Statement of Certifications shall be signed and sealed by a Professional Engineer and/or a Professional Surveyor and Mapper, both registered in the State of Florida.

Basis of Payment

Includes all efforts necessary for preparation of as-built (red-line) drawings showing approved deviations from plans and confirmed quantities to be used by engineer in the certification of as-built drawings.

As-Built Plans will be paid for at the contract lump sum price, completed and accepted.

Payment shall be made under:

Pay Item:		
900-1	As-Built Plans	Lump Sum

TECHNICAL PROVISIONS

TP 900-2 – Indemnification

INDEMNIFICATION

The Contractor shall indemnify, defend, and hold harmless the COUNTY and all its officers, agents, and employees, from all claims, losses, damages, costs, charges, or expenses arising out of any acts, action, neglect, or omission by the Contractor during the performance of the Contract, whether direct or indirect, and whether to any person or property to which the COUNTY or said parties may be subject, except that neither the Contractor nor any of its Subcontractors are liable under this Section for damages arising out of the injury or damage to persons or property directly caused or resulting from the sole negligence of the COUNTY or any of its officers, agents, or employees. The County sets a lump sum fee of $100 for indemnification.

Payment shall be made under:

Pay Item:		
900-2	Indemnification	Lump Sum ($100.00)

PART H
TECHNICAL PROVISIONS

for

PARK MANOR ESTATES SECTIONS 1-8
UNDERDRAIN IMPROVEMENTS
ORANGE COUNTY, FLORIDA

GEOTECHNICAL ENGINEERING REPORT

(Prepared by Devo Engineering)

GEOTECHNICAL INVESTIGATION AND DRAINAGE ASSESSMENT FOR..

PARK MANOR SUBDIVISION

PARK MANOR DRIVE, ORANGE COUNTY, FLORIDA
[SECTIONS 20, 21 & 29; TOWNSHIP 22 SOUTH; RANGE 31 EAST]

PARK MANOR SUBDIVISION

FEBRUARY 2016

Prepared by

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS

DEVO SEEREERAM, PH.D., P.E., LLC.
5500 ALHAMBRA DR., ORLANDO, FL-32808
PHONE: (407) 290-2371 - FAX: (407) 298-9011

Prepared for

Inwood consulting engineers

3000 Dovera Drive
Suite 200
Oviedo, Florida 32765

DEVO SEEREERAM, PH.D., P.E., LLC
CONSULTING GEOTECHNICAL ENGINEER
FLORIDA REGISTRATION NO. 48303

Geotechnical Engineering • Ground Water Modeling • Hydrogeologic/Geo-Environmental Engineering

5500 Alhambra Drive ❄ Orlando, Florida 32808 ❄ Phone: 407-290-2371 ❄ Fax: 407-298-9011

devo@devoeng.com | www.devoeng.com

Date: February 3, 2016 | *Devo's Project No.* 15-610.65

To:

INWOOD CONSULTING ENGINEERS, INC.
3000 Dovera Drive, Suite 200
Oviedo, FL 32765
phone: 407-971-8502; fax: 407-971-8955; ssommerfeldt@inwoodinc.com
attention: **STEVE SOMMERFELDT, P.E.**

Ref:
Geotechnical Investigation And Drainage Assessment For ...
PARK MANOR SUBDIVISION
Park Manor Drive, Orange County, Florida
[Section 20, 21, & 29, Township 22 South, Range 31 East]

Dear Mr. Sommerfeldt:

Attached is our geotechnical engineering report for the Park Manor Drainage Assessment Project.

Our site-specific geotechnical investigation included the drilling of eighty-five (85) hand auger borings, extraction of representative soil samples, installation of piezometers, measurements to the ground water table, inspection of the existing underdrains and observations of drainage issues following heavy rainfall events.

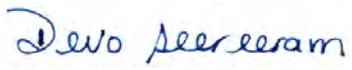
Included in this report are: ❶ our assessment of the geotechnical data, ❷ recommended location for new underdrains (as a minimum), and ❸ recommendations for cleaning, checking, and possible replacement of part of the existing underdrains based on these checks.

As a result of the presence of tannic ground water and associated ochre deposits noted in several areas, we have proposed a modified roadway underdrain detail to address the ochre problem.

We trust that the geotechnical data, evaluation, and recommendations communicated in this report are clear and responsive to the needs of Inwood and Orange County Public Works Department for this drainage retrofit project.

Please feel free to contact us if there are any questions or if any clarifications are needed.

Sincerely,



Devo Seereeram, Ph.D., P.E.
Florida Registration No. 48303
Date: February 3, 2016

TABLE OF CONTENTS

Page #

TABLE OF CONTENTS (CONTINUED)

Page #

List of Exhibits

List of Tables

TABLE OF CONTENTS (CONTINUED)

List of Attached Figures

Base Figures

Soil Profiles

Underdrain Layout and Details

List of Appendices

I.0 BACKGROUND INFORMATION

Orange County issued an emergency authorization to Inwood Consulting Engineers (Inwood) to investigate the observed drainage issues within the Park Manor subdivision and provide recommendations to rectify the root causes on an expedited basis. These services are required on a fast track basis since the street repaving project is about to commence and hence the need for the County to repair any underlying drainage before the resurfacing. The project boundaries are shown on an aerial image in Exhibit 1 and the highlighted roads ($\approx$ 10.5 miles) are to be evaluated to determine where underdrains and/or additional stormwater drainage inlets are required to alleviate the flooding issues. Structural assessment of the pavement itself was not included in this scope of work.

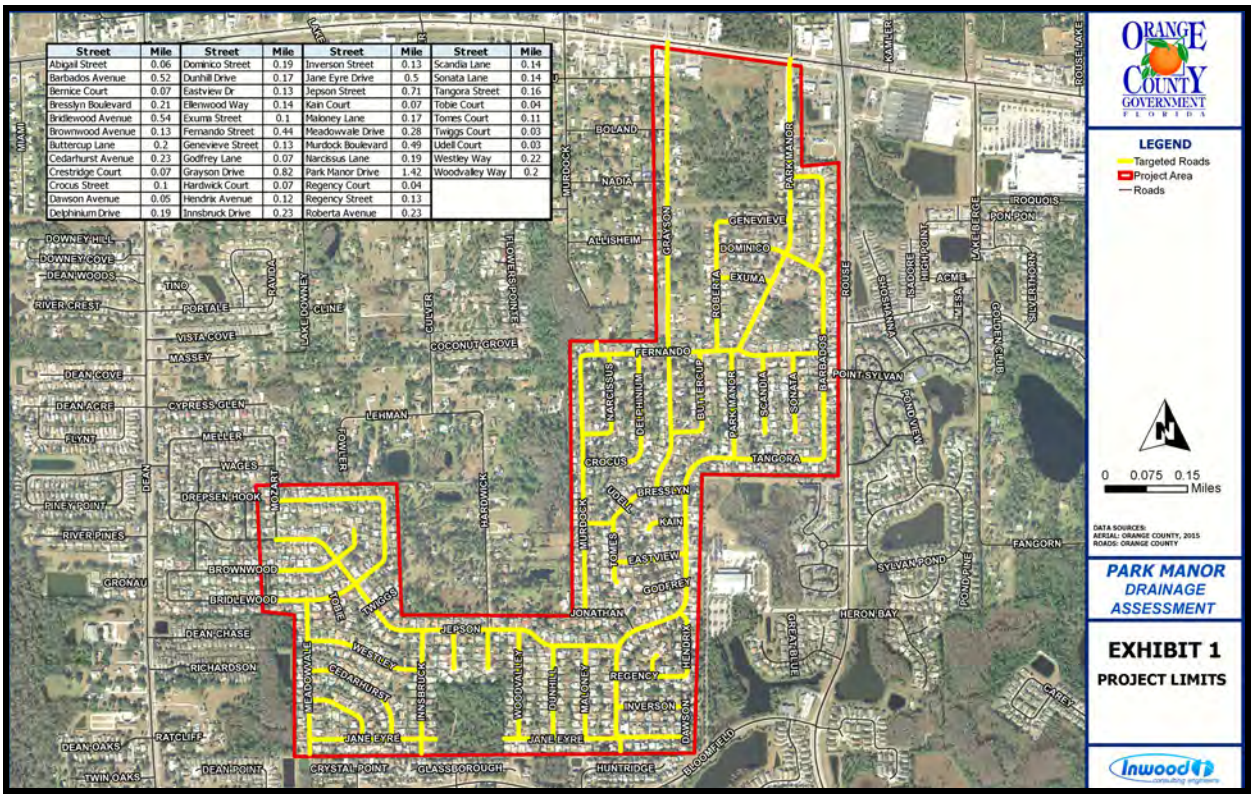


Exhibit 1. Park Manor Drainage Assessment - Study Limits

Inwood in turn requested that Devo Engineering provide the geotechnical engineering support services to provide data on perched water table and shallow subterranean soil conditions, which result in heavy seepage onto the pavement in certain parts of the subdivision.

Figure 1.1 (attached) shows the limits of the study area within Park Manor Subdivision on the USGS 7.5 minute series quadrangle map for Oviedo SW, Florida. As noted on Figure 1.1, the site lies within Sections 20, 21 & 29, Township 22 South, Range 31 East. According to information shown on the quadrangle map, the overall site is nearly level, but some areas are very gently sloping towards the east and southeast. Limited relative elevation surveys performed by Devo Engineering indicate that ground surface elevations at the test locations were typically in the range +65 ft to 80 ft NAVD.

Figure 1.2 shows the boundaries of the study area on a February 2015 aerial image. As noted on the image, the Park Manor Subdivision consists of single family lots and was predominantly built out. There is however, an undeveloped square section along Jane Eyre Drive between Innsbruck Drive and Woodvalley Way and some less dense areas in the northern part of the study area.

Exhibit 2 shows the historical wetlands which were impacted during the development of the subdivision and seepage in these areas are more prevalent since there is a natural tendency to re-establish their predevelopment flow paths following intense rainfall events. A magnified version of this image is shown with the site boundaries in Figure 1.2.a

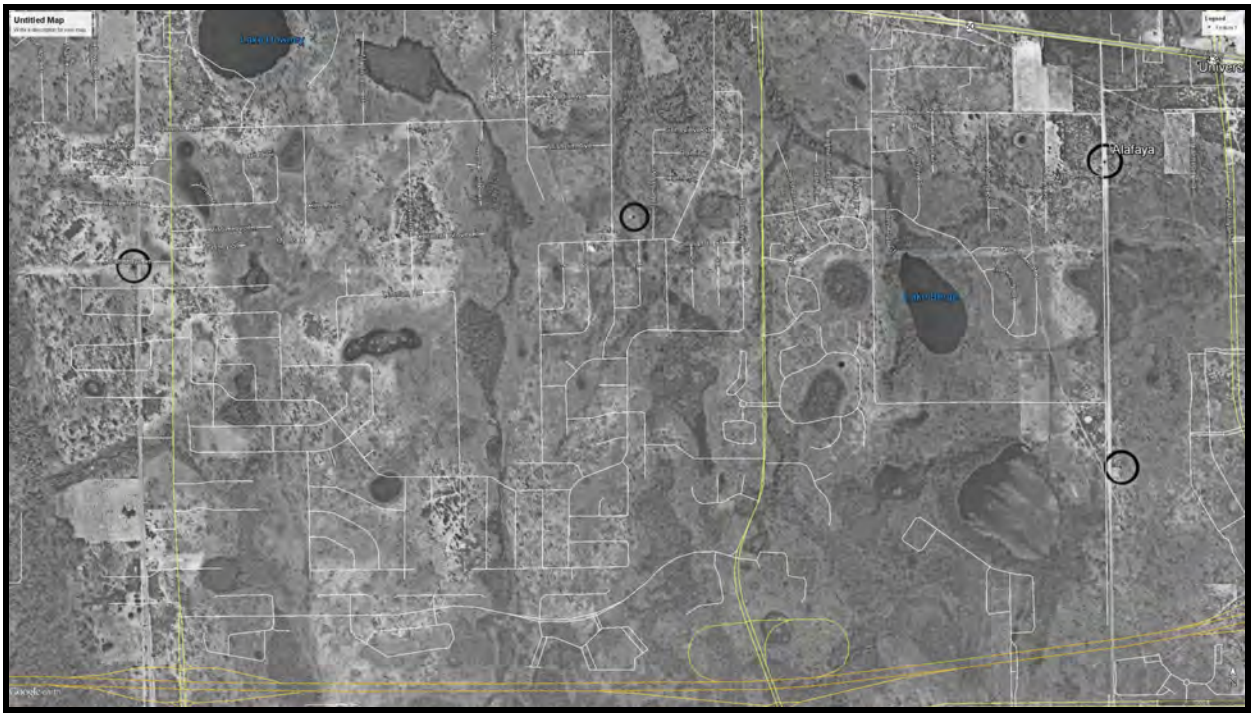


Exhibit 2. Park Manor and vicinity on 1947 Aerial Image. Note the wetland strands.

2.0 OBJECTIVES

The objectives of this investigation are as follows:

1. To provide geotechnical data at representative test locations within the subdivision, with a greater number of test locations in the critical and marginal zones as identified by Inwood.

2. To identify hydraulically restrictive zones within the subsoil strata which have a high propensity to create perched water table conditions.

3. To identify the true (or apparent) water table and the perched water table (if encountered) at each location on a depth below ground basis and provide estimates of the seasonal high conditions for long-term design.

4. To assess the flow rates and effectiveness of existing underdrains.

5. To provide recommended locations for new underdrains based on the soil and water table conditions disclosed during our intrusive exploration.

6. To provide an estimate of the typical baseflow that can be expected for the proposed underdrains based on grain size correlation.

We understand that Inwood will use this geotechnical data provided from this assessment to guide their designs of the roadway underdrains and positive stormwater conveyance to alleviate the flooding issues with the Park Manor Subdivision.

3.0 OBSERVATIONS FROM PRELIMINARY SITE VISIT

A senior engineer of our firm performed a preliminary site reconnaissance/inspection on September 22, 2015. This task included a drive-thru of the roadways and inspection for water table outcropping.

The following are the key observations/notes at the time of the inspection:

- The preliminary inspection was performed between the hours of 1:00 pm and 6:00 pm. There was no rainfall in the area prior to and during the visit on that day. Ambient conditions were dry and reasonably hot.

- Several of the roadway gutter drains showed wetness at the joints and in the adjacent landscaped areas, as shown on Figure 1.5. Selected photos of the wetness observed are included in Appendix A.

- The observed wetness was not prevalent through the entire study area, but within some localized sections.

- Given that the prevailing weather conditions were dry and reasonably hot during our inspection, it can be safely assumed that wet conditions immediately following an intense rainfall event would have been much more extensive.

- In many of the dry areas, there were signs of previous seepage and extensive rust colored stains on the driveways, walkways and roadway curb and gutters.

- The roadway landscaped areas are higher than the gutter, however in some cases it is mounded about a foot or more. Several of the yards are also highly mounded and it was in these areas that the groundwater daylighting problem was more prevalent, although seepage was also noted in some areas that were mounded very little.

- During the drive through, various types and severity of pavement distress were observed: These include, block cracking, longitudinal edge cracking, chicken wire cracking, pumping of base course, seepage (daylighting) though the roadway pavement, sidewalk slabs and adjacent driveways, numerous patches, etc.

- None of the pavement distress observed can be considered severe enough to adversely impact driveability at this time.

4.0 NRCS SOIL MAP UNITS

The Natural Resources Conservation Service (NRCS), an agency of the US Department of Agriculture, has mapped and published descriptions of the shallow soils (i.e., within 80 inches of land surface) in Orange County, Florida. In undeveloped areas (without the addition of impervious areas, the establishment of drainage systems, and/or site grading), the NRCS soil mapping is usually fairly reliable and it is good engineering practice to compare the published NRCS characterization data to the site-specific geotechnical data.

Figure 1.3 (attached) shows the limits of the study area with the Park Manor Subdivision overlaid on a NRCS web soils survey. This map is useful for detecting wetland areas which may contain surficial muck or poorly drained soils (i.e., highly corrosive soils). Review of this figure indicates that there are several NRCS soil map units within the road alignments. These soil map units are grouped according to their drainage characteristics as follows:

Moderately Well Drained Soils

- Pomello fine sand, 0 to 5 % slopes (#34).
- Pomello-Urban land complex, 0 to 5 % slopes (#35).

Somewhat Poorly Drained Soils

- Arents, nearly level (#1).
- Zolfo-Urban land complex (#55)

Poorly Drained Soils

- Ona-Urban land complex (#27).
- Smyrna fine sand (#44).
- Smyrna-Urban land complex (#45).

Very Poorly Drained Soils

- Basinger fine sand, depressional, 0 to 1 percent slopes (#3).

Pomello-Urban land complex, 0 to 5 % (#35) and Smyrna-Urban land complex (#45) are the dominant soil units being mapped in over 60% of streets within the study area. In these urban areas, the depth to the seasonal high water table depends on the functioning of the drainage system present.

In addition there are smaller areas mapped with Ona-Urban land complex (#27), Zolfo-Urban land complex (#55) and small isolated areas of Arents nearly level (#1), Basinger fine sand, depressional, 0 to 1 % slopes (#3). In urban areas #27 and #55, the depth to the seasonal high water table depends on the functioning of the drainage system present. Arents (#1) has a seasonal high water table that is at a depth of about 24 inches, while in Basinger fine sand (#3) the seasonal high water table can be as high as the ground surface.

Key characteristics of these NRCS soil map units are summarized in Tables 1 through 8, which follow.

Table 1. Key NRCS Data for Ona-Urban land complex (#27)

This complex consists of Ona soil that is nearly level and poorly drained and of areas of Urban land. This complex is on the flatwoods. In undrained areas, a seasonal high water table is within 10 inches of the surface for 1 month to 2 months. Drainage systems have been established in most areas. Depth to the high water table is dependent upon the functioning of the drainage system.		
Hydrologic Soil Group		B/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 3 in	Black fine sand	12 to 40 ft/day
3 - 16 in	Dark reddish brown fine sand	1.2 to 4 ft/day
16- 31 in	Gray fine sand	12 to 40 ft/day
31 - 80 in	Light gray fine sand	
Urban land		
0 - 80 in	n.a.	n.a.

Table 2. Key NRCS Data for Pomello fine sand, 0 to 5 percent slopes (#34)

This soil is nearly level to gently sloping and moderately well drained. It is on low ridges and knolls on the flatwoods. In most years, a seasonal high water table is at a depth of 24 to 40 inches for 1 month to 4 months and recedes to a depth of 40 to 60 inches during dry periods.		
Hydrologic Soil Group		C
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 3 in	Gray fine sand	> 40 ft/day
3 - 40 in	White fine sand	
40 - 48 in	Black fine sand	4 to 12.0 ft/day
48 - 55 in	Dark reddish brown fine sand	
55 - 80 in	Pale brown fine sand	12 to 40 ft/day

Table 3. Key NRCS Data for Pomello-Urban land complex (#35)

This complex consists of Pomello soil that is nearly level to gently sloping and moderately well drained and of areas of Urban land. This complex is on low ridges and knolls on the flatwoods.
This map unit consists of ≈ 53% Pomello soil, ≈ 40% Urban land, and ≈ 7% small areas of Archbold, Pompano, and Smyrna soils. The proportions and patterns of Pomello soil and Urban land are relatively consistent in most delineations of the map unit. The individual areas of the soils in this map unit are too mixed or too small to map separately at the scale used.
The Urban land part of this complex is covered by concrete, asphalt, buildings, or other impervious surfaces that obscure or alter the soils so that their identification is not feasible.
In most years, a seasonal high water table is at a depth of 24 to 40 inches for 1 month to 4 months and recedes to a depth of 40 to 60 inches during dry periods. Where drainage systems have been established, depth to the high water table is dependent upon the functioning of the drainage system.

Hydrologic Soil Group		C
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 5 in	Dark gray fine sand	> 40 ft/day
5 - 42 in	White fine sand	
42 - 48 in	Dark reddish brown fine sand	4 to 12.0 ft/day
48 - 54 in	Dark brown fine sand	
54 - 80 in	Light gray fine sand	12 to 40 ft/day

Table 4. Key NRCS Data for Smyrna fine sand (#44)

This soil is nearly level and poorly drained. It is on broad flatwoods. In most years, a seasonal high water table is within 10 inches of the surface for 1 month to 4 months. It recedes to a depth of 10 to 40 inches for more than 6 months.

Hydrologic Soil Group		B/D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 4 in	Black fine sand	12 to 40 ft/day
4 - 17 in	Gray fine sand	
17 - 22 in	Black fine sand	1.2 to 12 ft/day
22 - 27 in	Dark brown fine sand	
27 - 53 in	Pale brown fine sand	12 to 40 ft/day
53 - 80 in	Light gray fine sand	

Table 5. Key NRCS Data for Smyrna-Urban land complex (#45)

This complex consists of Smyrna soil that is nearly level and poorly drained and of areas of Urban land. This complex is on the flatwoods. In undrained areas, a seasonal high water table is within 10 inches of the surface for 1 month to 4 months. Drainage systems have been established in most areas. Depth to the high water table is dependent upon the functioning of the drainage system.		
Hydrologic Soil Group		B/D
Typical Soil Profile		
Smyrna fine sand		
Depth	Soil Color & Texture	Permeability
0 - 5 in	Black fine sand	12 to 40 ft/day
5 - 18 in	Light gray fine sand	
18 - 22 in	Black fine sand	1.2 to 12 ft/day
22 - 28 in	Dark brown fine sand	
28 - 50 in	Grayish brown fine sand	12 to 40 ft/day
50 - 80 in	Pale brown fine sand	
Urban land		
0 - 80 in	n.a.	n.a.

Table 6. Key NRCS Data for Zolfo-Urban land complex (#55)

This complex consists of ❶ Zolfo soil that is nearly level and somewhat poorly drained, and ❷ areas of Urban land. Zolfo soil is on broad, slightly higher positions adjacent to the flatwoods. In most years, a seasonal high water table is at a depth of 24 to 40 inches for 2 to 6 months. It is at a depth of 10 to 24 inches during periods of heavy rains. It recedes to a depth of about 60 inches during extended dry periods. The Urban land part of this complex is covered by concrete, asphalt, buildings, or other impervious surfaces that obscure or alter the soils so that their identification is not feasible.		
Hydrologic Soil Group		C
Typical Soil Profile for Zolfo soil		
Depth	Soil Color & Texture	Permeability
0 - 6 in	Dark grayish brown fine sand	12 to 40 ft/day
6 - 18 in	Brown fine sand	
18 - 42 in	Light brownish gray fine sand	
42 - 64 in	Very pale brown fine sand	
64 - 72 in	Brown fine sand	1.2 to 4 ft/day
72 - 80 in	Dark brown fine sand	

Table 7. Key NRCS Data for Arents, nearly level (#1)

Arents consists of material dug from several areas that have different kinds of soil. This fill material is the result of earth moving operations. This soil is used to fill such areas as sloughs, marshes, shallow depressions, swamps, and other low-lying areas above their natural ground levels during land-leveling operations; or it is used as a cover for sanitary landfills. The slopes are smooth to concave and range from 0 to 2 percent. Most soil properties are variable. A seasonal high water table varies with the amount of fill material and artificial drainage in any mapped area. In most years, a seasonal high water table is at a depth of 24 to 36 inches for 2 to 4 months. It recedes to a depth of about 60 inches or more during extended dry periods.

Table 8. Key NRCS Data for Basinger fine sand, depressional (#3)

This soil is nearly level and very poorly drained. It is in shallow depressions and sloughs and along the edges of freshwater marshes and swamps. Under natural conditions, the water table is above the surface for 6 to 9 months or more each year and is within 12 inches of the surface for the rest of the year.		
Hydrologic Soil Group		D
Typical Soil Profile		
Depth	Soil Color & Texture	Permeability
0 - 7 in	Black fine sand	12 to 40 ft/day
7 - 32 in	Gray fine sand	
32- 47 in	Dark brown and light brownish gray fine sand	
47 - 80 in	Pale brown fine sand	

5.0 GEOTECHNICAL FIELD AND LABORATORY TEST PROGRAMS

The following program of field and laboratory work was performed (refer to Figure 1.4 for test locations):

- ✎ Stake-out boring and core locations and call-in utility clearance.
- ✎ Prepare, submit, and obtain a right-of-way utilization permit.
- ✎ Compliance with the requirements of the approved right-of-way utilization permit.
- ✎ Visual inspection of the ground surface conditions along the landscaped areas directly adjacent to the roadway pavement.
- ✎ Drilling of eighty-five (85) hand auger borings within the roadside landscaped areas, to a depth of 7 ft below ground surface. These test locations are labeled HA-1 to HA-85 in Figure 1.4.
- ✎ Retrieval of selected soil samples from the boreholes and from the underdrain envelopes at selected locations within the existing underdrains. These locations are labeled P-1 to P-11 in Figure 1.4.
- ✎ Installation of piezometers in each borehole and measurement of depth to stabilized water table in each piezometer.
- ✎ Removal of the manhole covers and observation of the flow rates of existing underdrains. Actual flow rates were measured where practical and inspection for bacterial and other growth which may impede flow.
- ✎ Performed a relative elevation survey of the ground surface at the boring locations, where needed for our evaluation.
- ✎ Performed visual and tactile examination of the extracted soil samples.
- ✎ Performed approximately fifty (50) fines fraction and natural moisture content tests on selected soil samples.

Site reconnaissance, field observations, measurements and borings were conducted over the period, September 22 through to October 25, 2015. Note that the test locations were approximated in the field using available aerial maps, drawings and site features and the coordinates were subsequently recorded by a handheld GPS instrument.

6.0 SHALLOW SOIL AND WATER TABLE CONDITIONS

6.1 Presentation of Data

Boring locations, as well as underdrain filter sand sampling locations, are shown in Figure 1.4 (attached). Soil profiles for borings HA-1 to HA-85 are presented in Figures 2.01 to 2.17 (attached).

Water table depth measurements and laboratory test results (where applicable) are annotated adjacent to the soil profiles. Table 9 lists the measure depths to the ground water table at the test locations.

6.2 Shallow Soil Stratigraphy [Ref: Figures 2.01 to 2.17]

Approximately sixty-five percent of the 85 borings disclosed layers of fine sand through their 7 ft depth of exploration. The other borings generally disclosed surficial layers of fine sand, 0.5 ft to 3 ft thick, underlain by either slightly silty fine sand, silty fine sand, slightly clayey fine sand and clayey fine sands, 0.5 ft to 3 ft thick, and then layers of fine sands through to the 7 ft of exploration. However, some buried layers of sandy clay and some cemented sands, were disclosed at a few boring locations.

6.3 Water Table

The stabilized ground water table was encountered at depths ranging from, 0.7 ft to 3.7 ft, below the ground surface as summarized in Table 9. Note also that a perched water table was recorded on the actual date of drilling at locations HA-31, HA-39 & HA-73. The perched water table, where present, appeared to be due to the presence of shallow buried hydraulically restrictive soils. The ground water table quite shallow at several locations, some of which had underdrains. This implies that not all the underdrains are fully effective.

The water table altitude fluctuates seasonally due to short-term and long-term differences in rainfall and evapotranspiration. The stabilized water table measurements were recorded on October 19, 2015, which is at the onset of a dry period when the ground water table would have just started falling from seasonal high levels. The water table altitude is influenced by short-term and long-term rainfall deficits/surpluses and artificial recharge sources, such as landscape irrigation. Based on observations made during the site visits, quite a few homeowners irrigate their yards and the adjacent roadside landscaped areas. The degree of irrigation was observed to vary from sparse or none at all, to heavy and even excessive. Well water was understood to be major source of irrigation water in several properties and this was felt to be major reason for the high degree of curb staining observed in some areas.

The seasonal high water table is estimated to between the measured level and 0.5 ft above the measured level. These estimates were developed by reviewing the measured depths to the water table, the soil stratigraphy, NRCS soil survey, the antecedent rainfall and the site topography.

Table 9. Water Table Data				
Boring No.	Ground surface elevation * (ft NAVD)	Perched WT depth on date of drilling (ft)	Depth to stabilized water table 10-19-15 (ft NAVD)	Water table elevation 10-19-15 (ft NAVD)
HA-1	71.6	-	3.1	68.5
HA-2	73.5	-	2.8	70.7
HA-3	74.0	-	1.4	72.6
HA-4	75.4	-	2.0	73.4
HA-5	75.1	-	2.0	73.1
HA-6	73.8	-	1.3	72.5
HA-7	63.4	-	3.4	60.0
HA-8	66.6	-	3.7	62.9
HA-9	67.6	-	1.0	66.6
HA-10	68.5	-	1.3	67.2
HA-11	69.0	-	1.4	67.6
HA-12	69.4	-	1.9	67.5
HA-13	69.0	-	1.7	67.3
HA-14	72.3	-	2.1	70.2
HA-15	73.5	-	1.9	71.6
HA-16	76.5	-	3.6	72.9
HA-17	76.5	-	1.7	74.8
HA-18	78.6	-	2.2	76.4
HA-19	77.7	-	2.5	75.2
HA-20	65.7	-	3.4	62.3
HA-21	67.1	-	1.7	65.4
HA-22	67.5	-	1.1	66.4
HA-23	67.7	-	1.1	66.6
HA-24	68.8	-	0.7	68.1
HA-25	67.1	-	3.3	63.8
HA-26	67.8	-	1.6	66.2
HA-27	69.1	-	3.3	65.8
HA-28	68.8	-	2.3	66.5
HA-29	74.5	-	1.7	72.8
HA-30	75.0	-	2.1	72.9
HA-31	72.0	1.0	1.2	70.8
HA-32	68.7	-	2.2	66.5
HA-33	74.6	-	1.7	72.9
HA-34	75.8	-	2.0	73.8
HA-35	65.0	-	3.4	61.6
HA-36	77.7	-	2.7	75.0

Table 9. Water Table Data				
Boring No.	Ground surface elevation * (ft NAVD)	Perched WT depth on date of drilling (ft)	Depth to stabilized water table 10-19-15 (ft NAVD)	Water table elevation 10-19-15 (ft NAVD)
HA-37	74.9	-	1.7	73.2
HA-38	75.8	-	1.7	74.1
HA-39	78.0	2.0	2.6	75.4
HA-40	77.4	-	2.1	75.3
HA-41	80.0	-	2.7	77.3
HA-42	74.7	-	1.7	73.0
HA-43	76.0	-	1.2	74.8
HA-44	77.6	-	2.5	75.1
HA-45	72.6	-	1.2	71.4
HA-46	74.0	-	1.6	72.4
HA-47	68.6	-	2.4	66.2
HA-48	69.5	-	2.2	67.3
HA-49	76.3	-	1.4	74.9
HA-50	79.1	-	1.5	77.6
HA-51	80.3	-	2.0	78.3
HA-52	78.4	-	1.3	77.1
HA-53	76.3	-	1.3	75.0
HA-54	76.9	-	2.9	74.0
HA-55	76.2	-	2.3	73.9
HA-56	75.9	-	1.9	74.0
HA-57	76.1	-	1.1	75.0
HA-58	76.7	-	1.0	75.7
HA-59	77.8	-	1.5	76.3
HA-60	76.9	-	1.5	75.4
HA-61	76.3	-	2.4	73.9
HA-62	76.3	-	3.4	72.9
HA-63	74.8	-	2.8	72.0
HA-64	74.4	-	2.6	71.8
HA-65	79.7	-	2.8	76.9
HA-66	78.0	-	3.0	75.0
HA-67	75.7	-	2.5	73.2
HA-68	75.8	-	2.0	73.8
HA-69	77.7	-	2.4	75.3
HA-70	77.6	-	2.5	75.1
HA-71	76.5	-	1.4	75.1
HA-72	76.8	-	1.9	74.9

Table 9. Water Table Data				
Boring No.	Ground surface elevation * (ft NAVD)	Perched WT depth on date of drilling (ft)	Depth to stabilized water table 10-19-15 (ft NAVD)	Water table elevation 10-19-15 (ft NAVD)
HA-73	78.9	1.5	2.1	76.8
HA-74	79.3	-	1.0	78.3
HA-75	79.5	-	1.8	77.7
HA-76	80.0	-	3.3	76.7
HA-77	79.5	-	1.7	77.8
HA-78	78.6	-	1.7	76.9
HA-79	79.0	-	1.6	77.4
HA-80	77.9	-	3.6	74.3
HA-81	76.5	-	3.6	72.9
HA-82	77.5	-	2.3	75.2
HA-83	76.9	-	2.0	74.9
HA-84	79.6	-	2.2	77.4
HA-85	78.2	-	1.8	76.4

* Ground surface elevations were approximated based on a relative elevation survey and are not to be relied upon for detailed designs.

7.0 UNDERDRAIN INSPECTION

7.1 Underdrain Inspection

A visual inspection was performed on the outlets of the existing roadway underdrains. The underdrain locations are shown in Figure 1.5 (attached). Pertinent notes were recorded on the type of pipe, relative flow rate, algae and any other form of growth, bacterial or otherwise, that may inhibit flow. These were the key observations made with respect to the underdrains:

- ☞ The dominant pipe material was corrugated polyethylene, although rigid PVC and clay pipes were observed at a few locations. According to information received, the underdrains were installed 2010, however, the clay underdrain pipes present were of the type that have no longer been used in the industry for many years now, therefore, these are believed to have been installed many years prior to 2010.

- ☞ The underdrains generally appeared to be 6" diameter pipes, except that clay pipes were closer to 4" diameter.

- ☞ In most of the structures there was no standing water, thus allowing the incoming flows from the underdrain pipe to be clearly observed. However, at a few locations, the underdrain pipes were partially or fully submerged (due to standing water in the stormwater structure) and therefore, underdrain flow, if present, could not have been detected just by visual observations alone. Measurement of underdrain flow was practical at some locations, while at some other locations it was impractical (See Section 7.2).

- ☞ Flow rates ranged from a very slow trickle to a very rapid flow (equivalent to an open tap).

- ☞ Growth and/or deposits of what appeared to be iron bacterial growth, or some other related deposit, was present at the few underdrain outfalls, within the pipe and the area directly where the water was trickling down. Based on a review of several technical publications which we were able to research, the signs of growth at the ends of the underdrain pipes appear to be formations of *"ochre deposits"*. The topic, ochre deposits, is discussed separately in Section 8.0.

- ☞ The color of the underdrain flow was mostly clear. At one location however a slight green tinge was observed.

- ☞ While some underdrain cleanouts were easily visible, some were difficult to see and others where either buried or overgrown with sod and could not be found.

A tabular summary of the underdrain inspection observations and flow measurements is presented in Appendix "B".

7.2 Underdrain Flow Measurements

In addition, where practical to insert a collection device beneath the invert of the pipe, the flow rate was measured.

- ☞ The flow rates were measured, wherever practical. At some locations it was not possible to insert even a very shallow vessel beneath the underdrain pipe to catch the flow because the invert was too close to the base of the structure, or the projection through the structure wall was inadequate to permit a direct falling flow.

- ☞ Flow rates, where measured, ranged from 0.053 gpm to 4.76 gpm.

- ☞ The scope of the investigation did not include checking of the underdrain length, however, based on information provided to us by Inwood, we were able to estimate the lengths of the underdrain runs.

- ☞ Using the estimated length of the underdrain run and the measured flow rate we were able to calculate an average baseflow of 0.00022 gpm/linear foot to 0.0185 gpm/linear foot of underdrain.

Data collected from the flow measurements and estimates of the flow/unit length are also included in Appendix "B".

Although observations of the stormwater structures were not in our scope, during the underdrain observations, we had made some observations on some of the stormwater structures that are incidental to the underdrain inspection. These were the observations made:

- ☒ The penetration in the structure wall for the underdrain pipe was not properly sealed at several locations.

- ☒ Ground water seepage was observed coming from the soils surrounding the structures through joints in the riser segments and through improperly sealed underdrain penetrations.

- ☒ Ground water inflow, where present in structures, ranged in color from somewhat clear to a light rust brown stain.

- ☒ There was a rust brown stain on the internal walls at some manhole locations. In some cases there were just spots, while at other locations the staining was extensive.

7.3 Gradation Of Existing Underdrain Filter Material

Fine fraction tests were performed on samples of the existing underdrain filter material . The purpose of this was to check the suitability of gradation of the material, as excessive fines can inhibit underdrain effectiveness. A total of eleven (11) samples were retrieved from eleven (11) underdrain locations. The test results are summarized in Table 10. The results disclosed fines fraction contents ranging from 0.4% to 2.3%. Note that FDOT recommends a maximum of 2% fine fraction passing for underdrain filter material.

These values are generally within the acceptable limits, although somewhat exceeded at one location on Bresslyn Boulevard, where the FDOT fines fraction limit was exceeded by 0.3%.

Table 10. Fine Fraction Test Results On Underdrain Filter Material			
Street	Side	Sample Number	Fine fraction content
Murdock (north segment)	West	P-1	0.7%
Murdock (middle segment)	East	P-2	0.4%
Murdock (south segment)	West	P-3	0.8%
Bresslyn B'lvd. (west segment)	North	P-4	2.3%
Bresslyn B'lvd. (east segment)	South	P-5	1.1%
Scandia Lane	East	P-6	1.0%
Park Manor Drive (north segment)	East	P-7	0.5%
Park Manor Drive (north-middle segment)	West	P-8	0.7%
Park Manor Drive (middle segment)	East	P-9	1.0%
Park Manor Drive (south-middle segment)	West	P-10	0.7%
Park Manor Drive (south segment)	East	P-11	0.6%

FDOT recommends a maximum fine fraction of 2.0%

8.0 OVERVIEW ON OCHRE DEPOSITS IN SUBSURFACE DRAINS

8.1 Roadway Underdrain Design for Iron Ochre

In subsurface drains, there are four known types of sludge deposits that are associated with bacterial activity: ochre, manganese deposits, sulfur slime, and iron sulfide. Iron deposits, collectively named ochre, are the most serious and widespread. Ochre deposits and associated slimes are usually red, yellow, or tan in color. Ochre is filamentous (from bacterial filaments), amorphous (more than 90% water), and has a high iron content (2 to 65% dry wt.). It is a sticky mass combined with an organic matrix (2 to 50% dry wt.) that can clog drain entry slots, drain envelopes, filter fabric at trench interface, and the valleys of the corrugations between envelope and inlet slots.

A list of selected references on the subject is included at the end of this topic. Based on this literature review, there is no assured design method to completely eliminate iron ochre clogging issues in roadway subsurface drainage systems (a.k.a. underdrains). However, there are several design modifications which can mitigate the clogging impact. Most of the research on iron ochre clogging of subsurface drains (and methods to mitigate) emanates from Canadian universities (Quebec, British Columbia, etc.) and the University of Florida within USA, with a primary focus on agricultural drainage applications. Canadian, Dutch, and German research has also focused on the propensity of different types of filter fabrics to serve as conducive media for bacteria growth. Research has shown that the woven monofilament polypropylene fibers (700 µm is preferable over 450 µm) is least subject to clogging by iron ochre. It is therefore the fabric we recommend for use in the problematic underdrain sections {both @ pipe sock (if available) and the trench envelope}.

Exhibit 3.a to 3.d are from a presentation by Koerner (Feb 2012) which provides a ready synopsis of the iron ochre issue in highway applications.

2.2.4 Ferrous iron soils leading to "Ochre"

- Ochre is an orange substance rich in organic matter and high in iron oxides

Ochre Clogging Hazard Ranking

	Fe^{2+} content (mg/L)		Clogging Hazard
Ford (1982)	< 0.5 > 2.5		None Severe
	Fe^{2+} content (mg/L)		Clogging Hazard
	pH < 7	pH > 7	
Kuntze (1982)	< 0.5 0.1-1.0 1.0-3.0 3.0-6.0 > 6.0	< 1.0 1.0-3.0 3.0-6.0 6.0-9.0 > 90	None Slight Moderate Great Very Great
	Fe^{2+} content (mg/L)	Clogging Hazard	
Maslov, et al. (1975)	3-5 5-8 8-14 > 14	Slight Moderate Great Very Great	

Exhibit 3.a Identification of clogging hazard

Ochre deposition on geotextile filters

Ochre deposits in a highway underdrain pipe

Exhibit 3.b Photos of ochre deposits on pipe as well as on fabric

Exhibit 3.c shows the zone of fluctuating saturation at an underdrain pipe where conditions (moisture & oxygen) allow growth of iron ochre bacteria. If the soil were mostly dry or always inundated, the conditions will not allow growth of the bacteria so the focus is on the dynamic moisture zone. The soil matrix must contain iron producing bacteria and the soil must be sandy with hardpan type layers (dark reddish brown sands or organics). These conditions are typically found in east Orange County near or overlying wetlands and in zones with iron-rich hardpan. The ochre develops to maturity within a year after installation and then does not grow further as the iron source generally diminishes. However, if the underdrain is on a long slope with a good fetch of groundwater capture, the feed of iron-rich seepage can be extended for many years with continual regrowth.

Within this particular subdivision some of the existing underdrain runs are long and although it has been about three years since the majority of underdrains were installed, some ochre growth can likely continue.

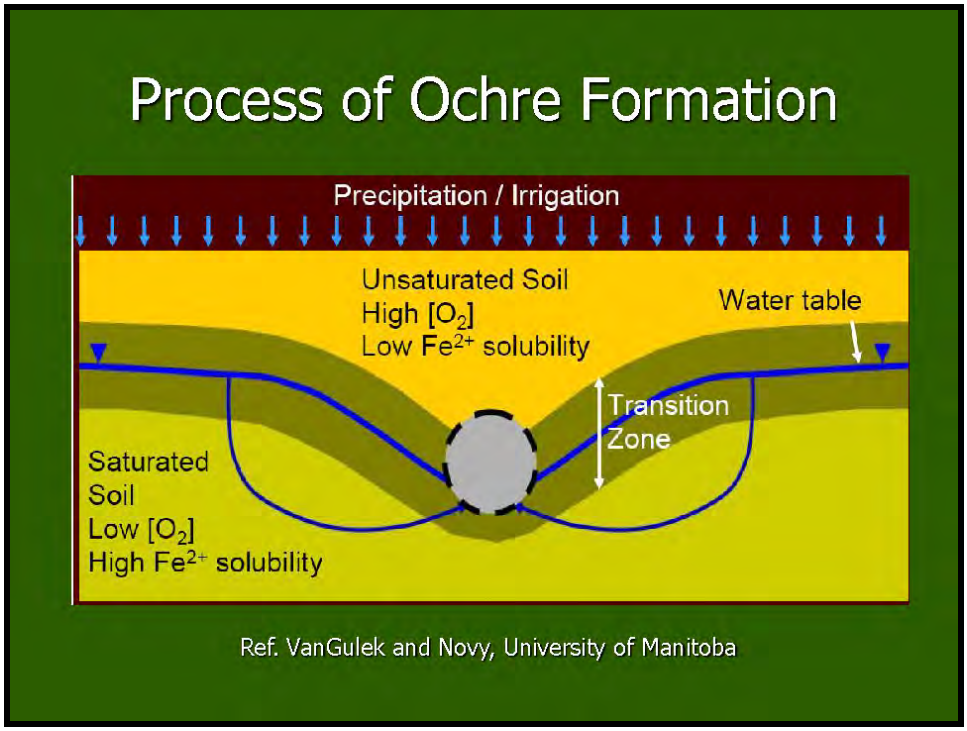


Exhibit 3.c Ochre formation process and zone of interest

8.2 Cleaning Of Underdrains Subject to Ochre Deposits

Jet cleaning the underdrains at the end of the first year following installation is recommended since the growth should be near maximum and still gelatinous enough to be pressure-washed off the pipe. Once the bacteria crystallizes, its harder to remove by jet cleaning. Some of the prevention/remedial measures are shown in Exhibit 3.d.

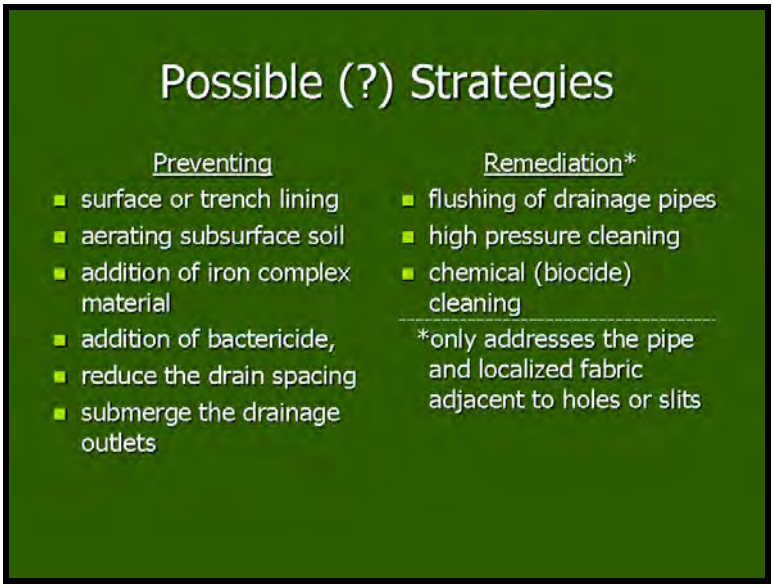


Exhibit 3.d Some remedial methods

9.0 ASSESSMENT AND RECOMMENDATIONS

9.1 General Assessment

Most of the borings disclosed layers of fine sand though their 7 ft depth of exploration. Several other borings disclosed buried layers of sand with varying amounts of silts and clays and the odd layer of cemented sand and sandy clay.

The stabilized ground water table was encountered at depths ranging from, 0.7 ft to 3.7 ft, below the ground surface as summarized in Table 9. Note also that a perched water table was recorded on the actual date of drilling at locations, HA-31, HA-39 & HA-73. The perched water table, where present, appeared to be due to the presence of shallow buried hydraulically restrictive soils.

Visual inspection of the roadway landscaped areas conducted 24 hrs after a rainy period ceased, disclosed areas of wetness and water seeping into roadside gutters. In addition, several of these areas were evidently still very saturated and quite soft. Historical aerial imagery shows that prior to the development of the subdivision, wetlands occupied certain portions of the site. These areas, even though backfilled, displayed elevated water table conditions.

Maintaining adequate separation between the pavement base course and the ground water table is critical to the life of a pavement. At several locations the ground water table was observed to be very shallow and is certain to impact the pavement base. In fact, during the drainage assessment, we observed pumping and flushing of basecourse material through cracks in several areas of roadway pavement as a result of high ground water conditions.

The recommended method of lowering the ground water table along the roadways within this subdivision is by the use of properly designed and constructed roadway underdrains.

Note that several segments of the existing roadway underdrains are ineffective in lowering the water table and would have to be repaired or replaced due to clogging of the filter fabric. The main reason the fabric usually clogs is because of the tannic water source providing food for the algae which likes to latch onto and grow on the fabric media.

New underdrains should be installed in all other areas where elevated ground water conditions are present.

9.2 Checks And Retrofit To Existing Underdrains And Stormwater Structures

Detailed description of the observations of the existing underdrains and flow measurements taken, are included in Figure 1.5. Based on the flow measurements, some underdrain segments may be underperforming and this can be due to a variety of reasons. It is difficult to pinpoint the precise reason or reasons that a particular segment may not be functioning properly. Following are recommendations for checking and improving underdrain performance:

1. Locate, expose and mark the locations of all cleanouts.

2. Cleanout/clear each segment of underdrain with a conventional vacuum truck. Note it is important to observe the water flow before and after to see whether there was any improvement with flow.

3. The particular segments that showed bacterial buildup and restrictive flow usually means the fabric also has algae growth. Consider the use of environmentally friendly chemical agents which can remove algae or other bacterial related growth for the underdrain. However, if this proves to be costly, replacement of the underdrain would be necessary.

4. Clean stormwater structures and remove any algae or bacterial build up from within.

5. The staining within the structure is due to high iron surficial aquifer groundwater seeping through the leaky joints. Breaches in the stormwater structures can also lead to soil loss and subsidence of the surrounding areas and adjacent pavements. Seal the joints in the risers of stormwater structure and the improperly reinstated penetrations for the underdrain pipes.

Note: the inset table in Figure 1.5 lists the underdrain runs with sluggish flow rates and these are recommended for cleaning **as a first trial**. The ochre-clogged zones to be replaced are those which fail to respond to cleaning in this first trial. There may be significant economic waste if it is assumed all of the slow flowing underdrains are clogged by iron ochre and have to be replaced so it is best to make this decision based on their response to cleaning.

9.3 Recommended Minimum New Underdrain Locations

Based on the seasonal high water table data obtained from the test locations, an inspection of the roadway landscaped areas, historical data and existing pavement section, new underdrains are recommended at the locations shown on Figure 3.1, as a minimum. However, in designing the system, the actual underdrain segments may have to extend beyond the limits shown when taking into consideration the location of existing stormwater structures and practicality of flow direction. In light of the presence of tannic water and the ochre deposits observed, the use of typical underdrains is not recommended. Rather, a specially recommended underdrain detail for use in areas of tannic water is presented in Figure 3.2.

For the purpose of sizing the storm water system, the contribution from the roadway underdrains can be estimated to be 0.0075 gpm/linear foot of installed drain, but this does not include any sheetflow that enters the underdrain system from above.

9.4 Special Underdrain Recommendation For Areas With High Tannic Seepage

Table 11 lists modifications (ranked by level of assuredness) to the standard pavement underdrain design, which we recommend for the zones showing high tannic seepage water and with evidence of underdrain clogging. Different options are presented on Table 11 ranging from the most assured commercial-grade design (for building foundations) to the standard roadway underdrain detail.

The key design modifications are as follows:

- ⇨ Use the 8" diameter pipe instead of the 6" diameter pipe since the former will be easier to jet clean (this size increase is not related to conveyance capacity). Jet cleaning runs should not extend more than 400 ft for equipment limitations.

- ⇨ If PVC pipe with circular perforations (fairly large) are used in a gravel envelope, there will be no need to place a filter fabric sock or wrap at that interface; the circular perforations will be less likely to clog than slit perforations or the perforations in standard HDPE underdrain pipe.

- ⇨ Use the woven polypropylene monofilament (700 µm fibers) filter fabric on the external trench wrap to reduce bacteria formation (FDOT Index 199 still applies).

- ⇨ Perform jet cleaning (400 psi at the nozzle) after 1 year and inspect again after 6 months for ochre buildup. Note that jet cleaning will be ineffective if the ochre ages and becomes crystalline so it is important to do the first cleaning at about 12 months.

Figure 3.2 shows the modified underdrain detail that is recommended for use in areas of tannic water.

Our review of historical aerial imagery disclosed that on this site, there were uplands, wetlands, and the in-between zones. The existing underdrains are not restricted to the historical wetland areas alone. Therefore, historical wetland cover alone cannot be used the criteria for predicting areas where underdrains might be potentially clog-prone (due to ochre deposits). Consequently, we recommend the special type of underdrain throughout the subdivision, with "Option 1" in Table 11 being the most assured option.

Table 11. Orange County Roadway Underdrain Design Matrix for Iron Ochre Control

Parameter	Underdrain Design Options Listed in Order of Assurance (1 is most assured)			
	1	2	3	4
Expected service life	25 to 30 yr for 8" pipe 10 to 15 yr for 6" pipe	15 to 20 yr for 8" pipe 8 to 10 yr for 6" pipe	8 to 12 yr for 8" pipe 6 to 8 yr for 6" pipe	1 to 5 yr (with maintenance) 1 yr (little or no maintenance)
Type of underdrain pipe	8" PVC with perforations (not slots which are more prone to clog); 8" diameter is preferred over 6" diameter to allow easier access for the jet cleaning tools; cleaning/jetting pressure of 400 psi at the nozzle is recommended for stability		8" HDPE underdrain; double wall to withstand jetting pressure; 8" diameter is preferred over 6" diameter to allow easier jet cleaning.	6" HDPE with non-woven sock (standard underdrains)
Type of filter around the pipe	none; as the circular perforations will be sized to keep the gravel out		woven fabric sock if available meeting requirements of trench filter fabric	non-woven (standard)
Trench backfill material	granite (#57)	limestone (#57); less suitable than granite but is allowed by some counties	FDOT 902.4 Sand (per Orange County roadway design)	
Trench surround filter fabric	woven geotextile, polypropylene monofilament with fiber diameter 700µm; no woven slit film fabric allowed Terratex EP-10 or Geotex 2 × 2 HF; this type of filter fabric is shown by experiments to be less prone to clogging from iron ochre; design per FDOT Index 199, Index No. 285 for gravel envelope and Index No. 286 for sand envelope			
Sand above trench envelope filter wrap, under sod	fine sand with less than 7% passing the US#200 sieve **and** minimum remolded permeability of 7 ft/day			
Scheduled Maintenance after installation	jet cleaning, 400 psi must be performed within 6 to 12 month of installation when most ochre buildup occurs. Drain cleaning provisions should be installed in such a way that the drains can be cleaned in an upstream or rising grade direction			
Anticipated Maintenance Frequency After First Year	every 10^{+} yr for 8" pipe every 5 yr for 6" pipe	every 8^{+} yr for 8" pipe every 3 to 5 yr for 6" pipe	every 5 yr for 8" pipe every 3 yr for 6" pipe	every 2 years
Cleanouts for jet cleaning	design such that the spacing is not more than 400 ft (or at bends) to facilitate jet cleaning			

10.0 LIST OF REFERENCES

Gameda S., Jutras P.J., and Broughton R.S. July 1982. *"Ochre In Subsurface Drains In A Quebec Fine Sandy Soil"*. Canadian Agricultural Engineering Journal, Vol. 25, No. 2, Winter 1983

Bryant R. January 1988. *"Iron Ochre Problems in Agricultural Drains."* Drainage Factsheet, Order No. 543.300-1, British Columbia Ministry of Agriculture and Food

Bryant R.G and Shaw K. January 1988. *"Iron Ochre Control Methods"*. Drainage Factsheet, Order No. 543.300-2, British Columbia Ministry of Agriculture and Food

Ford H.W., January 1993 (reviewed December 2005). *"Iron Ochre and Related Sludge Deposits In Subsurface Drain Lines"*. UF/IFAS Extension, Circular 671, University of Florida

de Mendonca B., Marcos E., Mauricio C., and Magali C. July 2003. *"Conditioning Factors of Iron Ochre Biofilm Formation on Geotextile Filters"*. Canadian Geotechnical Journal, Vol. 40, p. 1225-1234

Stuyt, Dierickx, and Beltrán. 2005. "*Materials for subsurface land drainage systems*". Food and Agriculture Organization of the United Nations Rome, 2005. FAO Irrigation and Drainage Paper 60 Rev. 1

Lee S. and Phillippe L. Bordeau. May 2006. *"Filter Performance and Design for Highway Drains"*. Technical Summary, Publication No.: FHWA/IN/JTRP-2005/1, SPR-2635, Purdue University.

New Jersey NRCS. March 2007, *"Subsurface Drainage"*. Water Management Guide, Chapter 3, Part NJ650.14,

New Jersey NRCS. July 2007. *"Interception Drainage"*. Water Management Guide, Chapter 4, Part NJ650.14, NRCS

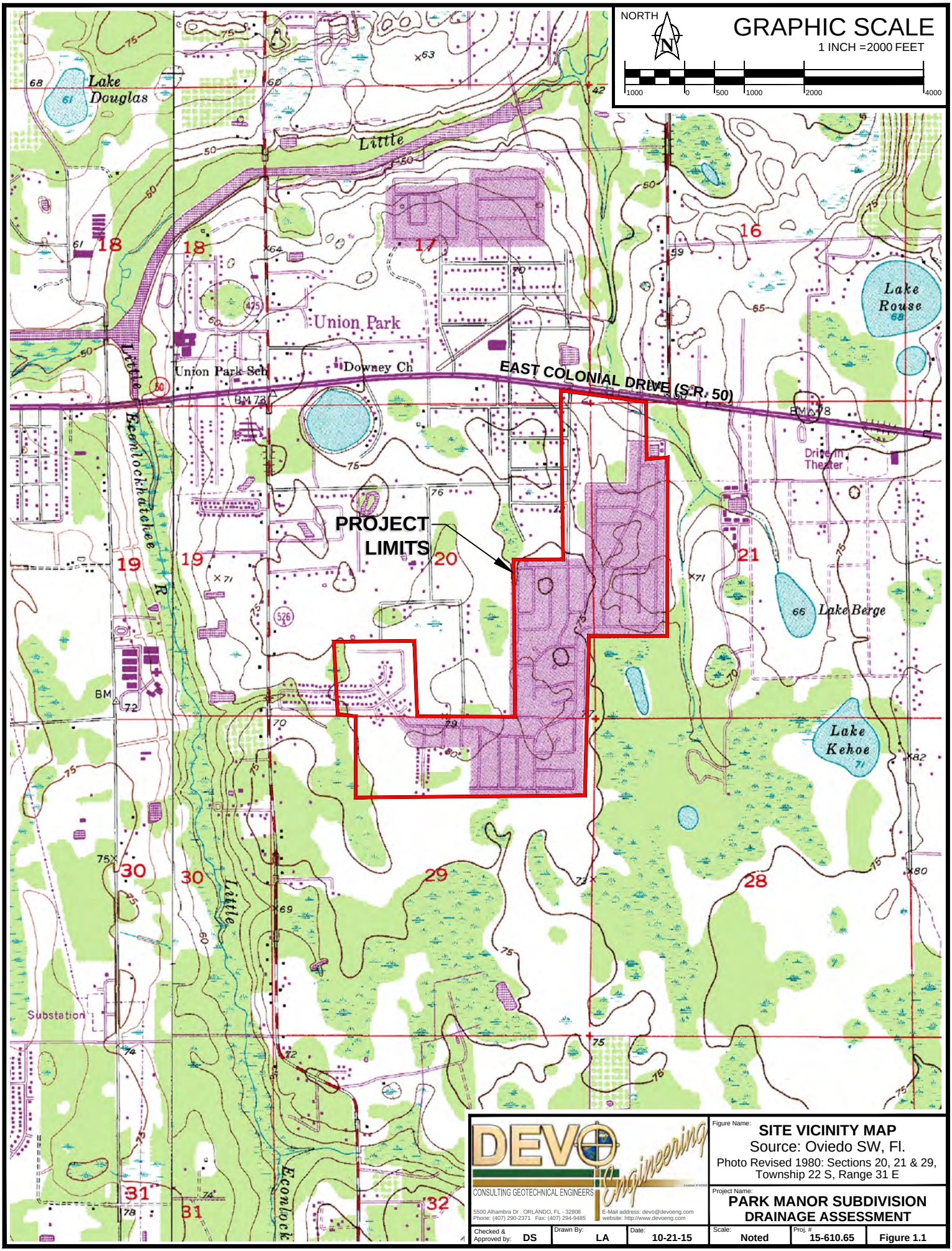
NRCS. September 2011, *"Subsurface Drain"*. Natural Resources Conservation Service Conservation Practice Standard, Code 606

Koerner, Robert. February 2012. "*Geotextile Filter Failures*". Presentation at the National Dam Safety Technical Seminar #19 "Filters, Drains, and Geotextiles in Dams and Levees" held February 22 - 23, 2012 at FEMA's Emergency Management Institute in Emmitsburg, MD

Ruark, Matt, Cooley, Eric, Panuska, John, Pagel, Joe. August 2013. *"Understanding and Locating Tile "Drainage Systems"*. Tile Drainage in Wisconsin, UW-Discovery Farms Office

Boman, Brian J., Tucker, D.P.H. June 2015. *"Drainage Systems for Flatwoods Citrus in Florida"*. UF/IFAS Extension, Circular 1412, University of Florida

FIGURES

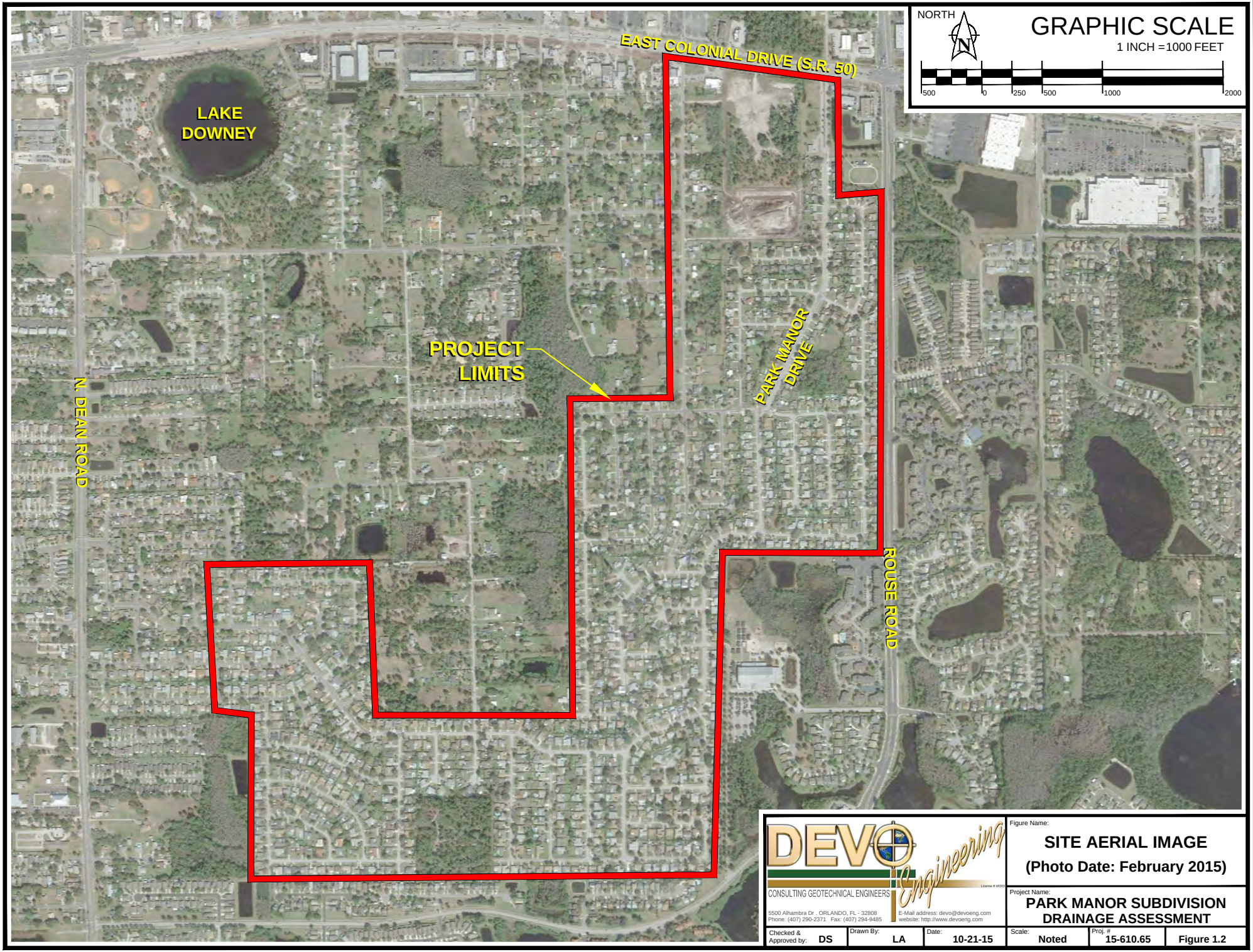


DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 290-2371 Fax: (407) 294-9485
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name: **SITE VICINITY MAP**
Source: Oviedo SW, Fl.
Photo Revised 1980: Sections 20, 21 & 29, Township 22 S, Range 31 E

Project Name: **PARK MANOR SUBDIVISION DRAINAGE ASSESSMENT**

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	LA	10-21-15	Noted	15-610.65	Figure 1.1

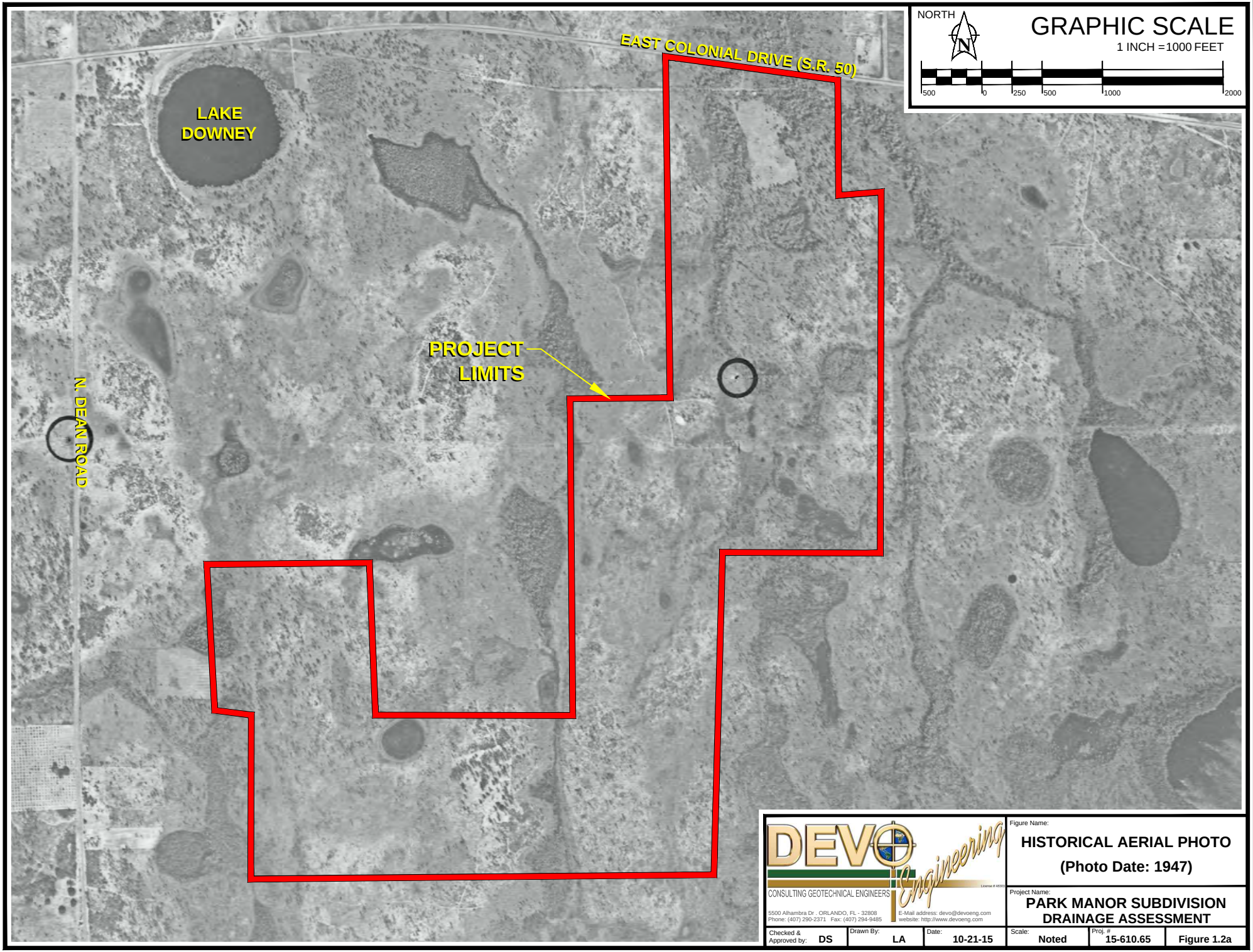


DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
License # 49727
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 290-2371 Fax: (407) 294-9485
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
SITE AERIAL IMAGE
(Photo Date: February 2015)

Project Name:
PARK MANOR SUBDIVISION
DRAINAGE ASSESSMENT

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	LA	10-21-15	Noted	15-610.65	Figure 1.2



NORTH

GRAPHIC SCALE

1 INCH = 1000 FEET

500 0 250 500 1000 2000

DEVO Engineering

CONSULTING GEOTECHNICAL ENGINEERS

5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 290-2371 Fax: (407) 294-9485

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

Figure Name:

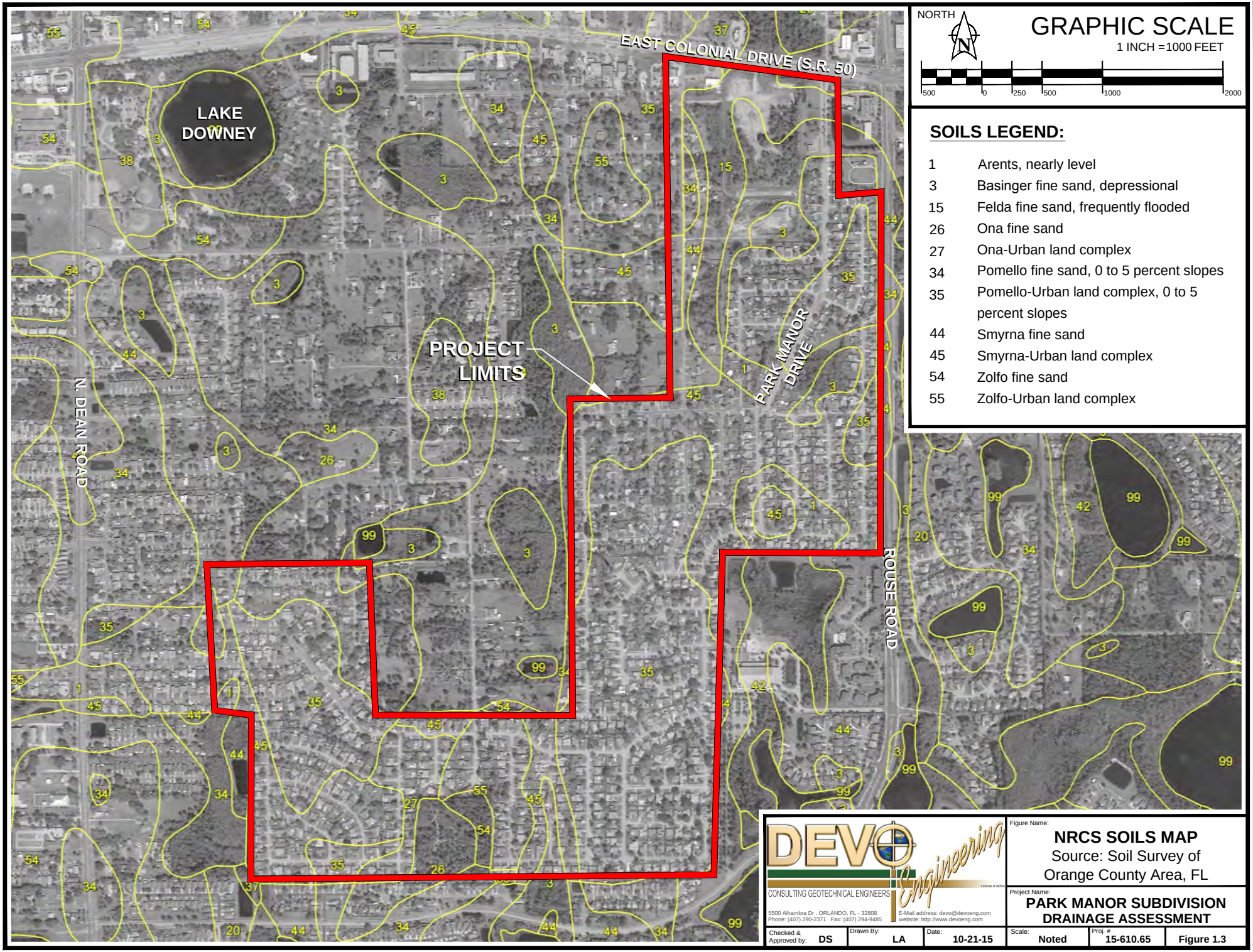
HISTORICAL AERIAL PHOTO

(Photo Date: 1947)

Project Name:

PARK MANOR SUBDIVISION
DRAINAGE ASSESSMENT

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	LA	10-21-15	Noted	15-610.65	Figure 1.2a



NORTH

GRAPHIC SCALE

1 INCH = 1000 FEET

500 0 250 500 1000 2000

SOILS LEGEND:

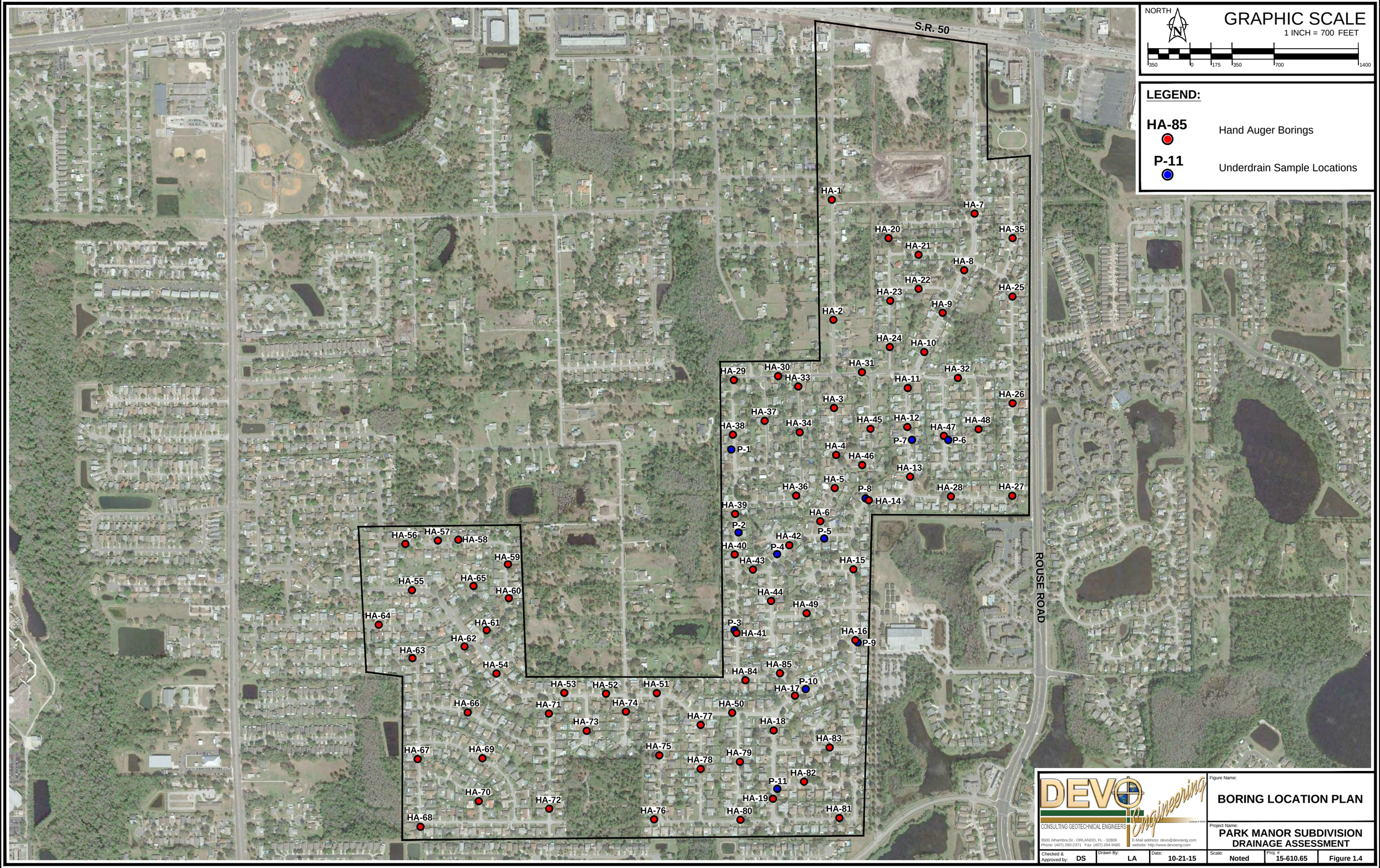
1	Arents, nearly level
3	Basinger fine sand, depressional
15	Felda fine sand, frequently flooded
26	Ona fine sand
27	Ona-Urban land complex
34	Pomello fine sand, 0 to 5 percent slopes
35	Pomello-Urban land complex, 0 to 5 percent slopes
44	Smyrna fine sand
45	Smyrna-Urban land complex
54	Zolfo fine sand
55	Zolfo-Urban land complex

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
License # 4923
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 290-2371 Fax: (407) 294-9485
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
NRCS SOILS MAP
Source: Soil Survey of Orange County Area, FL

Project Name:
PARK MANOR SUBDIVISION
DRAINAGE ASSESSMENT

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	LA	10-21-15	Noted	15-610.65	Figure 1.3



NORTH

GRAPHIC SCALE

1 INCH = 700 FEET

350 0 175 350 700 1400

LEGEND:

HA-85	Hand Auger Borings
P-11	Underdrain Sample Locations

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
License # 8312
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 290-2371 Fax: (407) 294-9485
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name: **BORING LOCATION PLAN**

Project Name: **PARK MANOR SUBDIVISION DRAINAGE ASSESSMENT**

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	LA	10-21-15	Noted	15-610.65	Figure 1.4

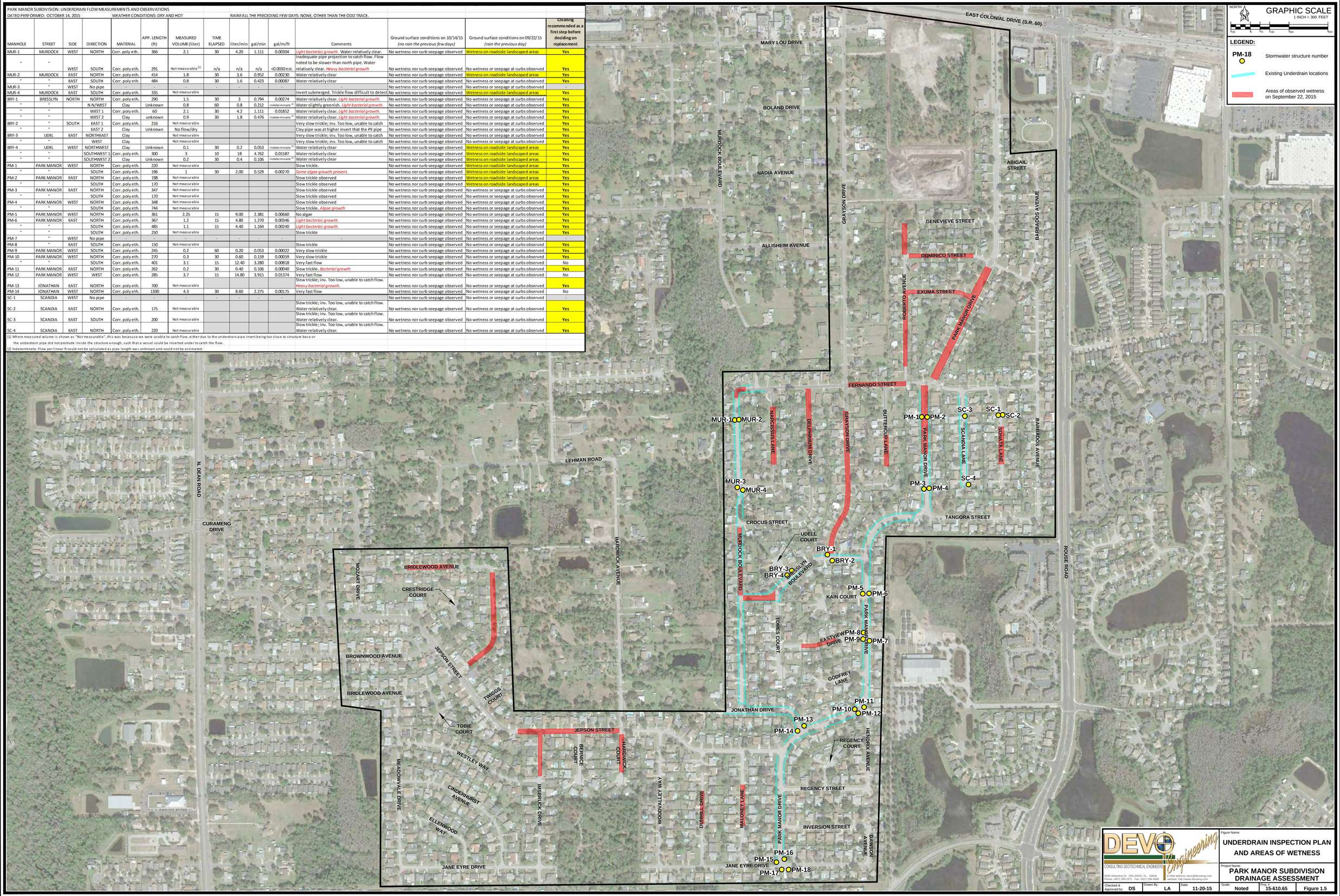
PARK MANOR SUBDIVISION: UNDERDRAIN FLOW MEASUREMENTS AND OBSERVATIONS

DATED PERFORMED: OCTOBER 14, 2015 | WEATHER CONDITIONS: DRY AND HOT | RAINFALL THE PRECEDING FEW DAYS: NONE, OTHER THAN THE ODD TRACE.

MANHOLE	STREET	SIDE	DIRECTION	MATERIAL	APP. LENGTH (ft)	MEASURED VOLUME (liter)	TIME ELAPSED	liter/min	gal/min	gal/m/ft	Comments	Ground surface conditions on 10/14/15 *(no rain the previous few days)*	Ground surface conditions on 09/22/15 *(rain the previous day)*	Cleaning recommended as a first step before deciding on replacement
MUR-1	MURDOCK	WEST	NORTH	Corr. poly eth.	366	2.1	30	4.20	1.111	0.00304	*Light bacterial growth.* Water relatively clear.	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
"	"	WEST	SOUTH	Corr. poly eth.	291	Not measurable [1]	n/a	n/a	n/a	<0.0030 est.	Inadequate pipe projection to catch flow. Flow noted to be slower than north pipe. Water relatively clear. *Heavy bacterial growth*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
MUR-2	MURDOCK	EAST	NORTH	Corr. poly eth.	414	1.8	30	3.6	0.952	0.00230	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
"	"	EAST	SOUTH	Corr. poly eth.	484	0.8	30	1.6	0.423	0.00087	Water relatively clear	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
MUR-3	"	WEST	No pipe	-	-	-	-	-	-	-	-	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	-
MUR-4	MURDOCK	EAST	SOUTH	Corr. poly eth.	335	Not measurable					Invert submerged. Trickle flow difficult to detect	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
BRY-1	BRESSLYN	NORTH	NORTH	Corr. poly eth.	290	1.5	30	3	0.794	0.00274	Water relatively clear. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		N N/WEST	Clay	Unknown	0.8	60	0.8	0.212	indeterminate [2]	Water slightly greenish. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		WEST 1	Corr. poly eth.	60	2.1	30	4.2	1.111	0.01852	Water relatively clear. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		WEST 2	Clay	unknown	0.9	30	1.8	0.476	indeterminate [2]	Water relatively clear. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
BRY-2	"	SOUTH	EAST 1	Corr. poly eth.	216	Not measurable					Very slow trickle; inv. Too low, unable to catch	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		EAST 2	Clay	Unknown	No flow/dry					Clay pipe was at higher invert that the PE pipe	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
BRY-3	UDEL	EAST	NORTHEAST	Clay		Not measurable					Very slow trickle; inv. Too low, unable to catch	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		WEST	Clay		Not measurable					Very slow trickle; inv. Too low, unable to catch	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
BRY-4	UDEL	WEST	NORTHWEST	Clay	Unknown	0.1	30	0.2	0.053	indeterminate [2]	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
"	"		SOUTHWEST 1	Corr. poly eth.	300	3	10	18	4.762	0.01587	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
"	"		SOUTHWEST 2	Clay	Unknown	0.2	30	0.4	0.106	indeterminate [2]	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
PM-1	PARK MANOR	WEST	NORTH	Corr. poly eth.	220	Not measurable					Slow trickle.	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
"	"		SOUTH	Corr. poly eth.	196	1	30	2.00	0.529	0.00270	*Some algae growth present.*	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
PM-2	PARK MANOR	EAST	NORTH	Corr. poly eth.	198	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
"	"		SOUTH	Corr. poly eth.	170	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	Yes
PM-3	PARK MANOR	EAST	NORTH	Corr. poly eth.	347	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		SOUTH	Corr. poly eth.	170	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-4	PARK MANOR	WEST	NORTH	Corr. poly eth.	348	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		SOUTH	Corr. poly eth.	744	Not measurable					Slow trickle. *Algae growth*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-5	PARK MANOR	WEST	NORTH	Corr. poly eth.	361	2.25	15	9.00	2.381	0.00660	No algae	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-6	PARK MANOR	EAST	NORTH	Corr. poly eth.	367	1.2	15	4.80	1.270	0.00346	*Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		SOUTH	Corr. poly eth.	485	1.1	15	4.40	1.164	0.00240	*Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		SOUTH	Corr. poly eth.	250	Not measurable					Slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-7	"	WEST	No pipe	-	-	-	-	-	-	-	-	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	-
PM-8	"	EAST	SOUTH	Corr. poly eth.	150	Not measurable					Slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-9	PARK MANOR	WEST	SOUTH	Corr. poly eth.	245	0.2	60	0.20	0.053	0.00022	Very slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-10	PARK MANOR	WEST	NORTH	Corr. poly eth.	270	0.3	30	0.60	0.159	0.00059	Very slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
"	"		SOUTH	Corr. poly eth.	401	3.1	15	12.40	3.280	0.00818	Very fast flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	No
PM-11	PARK MANOR	EAST	NORTH	Corr. poly eth.	262	0.2	30	0.40	0.106	0.00040	Slow trickle. *Bacterial growth*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-12	PARK MANOR	WEST	WEST	Corr. poly eth.	285	3.7	15	14.80	3.915	0.01374	Very fast flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	No
PM-13	JONATHAN	EAST	NORTH	Corr. poly eth.	700	Not measurable					Slow trickle; inv. Too low, unable to catch flow. *Heavy bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
PM-14	JONATHAN	WEST	NORTH	Corr. poly eth.	1300	4.3	30	8.60	2.275	0.00175	Very fast flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	No
SC-1	SCANDIA	WEST	No pipe	-	-	-	-	-	-	-	-	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	-
SC-2	SCANDIA	EAST	NORTH	Corr. poly eth.	175	Not measurable					Slow trickle; inv. Too low, unable to catch flow. Water relatively clear.	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
SC-3	SCANDIA	EAST	SOUTH	Corr. poly eth.	200	Not measurable					Slow trickle; inv. Too low, unable to catch flow. Water relatively clear.	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes
SC-4	SCANDIA	EAST	NORTH	Corr. poly eth.	220	Not measurable					Slow trickle; inv. Too low, unable to catch flow. Water relatively clear.	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	Yes

(1) Where measured volume is shown as "Not measurable", this was because we were unable to catch flow, either due to the underdrain pipe invert being too close to structure base or the underdrain pipe did not protrude inside the structure enough, such that a vessel could be inserted under to catch the flow.

(2) Indeterminate: Flow per linear ft could not be calculated as pipe length was unknown and could not be estimated.

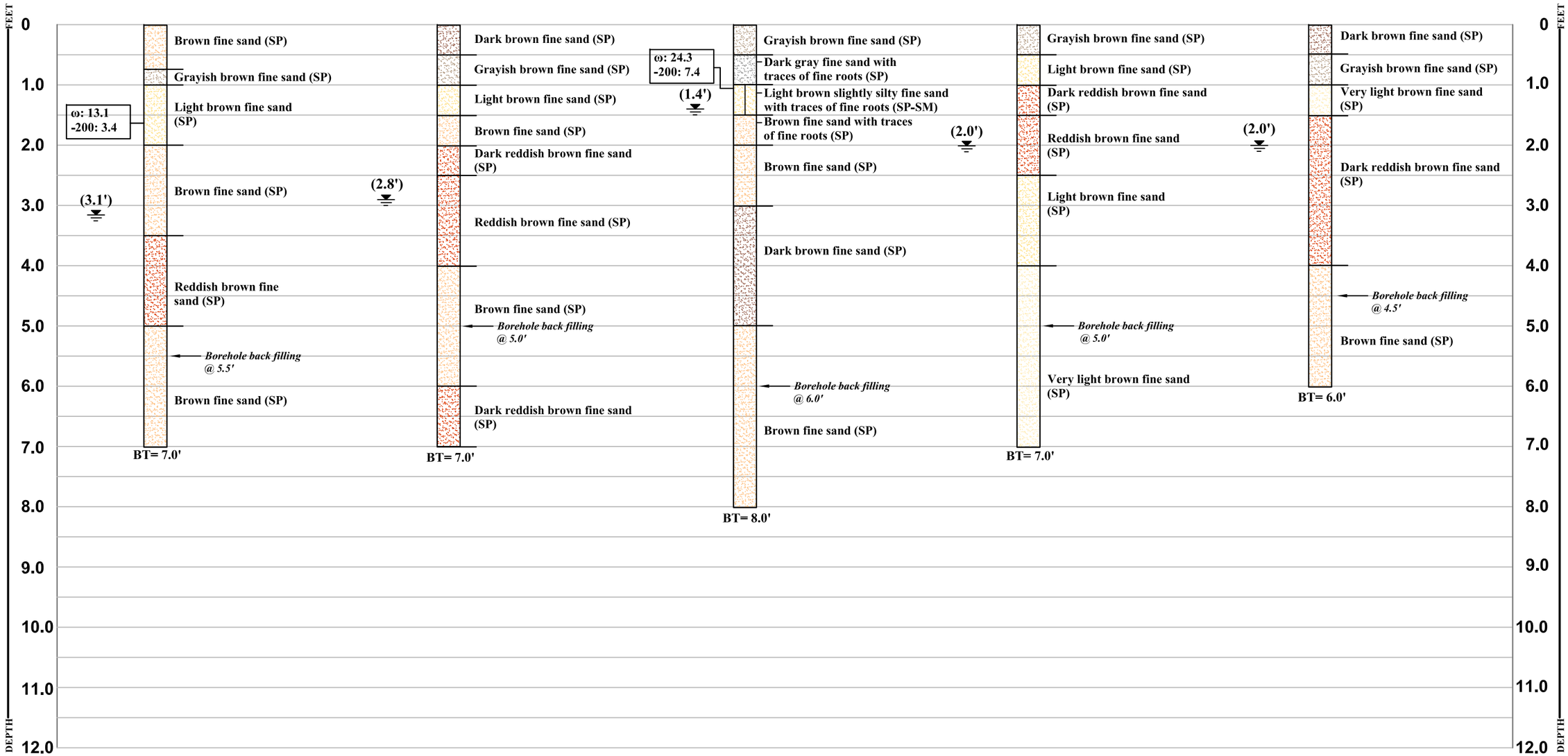


DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
16100 Alhambra Dr. ORLANDO, FL - 32808
Phone: (407) 290-2371 Fax: (407) 294-8405
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name: **UNDERDRAIN INSPECTION PLAN AND AREAS OF WETNESS**

Project Name: **PARK MANOR SUBDIVISION DRAINAGE ASSESSMENT**

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	LA	11-20-15	Noted	15-610.65	Figure 1.5



LEGEND

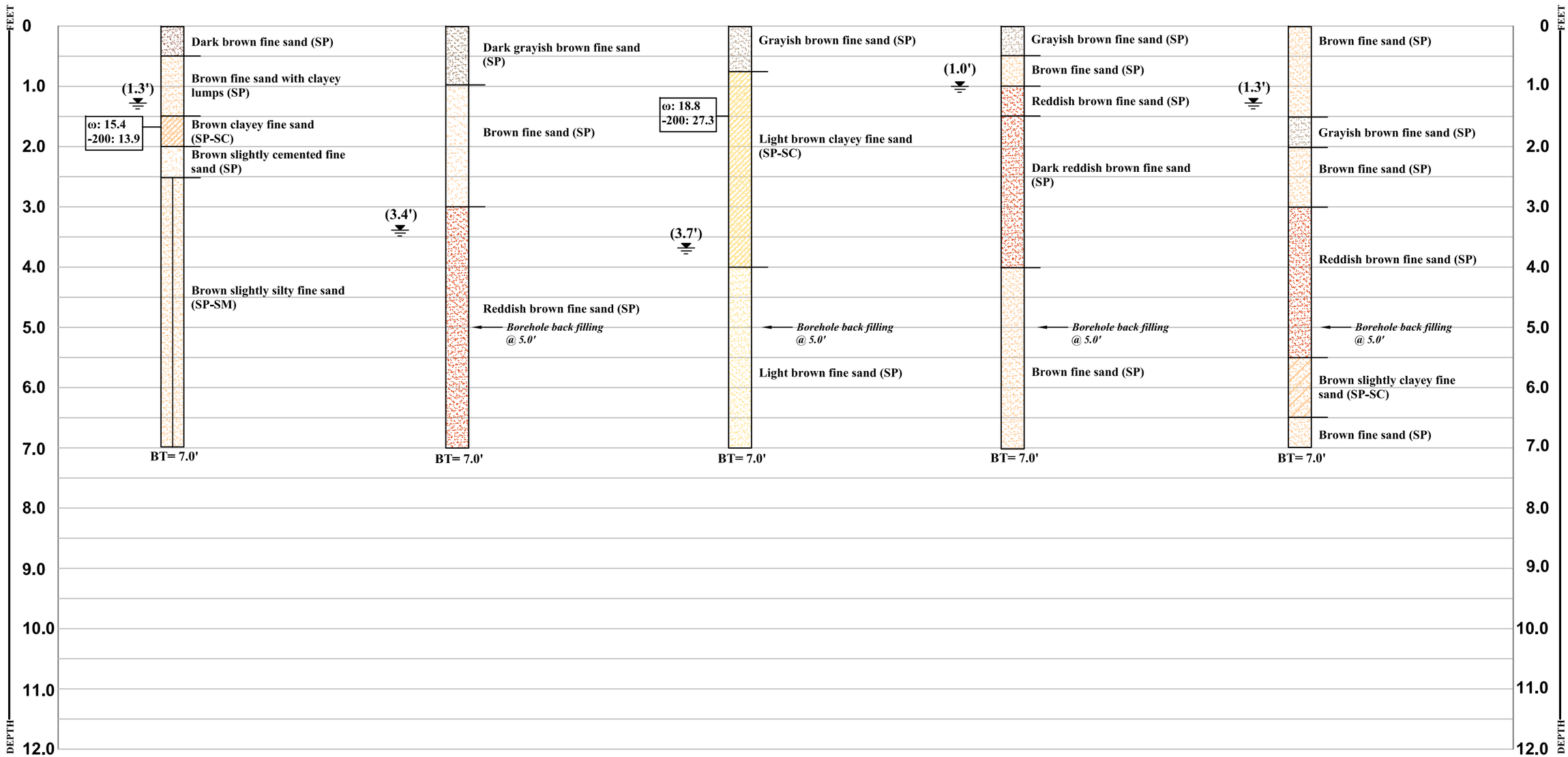
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
B.T	BORING TERMINATION DEPTH IN FEET
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

Figure Name:
SOIL PROFILES FOR BORINGS HA-1 TO HA-5

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-01-15	Noted	15-610.65	Figure 2.01



LEGEND

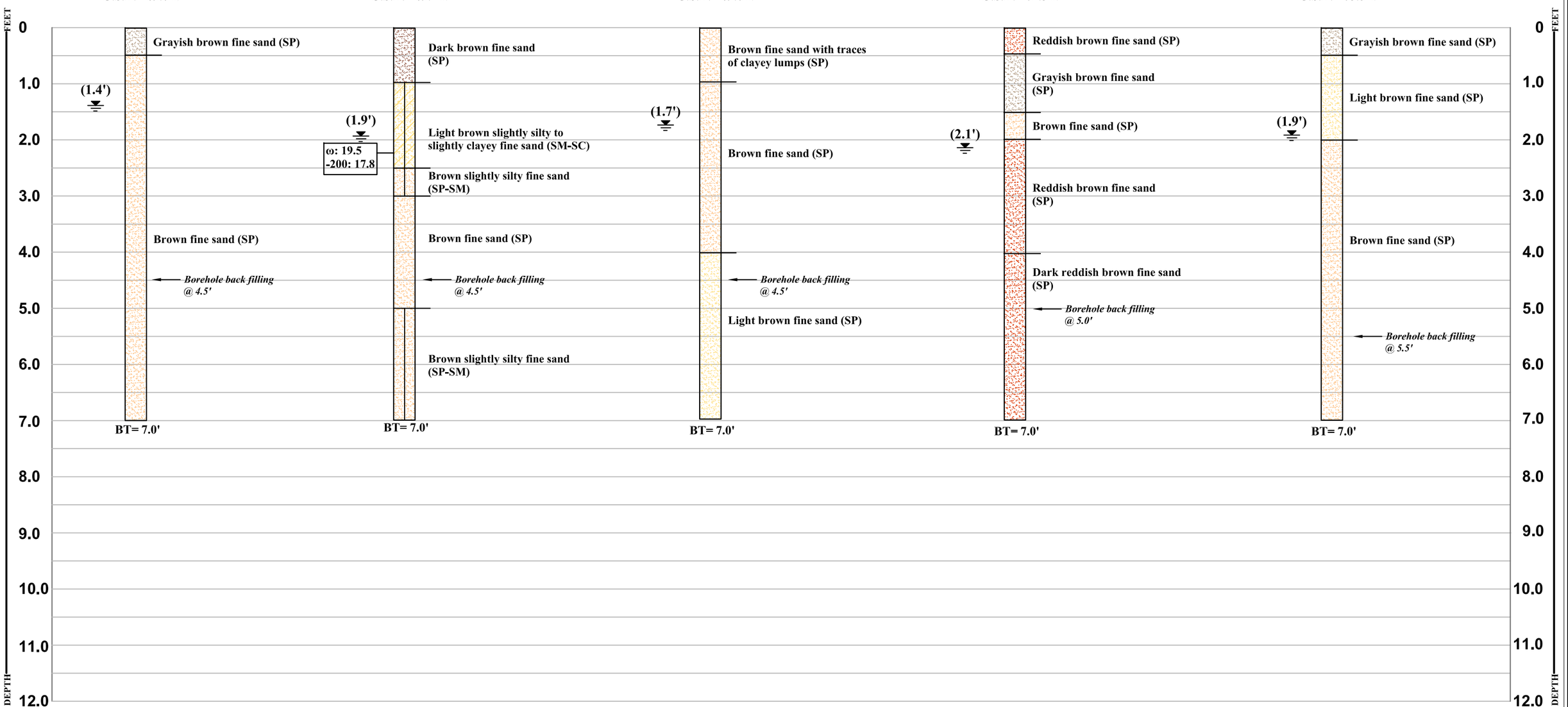
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-01-15	Noted	15-610.65	Figure 2.02



LEGEND

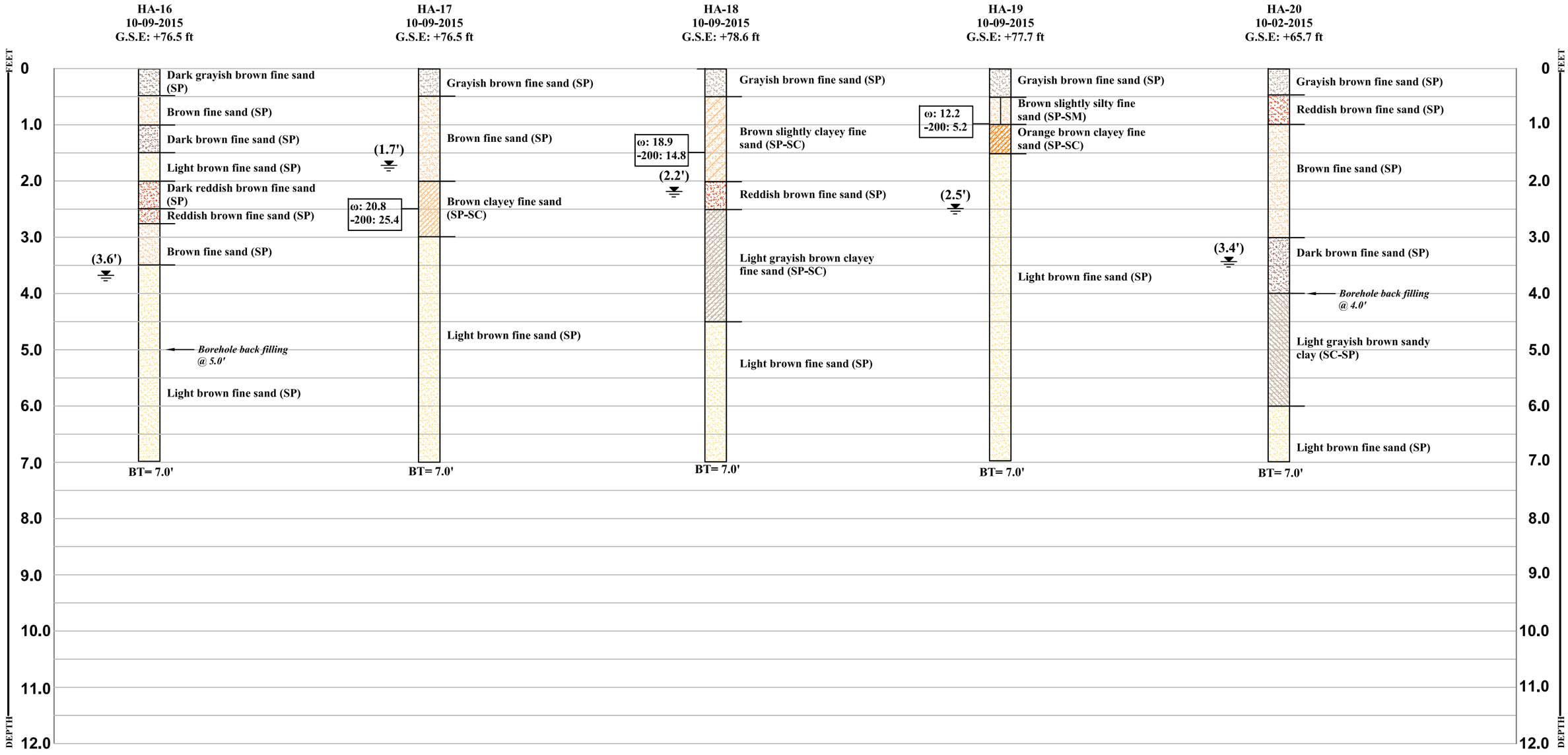
⏚	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
⏚	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

Figure Name: **SOIL PROFILES FOR BORINGS HA-11 TO HA-15**

Project Name: **PARK MANOR UNDERDRAIN ASSESSMENTS**

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-01-15	Noted	15-610.65	FIgure 2.03



LEGEND

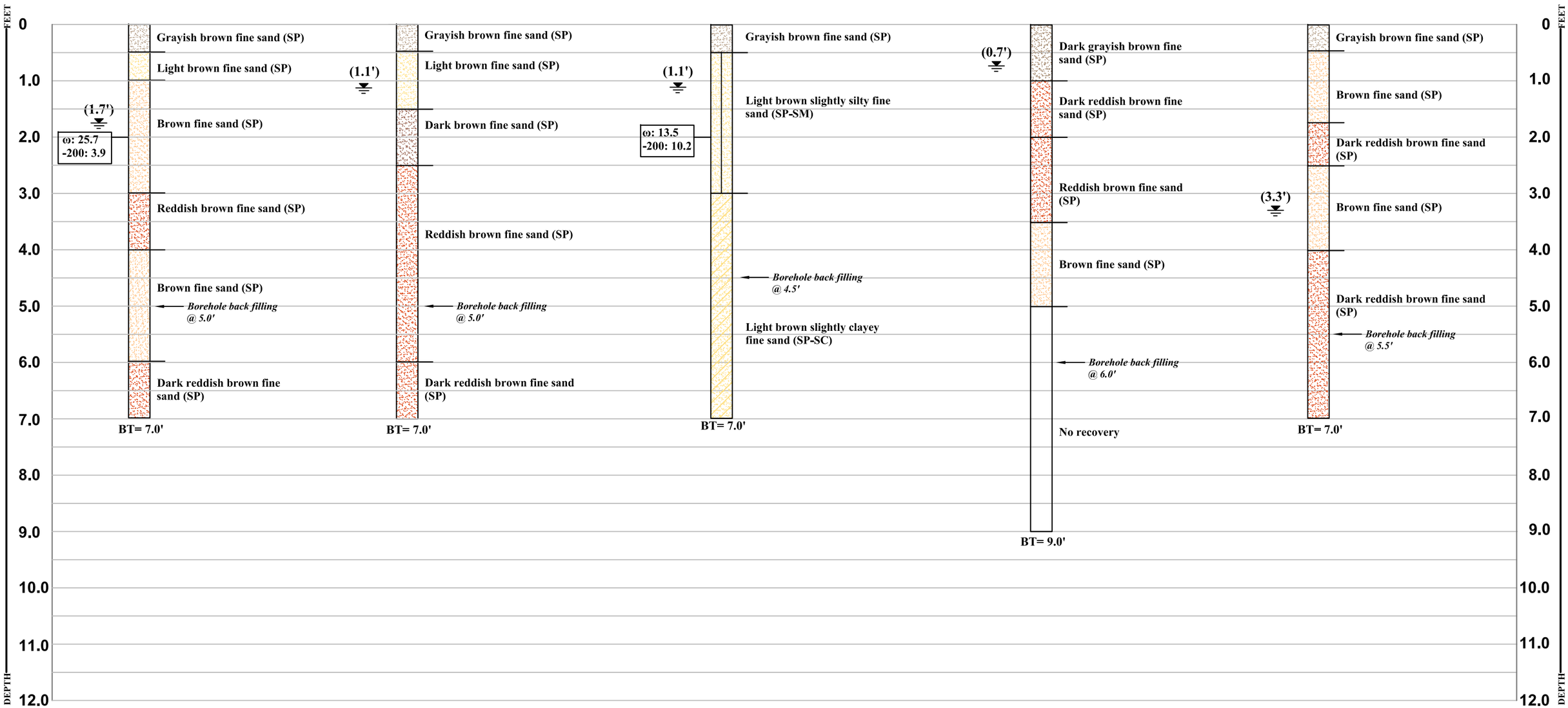
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr., ORLANDO, FL - 32808
Phone: (407) 920-2371 - Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Checked & Approved by: DS	Drawn By: DS	Date: 10-02-15	Scale: Noted	Proj. # 15-610.65	FIgure 2.04

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

Project Name: **PARK MANOR UNDERDRAIN ASSESSMENTS**



LEGEND

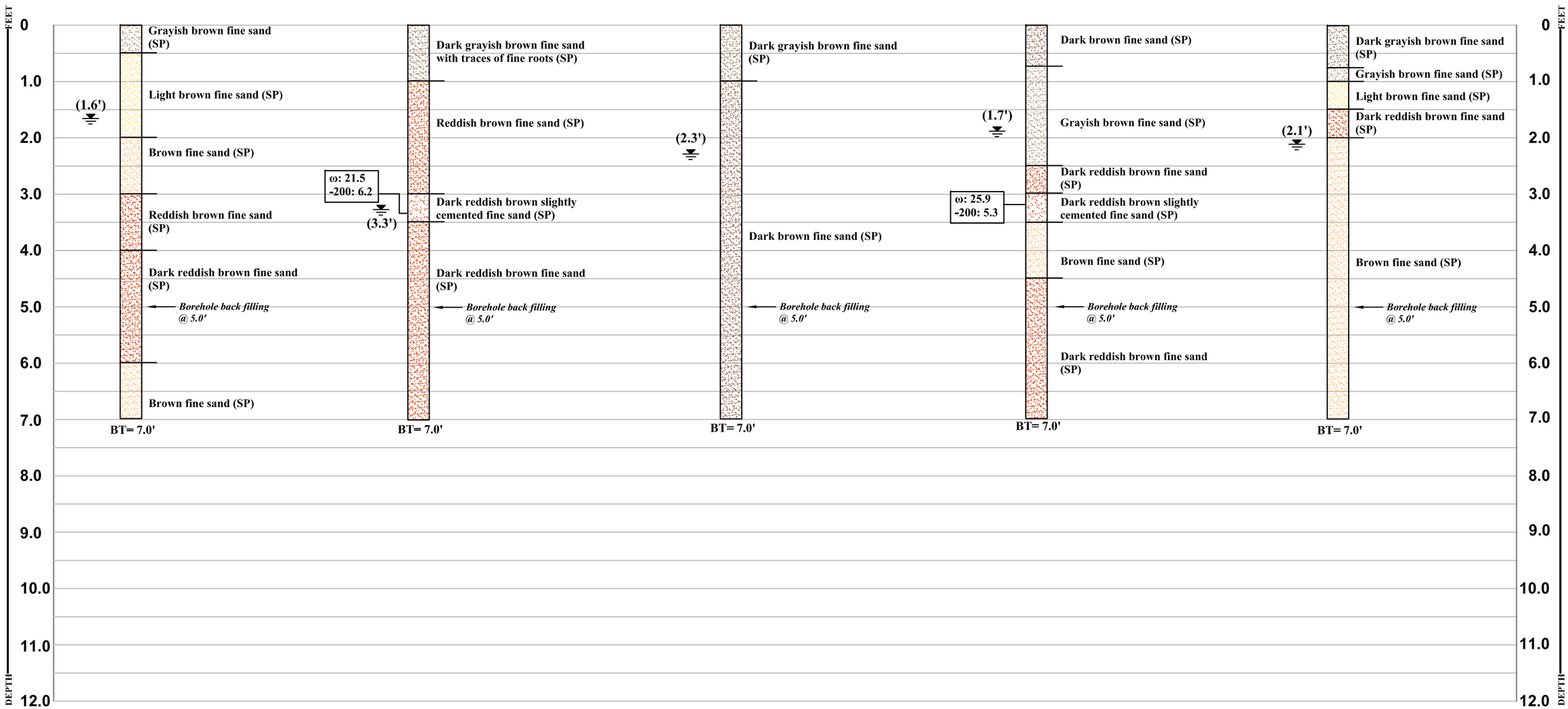
⏚	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
⏚	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 920-2371 . Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	FIgure 2.05
DS	DS	10-02-15	Noted	15-610.65	



LEGEND

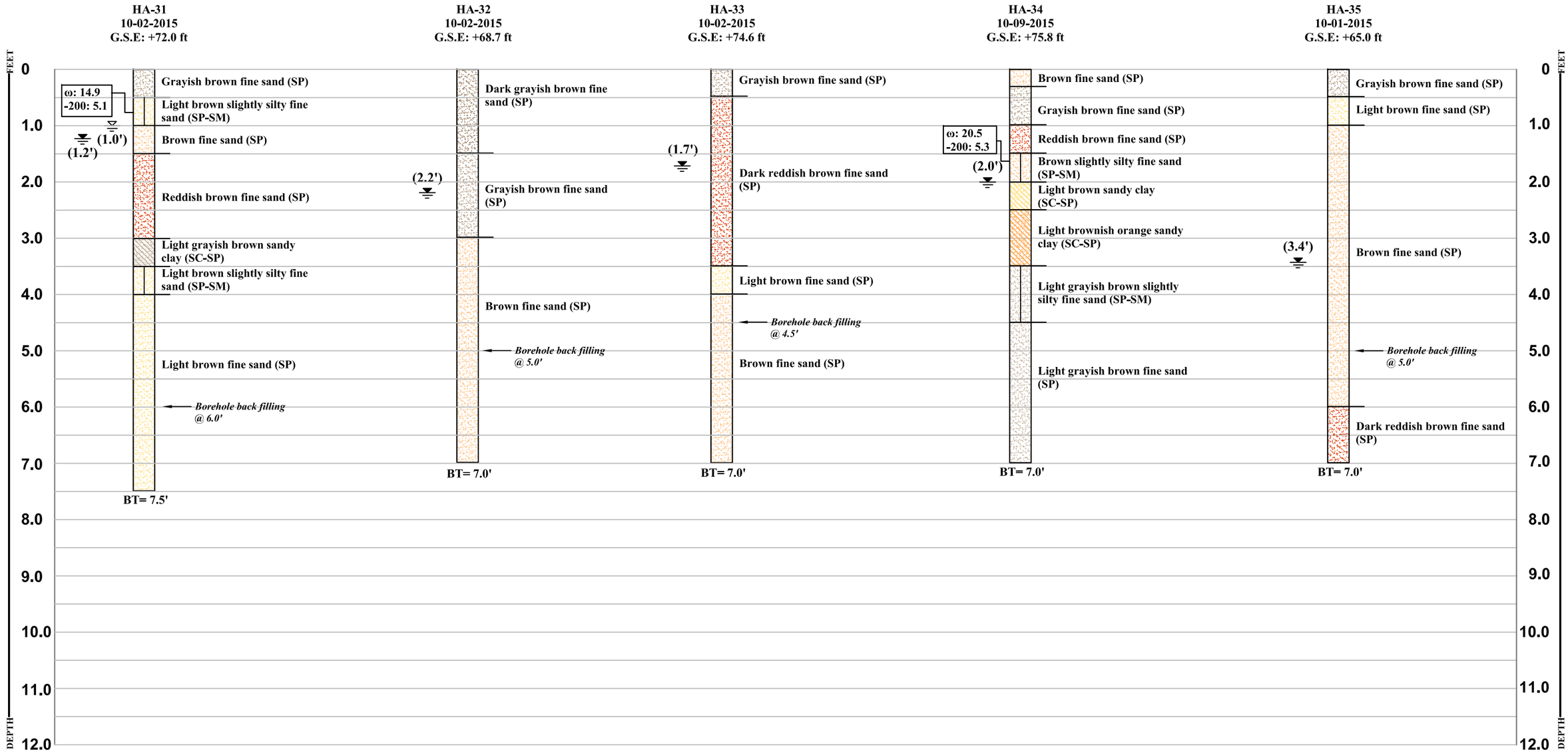
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 15, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-02-15	Noted	15-610.65	FIgure 2.06



LEGEND

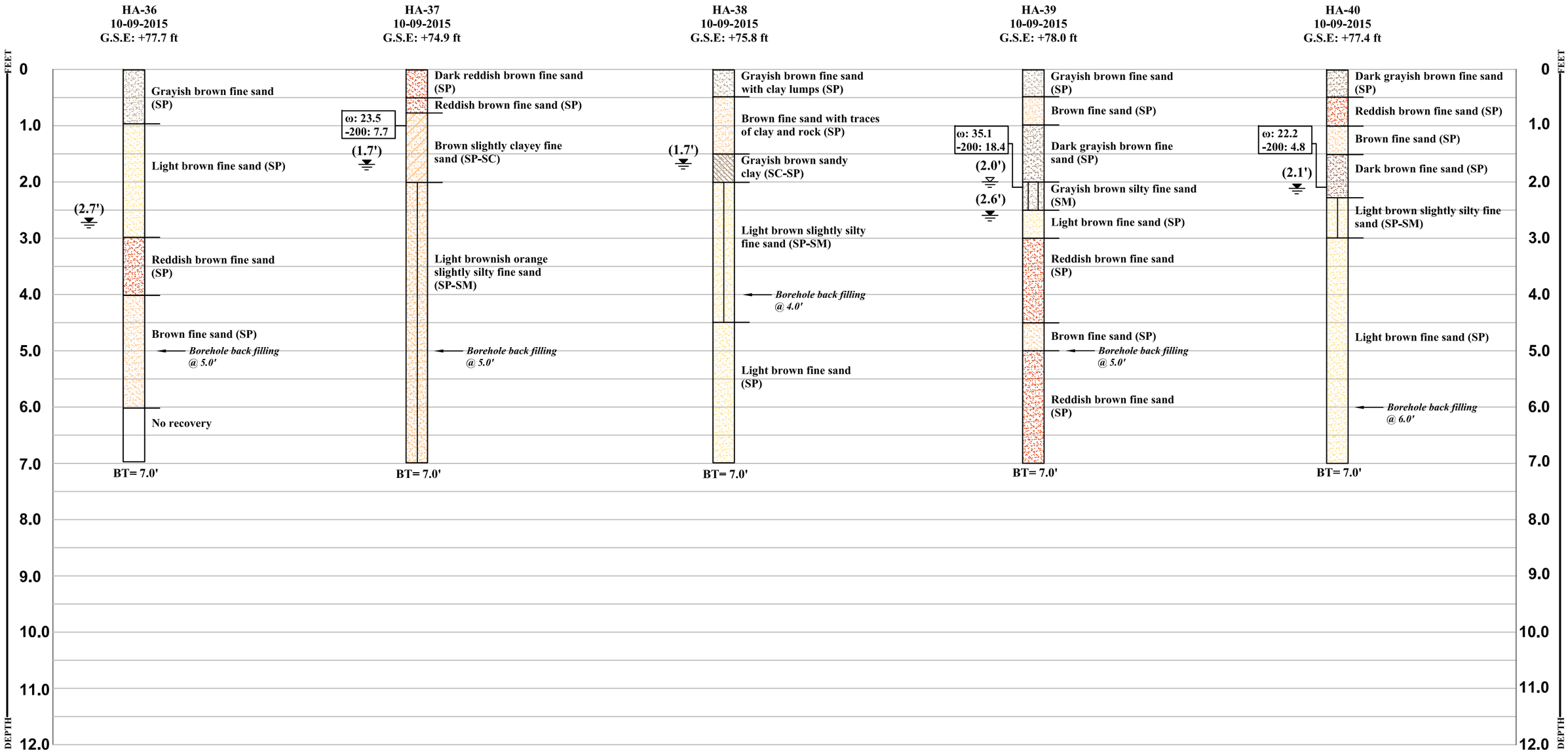
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

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

Project Name: **PARK MANOR UNDERDRAIN ASSESSMENTS**

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-02-15	Noted	15-610.65	Figure 2.07



LEGEND

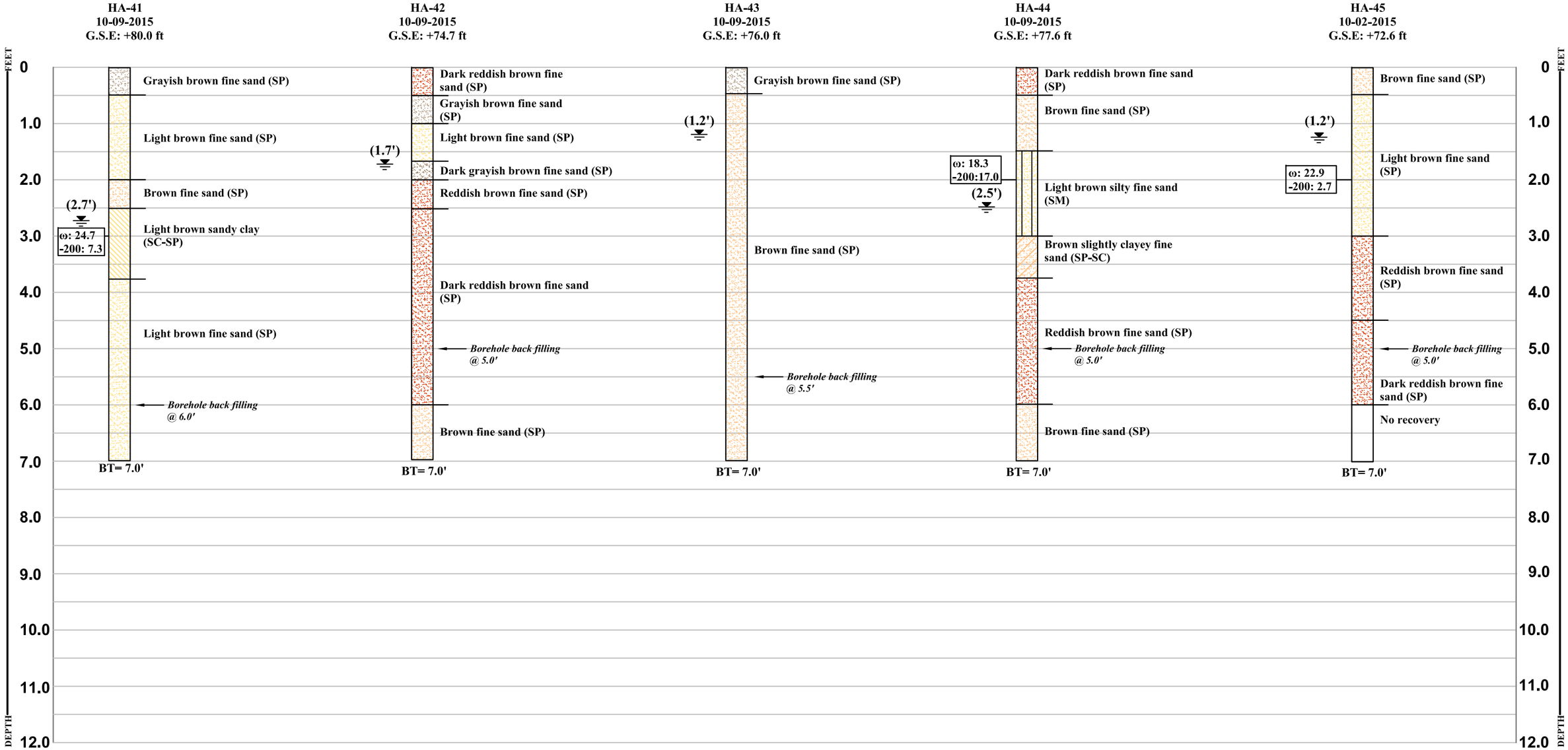
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr., ORLANDO, FL - 32808
Phone: (407) 520-2371 - Fax: (407) 298-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Checked & Approved by: DS	Drawn By: DS	Date: 10--05-15	Scale: Noted	Proj. # 15-610.65	Figure 2.08

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

Project Name: **PARK MANOR UNDERDRAIN ASSESSMENTS**



LEGEND

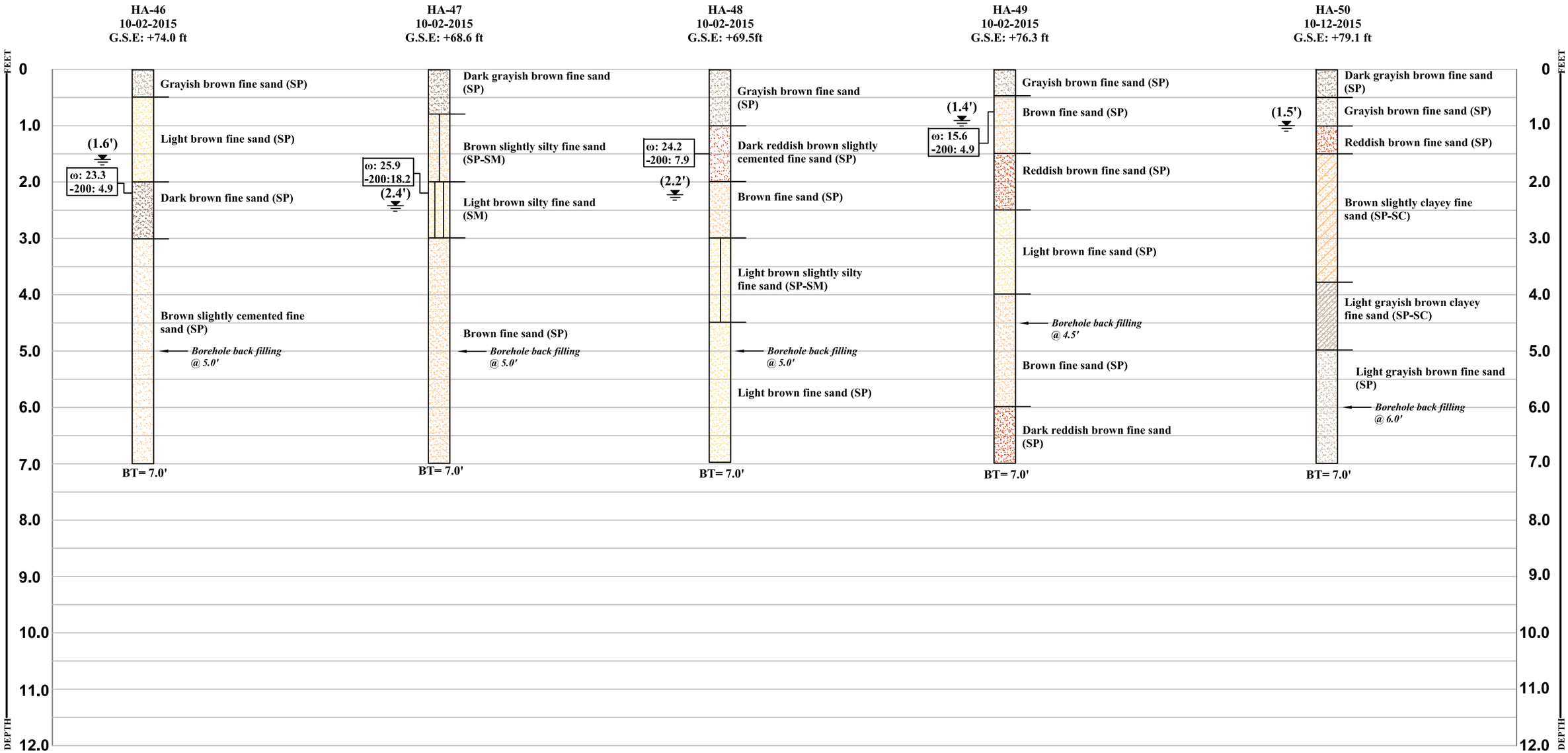
▼	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▼	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr., ORLANDO, FL - 32808
Phone: (407) 920-2371 - Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-02-15	Noted	15-610.65	Figure 2.09



LEGEND

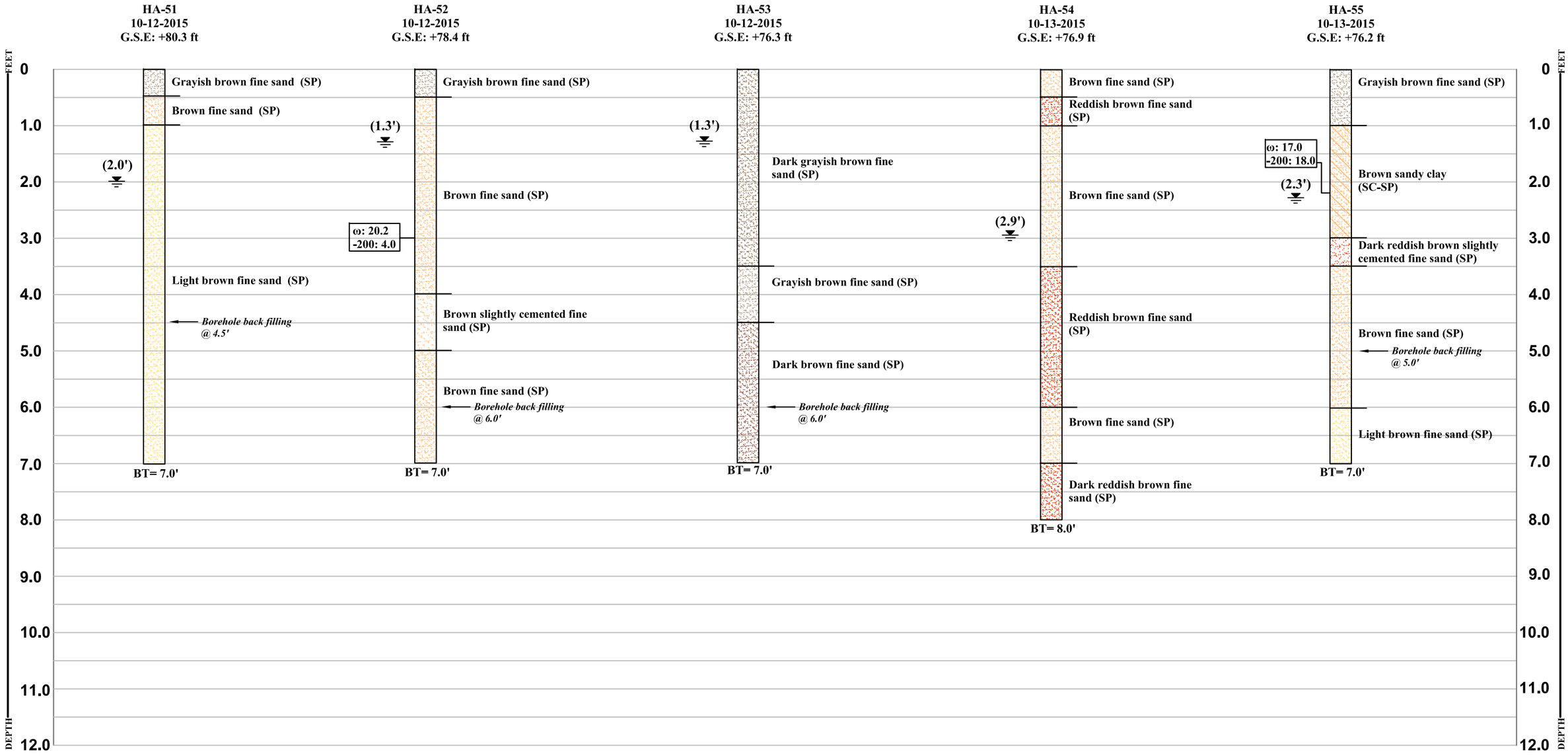
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr., ORLANDO, FL - 32808
Phone: (407) 920-2371 - Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-02-15	Noted	15-610.65	Figure 2.10



LEGEND

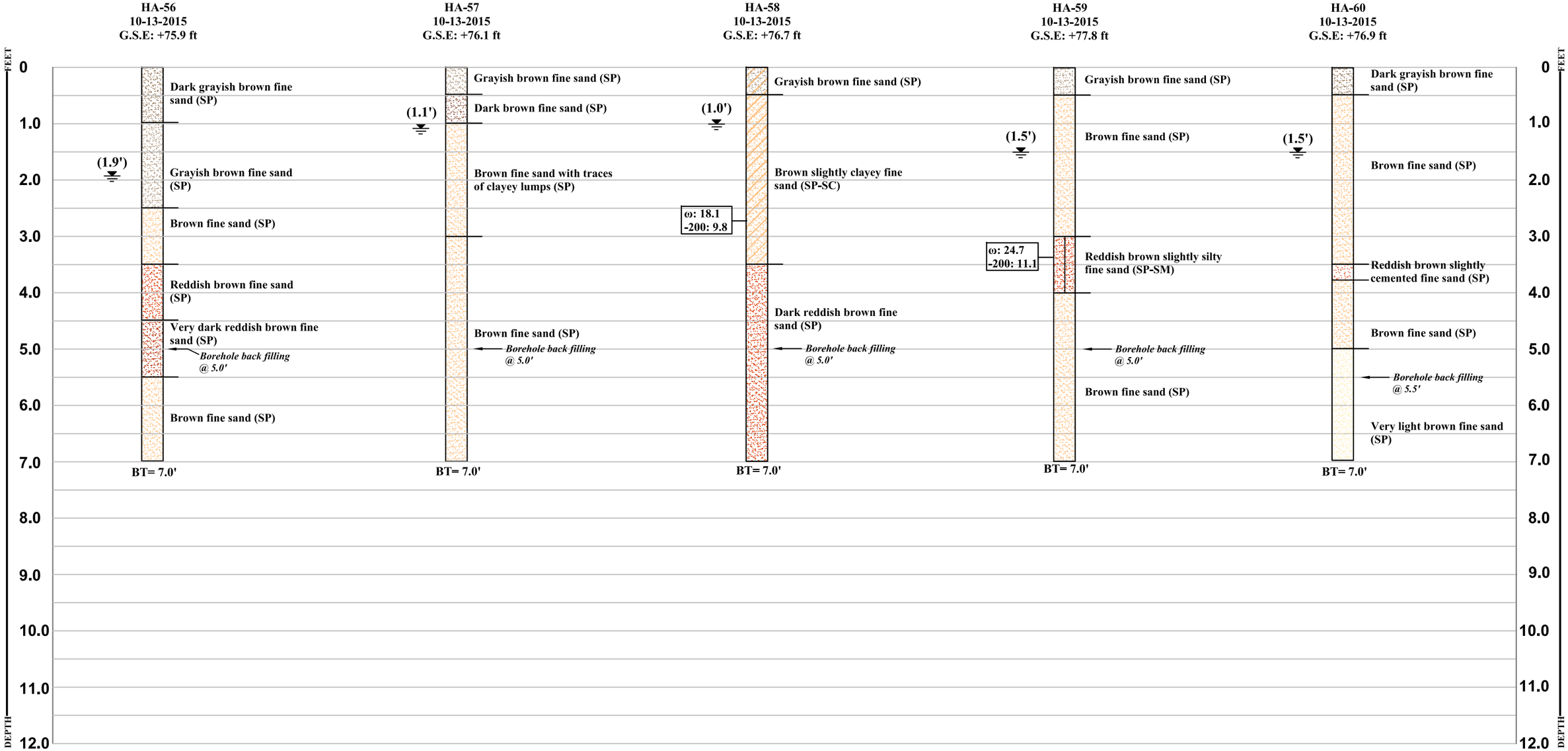
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

Figure Name:
SOIL PROFILES FOR HA-51 TO HA-55

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-12-15	Noted	15-610.65	FIgure 2.11



LEGEND

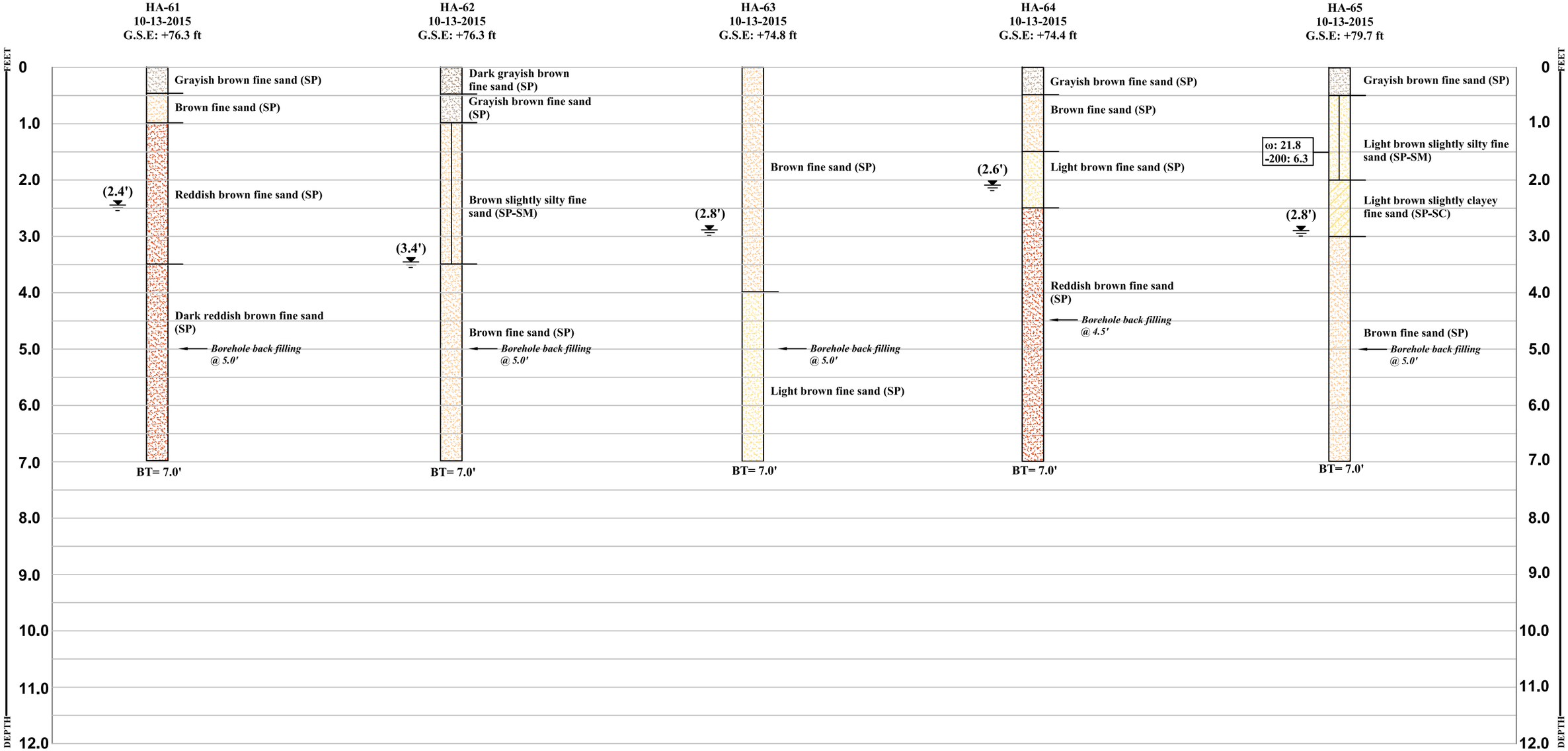
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr., ORLANDO, FL - 32808
Phone: (407) 920-2371 - Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
SOIL PROFILES FOR HA-56 TO HA-60

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-13-15	Noted	15-610.65	Figure 2.12



LEGEND

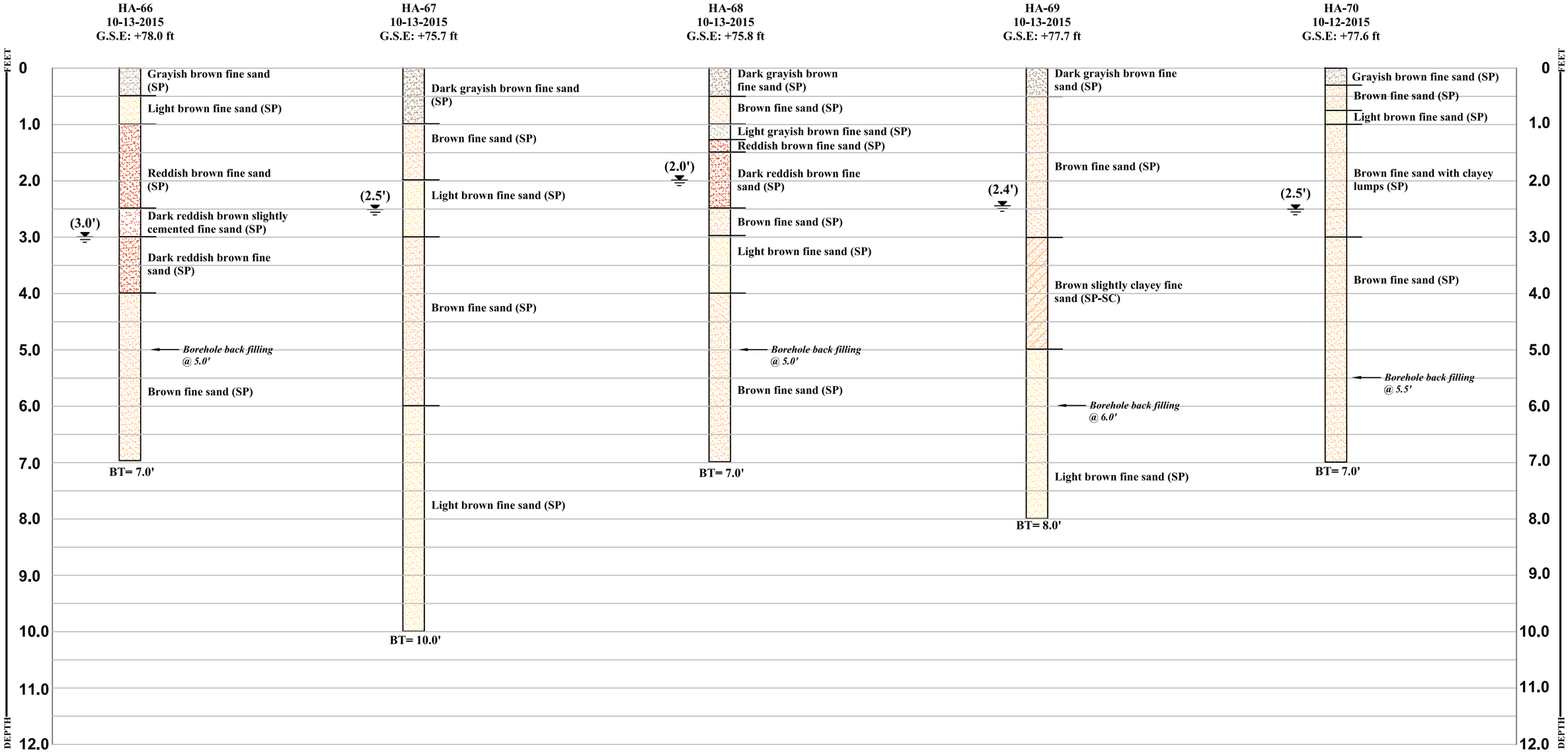
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr., ORLANDO, FL - 32808
Phone: (407) 920-2371 - Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	Figure 2.13
DS	DS	10-13-15	Noted	15-610.65	



LEGEND

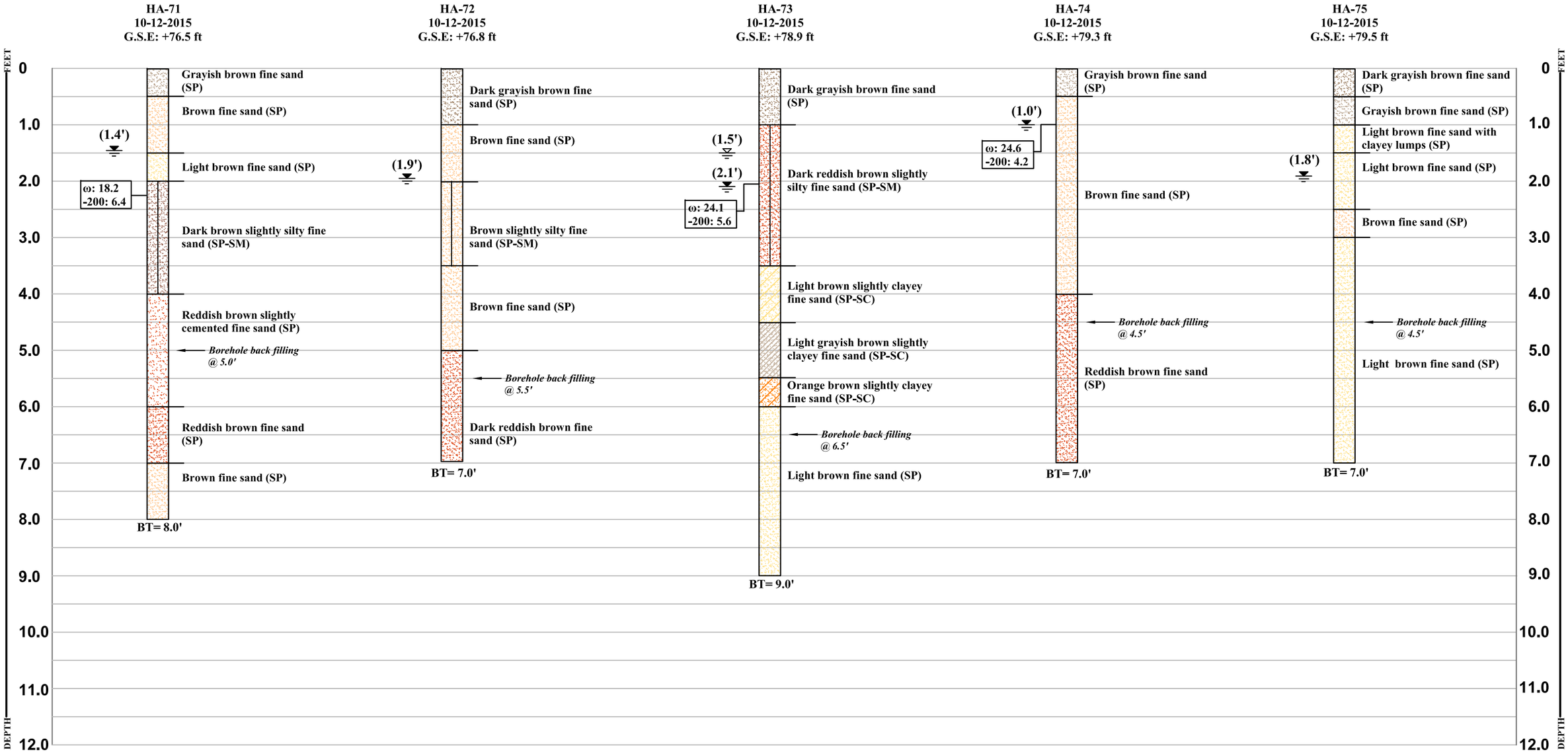
⏚	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
⏚	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
Kv	VERTICAL HYDRAULIC CONDUCTIVITY (FT/DAY)
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
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

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

Project Name: **PARK MANOR UNDERDRAIN ASSESSMENTS**

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-12-15	Noted	15-610.65	FIgure 2.14



LEGEND

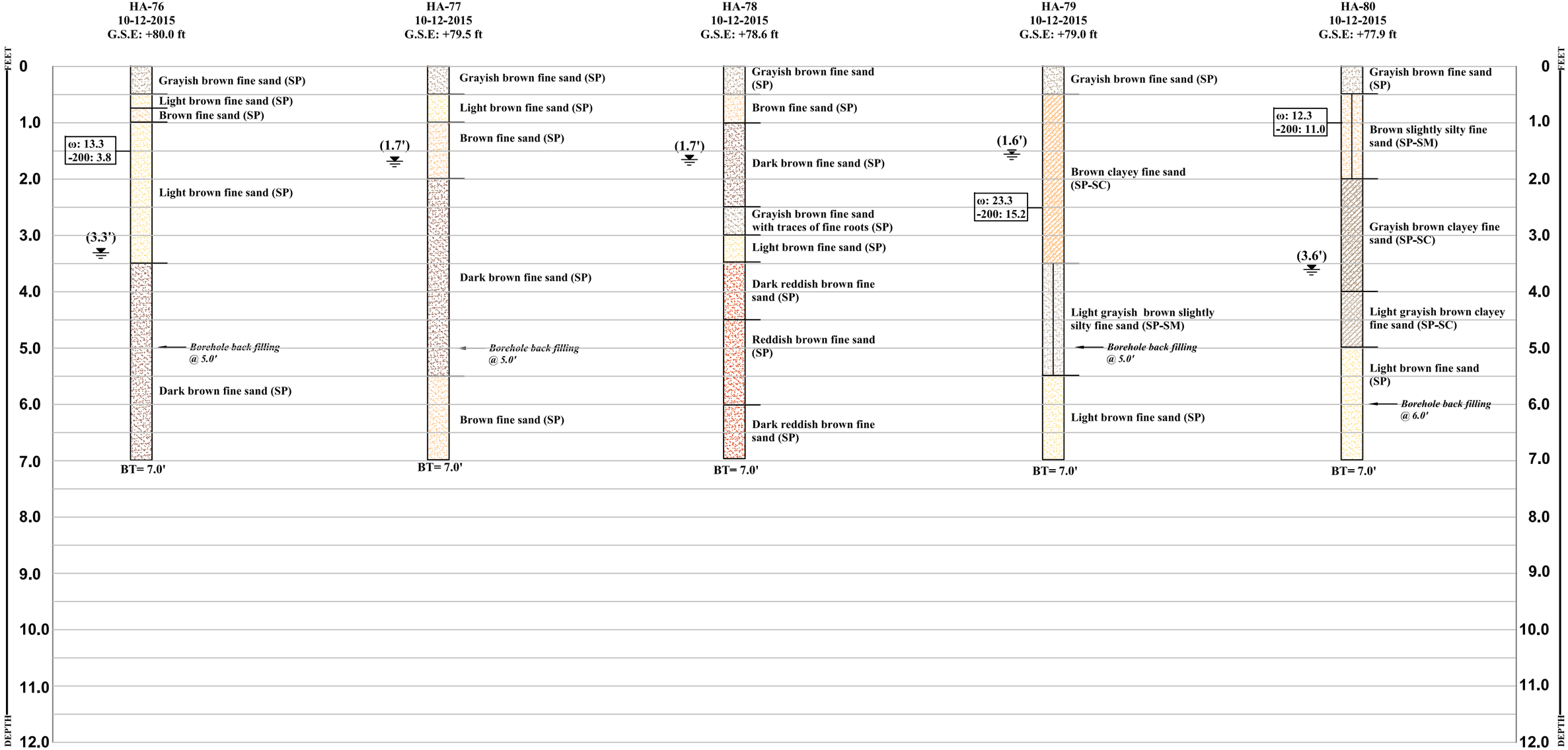
▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr. ORLANDO, FL - 32808
Phone: (407) 920-2371 - Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Checked & Approved by: DS	Drawn By: DS	Date: 10-12-15	Scale: Noted	Proj. # 15-610.65	Figure 2.15

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS



LEGEND

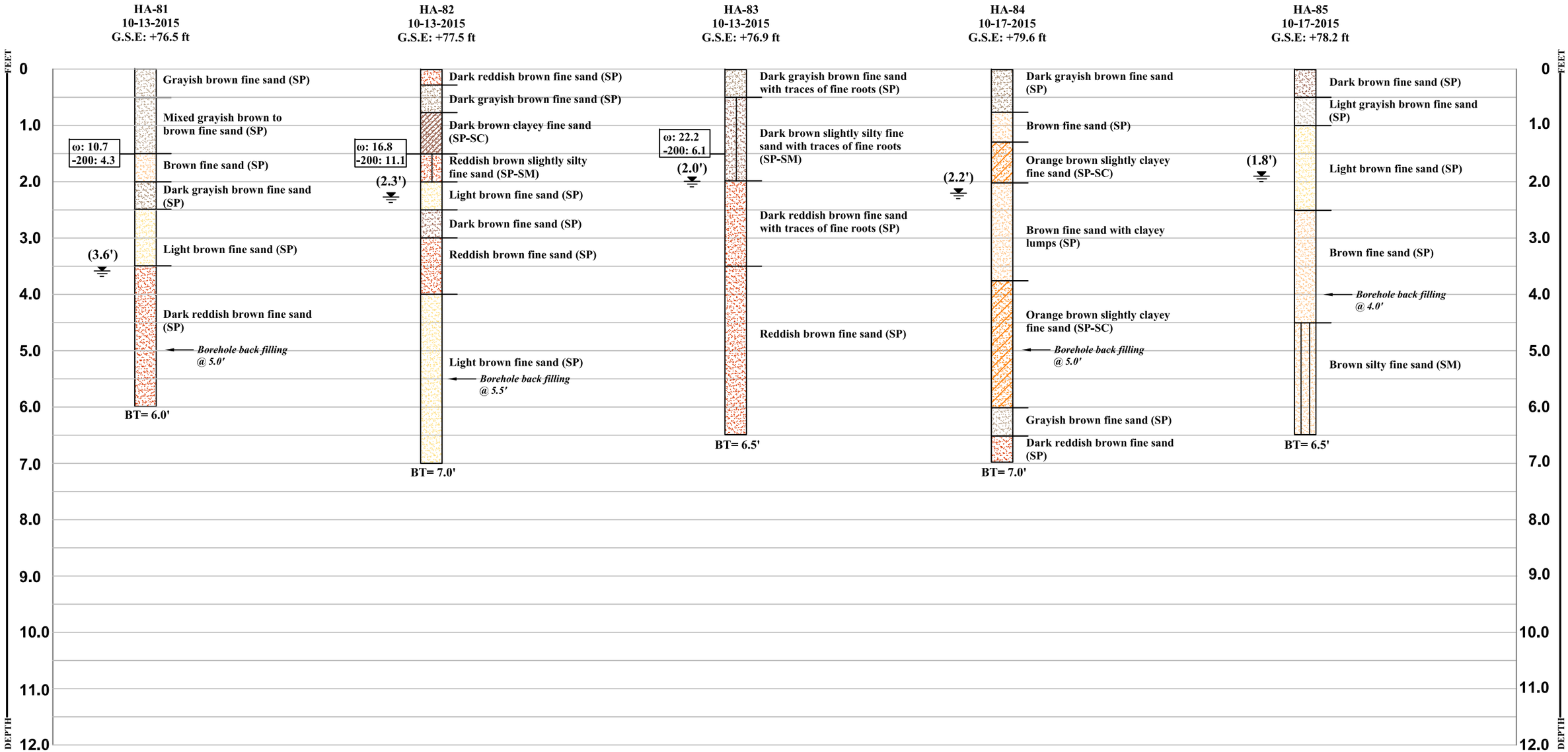
▼	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr . ORLANDO, FL - 32808
Phone: (407) 920-2371 . Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	
DS	DS	10-12-15	Noted	15-610.65	FIgure 2.16



LEGEND

▽	STABILIZED WATER TABLE READINGS MEASURED ON OCTOBER 19, 2015
▽	PERCHED WATER TABLE READINGS MEASURED ON DATE OF DRILLING
w	NATURAL MOISTURE CONTENT %
-200	PERCENT PASSING US # 200 SIEVE
G.S.E	SURVEYED GROUND SURFACE ELEVATION (FT NAVD)

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr , ORLANDO, FL - 32808
Phone: (407) 920-2371 . Fax: (407) 296-9011
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

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

Project Name:
PARK MANOR UNDERDRAIN ASSESSMENTS

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. #	Figure 2.17
DS	DS	10-12-15	Noted	15-610.65	

NORTH

GRAPHIC SCALE
1 INCH = 300 FEET
0 150 300 600 900

LEGEND:

- PM-18 — Stormwater structure number
- Existing Underdrain Locations
- Proposed Underdrain Locations

EAST COLONIAL DRIVE (S.R. 50)
MARY LOU DRIVE
BOLAND DRIVE
NADIA AVENUE
ALLISHEIM AVENUE
MURDOCK BOULEVARD
GRAYSON DRIVE
ABIGAIL STREET
BARBADOS AVENUE
GENEVIEVE STREET
DOMINICO STREET
EXUMA STREET
ROBERTO AVENUE
PARK MANOR DRIVE
N. DEAN ROAD
LEHMAN ROAD
HARDWICK AVENUE
CURAMENG DRIVE
ROUSE ROAD
NARCISSUS LANE
DELPHINIUM DRIVE
BUTTERCUP LANE
SCANDIA LANE
SONATA LANE
TANGORA STREET
CROCUS STREET
UDELL COURT
KAIN COURT
TOMES COURT
EASTVIEW DRIVE
GODFREY LANE
JONATHAN DRIVE
REGENCY COURT
REGENCY STREET
HENDRIX AVENUE
INVERSION STREET
DAWSON AVENUE
PARK MANOR DRIVE
BRIDLEWOOD AVENUE
CRESTRIDGE COURT
MOZART DRIVE
BROWNWOOD AVENUE
JEPSON STREET
TIMGGS COURT
TOBIE COURT
BERNICE COURT
WESTLEY WAY
CINDERHURST AVENUE
ELLENWOOD WAY
JANE EYRE DRIVE
MEADOWVALE DRIVE
IMSBRUCK DRIVE
WOODVALLEY WAY
DUNHILL DRIVE
MALONEY LANE

MUR-1 MUR-2 MUR-3 MUR-4
PM-1 PM-2 PM-3 PM-4 PM-5 PM-6 PM-7 PM-8 PM-9 PM-10 PM-11 PM-12 PM-13 PM-14 PM-15 PM-16 PM-17 PM-18
SC-1 SC-2 SC-3 SC-4
BRY-1 BRY-2 BRY-3 BRY-4

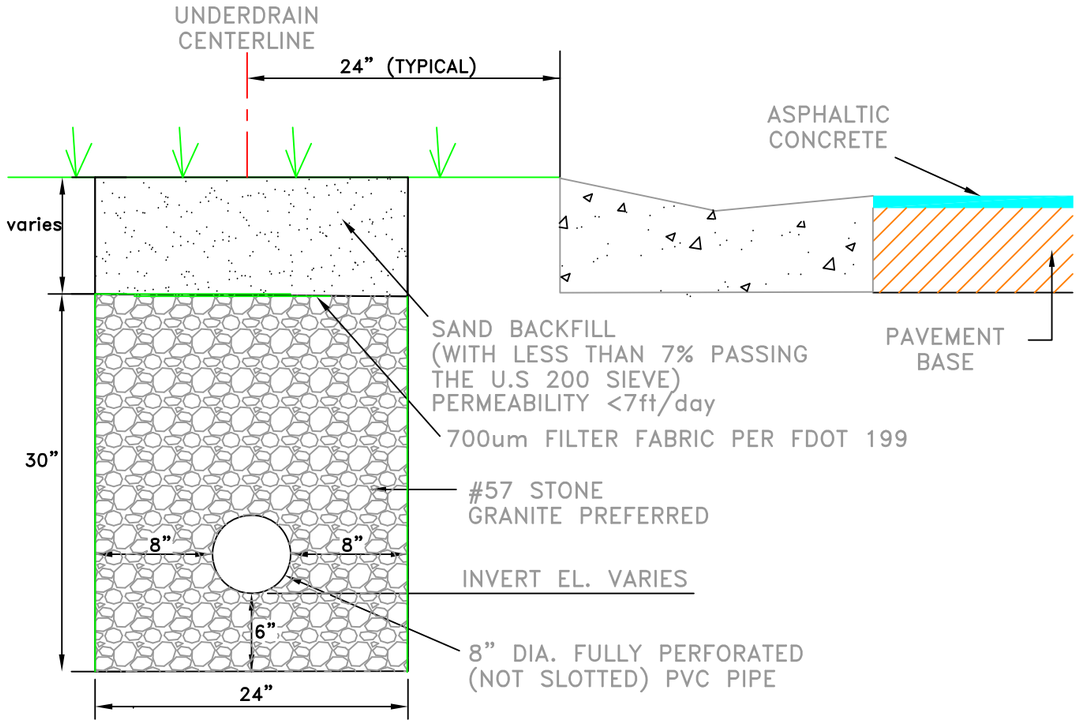
DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr. ORLANDO, FL - 32808
Phone: (407) 290-3371 Fax: (407) 294-9495
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Figure Name:
RECOMMENDED UNDERDRAIN LOCATIONS

Project Name:
PARK MANOR SUBDIVISION DRAINAGE ASSESSMENT

Checked & Approved by:	Drawn By:	Date:	Scale:	Proj. No.:	
DS	LA	10-27-15	Noted	15-610.65	Figure 3.1

CROSS-SECTION
CURB LINE ROADWAY UNDERDRAIN
IN AREAS OF TANNIC GROUND WATER



NOTE : UNDERDRAIN INVERT SHALL BE PLACED MIN. 30 INCHES BELOW TOP OF PAVEMENT AT CURB LINE

DEVO Engineering
CONSULTING GEOTECHNICAL ENGINEERS
5500 Alhambra Dr , ORLANDO, FL - 32808
Phone: (407) 920-2371 . Fax: (407) 294-6485
E-Mail address: devo@devoeng.com
website: http://www.devoeng.com

Checked & Approved by: DS	Drawn By: LA	Date: 10-26-15	Scale: Noted	Proj. # 15-610.65	Figure 3.2

Figure Name:
UNDERDRAIN DETAILS
AREAS OF TANNIC GROUND WATER

Project Name:
PARK MANOR SUBDIVISION
UNDERDRAIN ASSESSMENT

APPENDIX A

PHOTOS SHOWING
TYPICAL AREAS OF WETNESS

Photo #1. Seepage on Grayson Drive

Photo #2. Seepage on Bridlewood Avenue

Photo #3. Seepage on Jepson Street

Photo #4. Seepage on Roberta Avenue

APPENDIX B

UNDERDRAIN OBSERVATIONS AND FLOW MEASUREMENTS

PARK MANOR SUBDIVISION: UNDERDRAIN FLOW MEASUREMENTS AND OBSERVATIONS

DATED PERFORMED: OCTOBER 14, 2015 WEATHER CONDITIONS: DRY AND HOT RAINFALL THE PRECEDING FEW DAYS: NONE, OTHER THAN THE ODD TRACE.

MANHOLE	STREET	SIDE	DIRECTION	MATERIAL	APP. LENGTH (ft)	MEASURED VOLUME (liter)	TIME ELAPSED	liter/min	gal/min	gal/m/ft	Comments	Ground surface conditions on 10/14/15 *(no rain the previous few days)*	Ground surface conditions on 09/22/15 *(rain the previous day)*	**Cleaning recommended as a first step before deciding on replacement**
MUR-1	MURDOCK	WEST	NORTH	Corr. poly eth.	366	2.1	30	4.20	1.111	0.00304	*Light bacterial growth.* Water relatively clear.	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
"	"	WEST	SOUTH	Corr. poly eth.	291	Not measurable [1]	n/a	n/a	n/a	<0.0030 est.	Inadequate pipe projection to catch flow. Flow noted to be slower than north pipe. Water relatively clear. *Heavy bacterial growth*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
MUR-2	MURDOCK	EAST	NORTH	Corr. poly eth.	414	1.8	30	3.6	0.952	0.00230	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
"	"	EAST	SOUTH	Corr. poly eth.	484	0.8	30	1.6	0.423	0.00087	Water relatively clear	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
MUR-3	"	WEST	No pipe	-	-	-	-	-	-	-	-	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	-
MUR-4	MURDOCK	EAST	SOUTH	Corr. poly eth.	335	Not measurable					Invert submerged. Trickle flow difficult to detect	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
BRY-1	BRESSLYN	NORTH	NORTH	Corr. poly eth.	290	1.5	30	3	0.794	0.00274	Water relatively clear. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		N N/WEST	Clay	Unknown	0.8	60	0.8	0.212	indeterminate [2]	Water slightly greenish. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		WEST 1	Corr. poly eth.	60	2.1	30	4.2	1.111	0.01852	Water relatively clear. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		WEST 2	Clay	unknown	0.9	30	1.8	0.476	indeterminate [2]	Water relatively clear. *Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
BRY-2	"	SOUTH	EAST 1	Corr. poly eth.	216	Not measurable					Very slow trickle; inv. Too low, unable to catch flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		EAST 2	Clay	Unknown	No flow/dry					Clay pipe was at higher invert that the PE pipe	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
BRY-3	UDEL	EAST	NORTHEAST	Clay		Not measurable					Very slow trickle; inv. Too low, unable to catch flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		WEST	Clay		Not measurable					Very slow trickle; inv. Too low, unable to catch flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
BRY-4	UDEL	WEST	NORTHWEST	Clay	Unknown	0.1	30	0.2	0.053	indeterminate [2]	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
"	"		SOUTHWEST 1	Corr. poly eth.	300	3	10	18	4.762	0.01587	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
"	"		SOUTHWEST 2	Clay	Unknown	0.2	30	0.4	0.106	indeterminate [2]	Water relatively clear	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
PM-1	PARK MANOR	WEST	NORTH	Corr. poly eth.	220	Not measurable					Slow trickle.	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
"	"		SOUTH	Corr. poly eth.	196	1	30	2.00	0.529	0.00270	*Some algae growth present.*	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
PM-2	PARK MANOR	EAST	NORTH	Corr. poly eth.	198	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
"	"		SOUTH	Corr. poly eth.	170	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	Wetness on roadside landscaped areas	**Yes**
PM-3	PARK MANOR	EAST	NORTH	Corr. poly eth.	347	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		SOUTH	Corr. poly eth.	170	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-4	PARK MANOR	WEST	NORTH	Corr. poly eth.	348	Not measurable					Slow trickle observed	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		SOUTH	Corr. poly eth.	744	Not measurable					Slow trickle. *Algae growth*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-5	PARK MANOR	WEST	NORTH	Corr. poly eth.	361	2.25	15	9.00	2.381	0.00660	No algae	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-6	PARK MANOR	EAST	NORTH	Corr. poly eth.	367	1.2	15	4.80	1.270	0.00346	*Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		SOUTH	Corr. poly eth.	485	1.1	15	4.40	1.164	0.00240	*Light bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		SOUTH	Corr. poly eth.	250	Not measurable					Slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-7	"	WEST	No pipe	-	-	-	-	-	-	-	-	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	-
PM-8	"	EAST	SOUTH	Corr. poly eth.	150	Not measurable					Slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-9	PARK MANOR	WEST	SOUTH	Corr. poly eth.	245	0.2	60	0.20	0.053	0.00022	Very slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-10	PARK MANOR	WEST	NORTH	Corr. poly eth.	270	0.3	30	0.60	0.159	0.00059	Very slow trickle	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
"	"		SOUTH	Corr. poly eth.	401	3.1	15	12.40	3.280	0.00818	Very fast flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	No
PM-11	PARK MANOR	EAST	NORTH	Corr. poly eth.	262	0.2	30	0.40	0.106	0.00040	Slow trickle. *Bacterial growth*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-12	PARK MANOR	WEST	WEST	Corr. poly eth.	285	3.7	15	14.80	3.915	0.01374	Very fast flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	No
PM-13	JONATHAN	EAST	NORTH	Corr. poly eth.	700	Not measurable					Slow trickle; inv. Too low, unable to catch flow. *Heavy bacterial growth.*	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
PM-14	JONATHAN	WEST	NORTH	Corr. poly eth.	1300	4.3	30	8.60	2.275	0.00175	Very fast flow	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	No
SC-1	SCANDIA	WEST	No pipe	-	-	-	-	-	-	-	-	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	-
SC-2	SCANDIA	EAST	NORTH	Corr. poly eth.	175	Not measurable					Slow trickle; inv. Too low, unable to catch flow. Water relatively clear.	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
SC-3	SCANDIA	EAST	SOUTH	Corr. poly eth.	200	Not measurable					Slow trickle; inv. Too low, unable to catch flow. Water relatively clear.	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**
SC-4	SCANDIA	EAST	NORTH	Corr. poly eth.	220	Not measurable					Slow trickle; inv. Too low, unable to catch flow. Water relatively clear.	No wetness nor curb seepage observed	No wetness or seepage at curbs observed	**Yes**

[1] Where measured volume is shown as "Not measurable", this was becasuse we were unable to catch flow; either due to the underdrain pipe invert being too close to structure base or the underdrain pipe did not protrude inside the structure enough, such that a vessel could be inserted under to catch the flow.

[2] Indeterminate: Flow per linear ft could not be calculated as pipe length was unknown and could not be estimated.