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IFB NO. Y19-712-RM **ISSUED: October 12, 2018**

INVITATION FOR BIDS

FOR

PARK MANOR ESTATES SECTIONS 11-12 UNDERDRAIN IMPROVEMENTS

****

PART H
TECHNICAL SPECIFICATIONS

****

PART H
Volume II

TECHNICAL PROVISIONS

FOR

PARK MANOR ESTATES SECTIONS 11-12 UNDERDRAIN IMPROVEMENTS

ORANGE COUNTY, FLORIDA

PREPARED FOR:

ORANGE COUNTY PUBLIC WORKS DEPARTMENT
ROADS AND DRAINAGE DIVISION
4200 JOHN YOUNG PARKWAY
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NOVEMBER 2017

PART H
TECHNICAL PROVISIONS

for:

PARK MANOR ESTATES SECTIONS 11-12
UNDERDRAIN IMPROVEMENTS
ORANGE COUNTY, FLORIDA

ACKNOWLEDGMENTS

As always, Inwood has enjoyed the opportunity to serve Orange County on this assignment, and would like to express our appreciation for the continued support of the County Commissioners.

Orange County Board of County Commissioners

- Teresa Jacobs, County Mayor
- Betsy VanderLey, District 1
- Bryan Nelson, District 2
- Pete Clarke, District 3
- Jennifer Thompson, District 4
- Emily Bonilla, District 5
- Victoria P. Siplin, District 6

CERTIFICATION

The engineering material and data contained within the following **Technical Provisions** was prepared by Inwood Consulting Engineers for the sole use by the Orange County Roads and Drainage Division.

_____, P.E.
Steven M. Sommerfeldt, P.E.
Florida Registration No. 64074
Date:

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for:

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ORANGE COUNTY TECHNICAL PROVISIONS

✧ Orange County **Technical Provisions (TP's)** pertinent to this contract are listed below ✧

TP No.		**Technical Provision Description**
101		Mobilization
102		Maintenance of Traffic
104		Prevention, Control and Abatement of Erosion and Water Pollution
110		Clearing and Grubbing
440		Underdrains
520		Concrete Gutter, Curb Elements and Traffic Separator
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SCOPE OF WORK

The Park Manor Estates Underdrain Assessment project is located within the Park Manor Estates subdivision roughly bounded by Rouse Road to the east, Dean Road to the west, Colonial Boulevard (S.R. 50) to the north, and Bloomfield Drive to the south. The project area is located in the County's Three Points Maintenance District, the Little Econlockhatchee Drainage Basin, and Commissioner District 3. The project area is within the jurisdiction of the St. Johns River Water Management District. This contract includes the work necessary to construct underdrain throughout the Park Manor Estates subdivision. The proposed work will occur within existing rights-of-way and easements. The purpose of the work will be to provide better stormwater conveyance and reduce ponding water within the Park Manor subdivision. The work required to complete the project includes, but is not limited to, the installation of new and replacement of nonfunctional underdrain systems, including removal and replacement of existing damaged curbs, sidewalks and driveway approaches (regardless of thickness), sprinkler system repairs, roadway base and asphalt restoration. The Contractor shall furnish all labor, materials, equipment, supervision, quality control, tools, transportation, supplies, and manpower as well as pay for any applicable fees to complete the work specified in this contract.

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INDEX OF DRAWINGS

(Prepared by Inwood Consulting Engineers)

Sheet		Description
		Park Manor Estates Underdrain Improvements Construction Plans
1		Overview Map
2A		Underdrain Improvements
2B		Underdrain Improvements
3A		Broken Curb Inventory
3B		Broken Curb Inventory
3C		Broken Curb Inventory
3D		Broken Curb Inventory
4		Summary of Quantities
5		Underdrain Typical Section
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SCHEDULE OF PRICES (a.k.a. BID FORM)

SCHEDULE OF PRICES

PARK MANOR ESTATES UNDERDRAIN IMPROVEMENTS - SECTIONS 11-12

Please be advised that this estimate is based on FINAL drawings (as of November 2017) and was prepared for informational purposes only.

Item No.	Pay Item No.	Description	Units	Quantity	Unit Cost	Total
1	101-1	MOBILIZATION (5% OF ALL OTHER ITEMS)	LS	1		
2	102-1	MAINTENANCE OF TRAFFIC	LS	1		
3	104-1	PREVENTION, CONTROL AND ABATEMENT OF EROSION AND WATER POLLUTION	LS	1		
4	110-1-1	CLEARING AND GRUBBING	LS	1		
5	440-1-60	UNDERDRAIN, SPECIAL, PERFORATED (8" DIA.)	LF	18,210		
6	520-1-10	CONCRETE CURB AND GUTTER, DROP CURB	LF	700		
7	522-1	CONCRETE SIDEWALK, 4" THICK	SY	820		
8	522-2	CONCRETE SIDEWALK AND DRIVEWAY, 6" THICK (FOR DRIVEWAYS)	SY	4,850		
9	570-1	PERFORMANCE TURF, SOD	SY	17,900		
10	900-1	AS-BUILT PLANS	LS	1		
11	900-2	INDEMNIFICATION	LS	1	$100.00	$100.00
		ESTIMATED TOTAL PROJECT COST:				**$100.00**

NOTE:

1) The quantity of Pay Item No. 520-1-10 includes the rounded length of broken curb as shown on Sheet 4 of the Plans.

Inwood consulting engineers

PART H
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"**Standard Specifications**" shall mean the Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction, dated 2017, 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 2017), and "**Supplemental Specifications for Road and Bridge Construction**" (dated 2017), 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 Note 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	Lump Sum

Pay Item Note 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 Note 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 Note 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 removal of underdrain. 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, 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. Includes the cost of all materials, labor, testing and equipment required for construction of soil cement base.

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 3/8” diameter 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. At a minimum, Contractor shall survey underdrain invert elevations on the upstream and downstream ends of each segment and provide this information to the engineer.

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.

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

TECHNICAL PROVISIONS

TP 440 – Underdrains

County Representative. Underdrains included in the contract price of other pay items will not be included in this Section for payment.

Payment shall be made under:

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

Pay Item Note 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 Note 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

Pay Item Note No. 522-1 & 522-2
Includes the cost of all materials, labor, testing and equipment required for construction of concrete sidewalk and driveways.

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 Note 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 11-12
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.
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PHONE: (407) 290-2371 - FAX: (407) 298-9011

Prepared for

Inwood consulting engineers

3000 Dovera Drive
Suite 200
Oviedo, Florida 32765

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CONSULTING GEOTECHNICAL ENGINEER
FLORIDA REGISTRATION NO. 48303

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

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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.

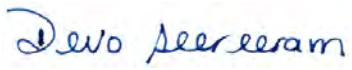
Included in this report are: ❶ our assessment of the geotechnical data, ❷ recommended location for new underdrains (as a minimum), and ❸ recommendations for cleaning, checking, and possible replacement of part of the existing underdrains based on these checks.

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

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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.

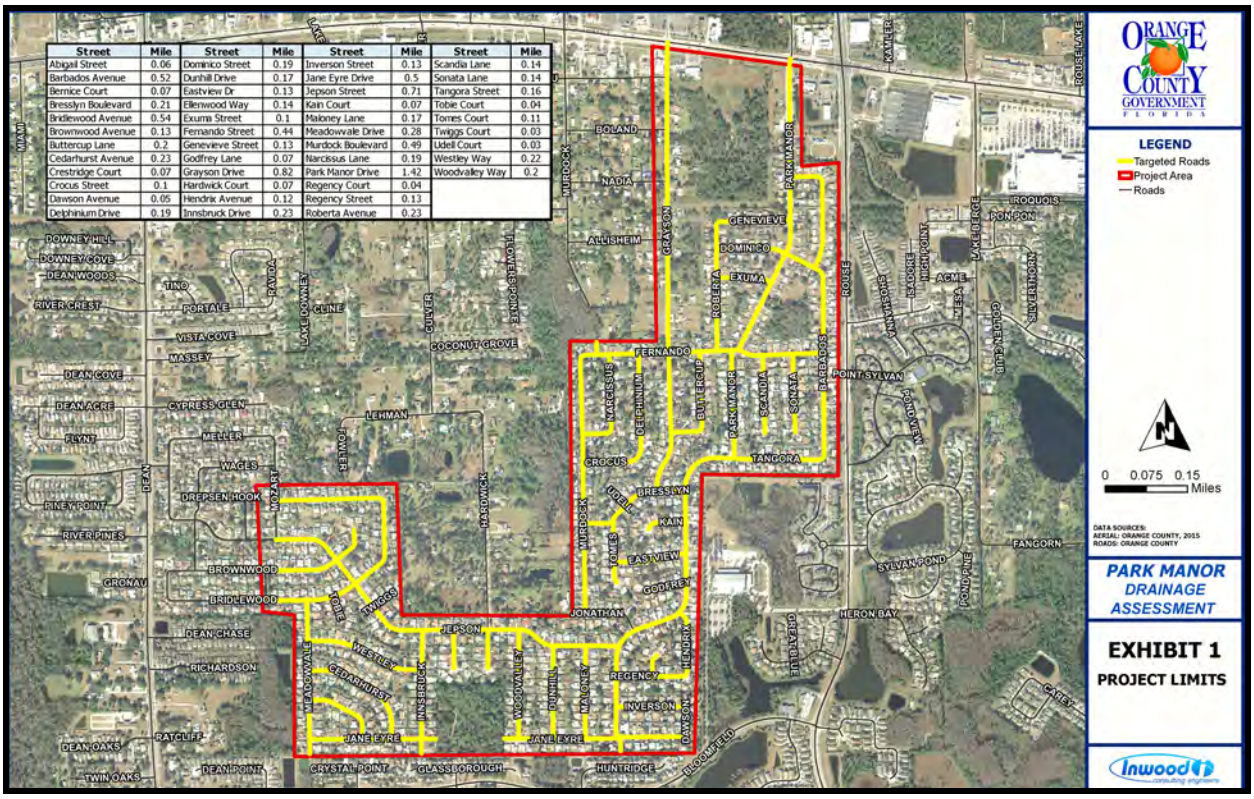

Exhibit 1. Park Manor Drainage Assessment - Study Limits

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

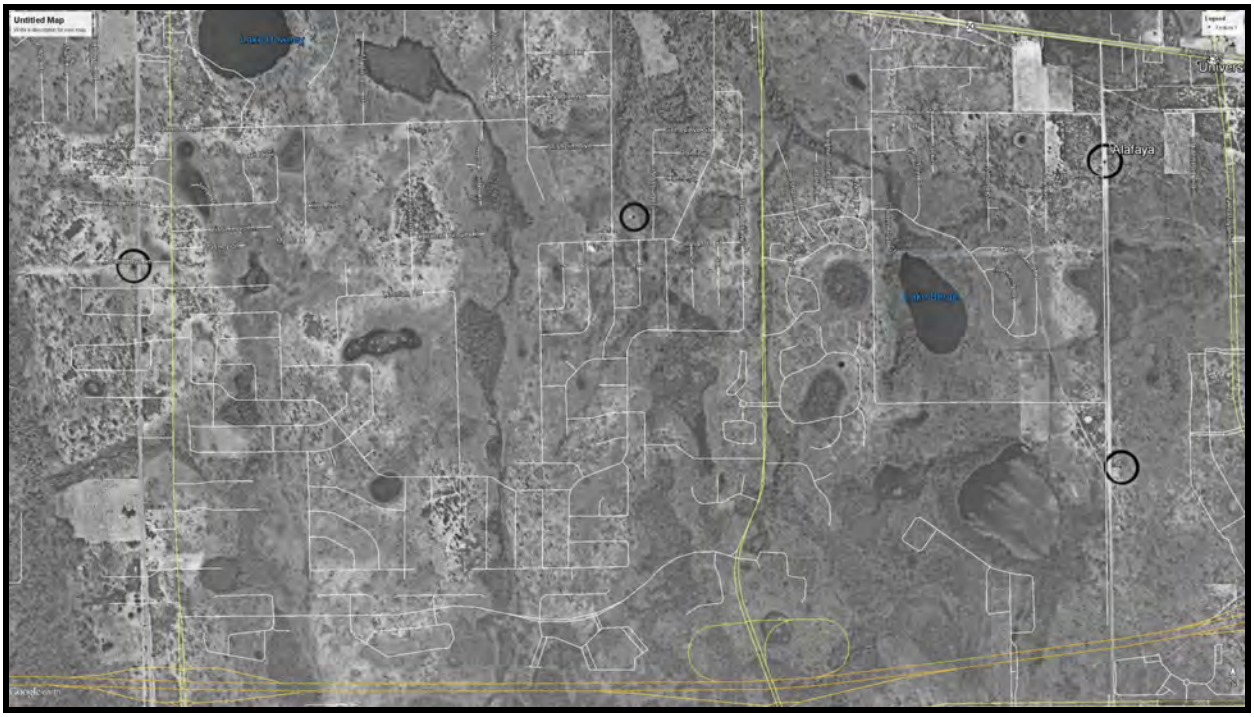

Exhibit 2. Park Manor and vicinity on 1947 Aerial Image. Note the wetland strands.

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.

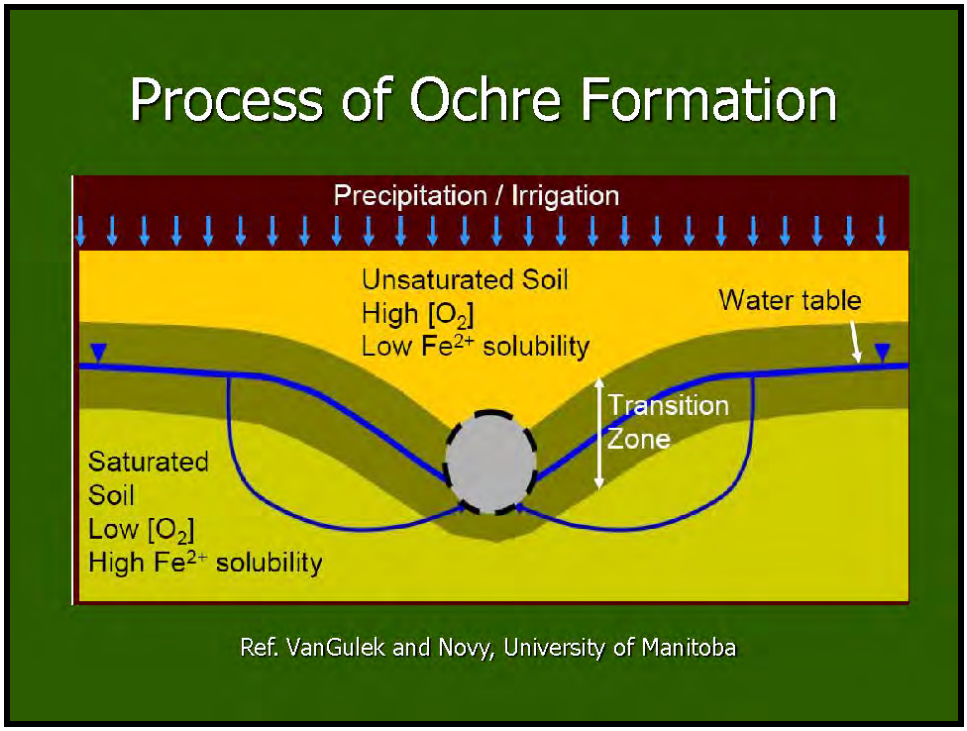

Exhibit 3.c Ochre formation process and zone of interest

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.

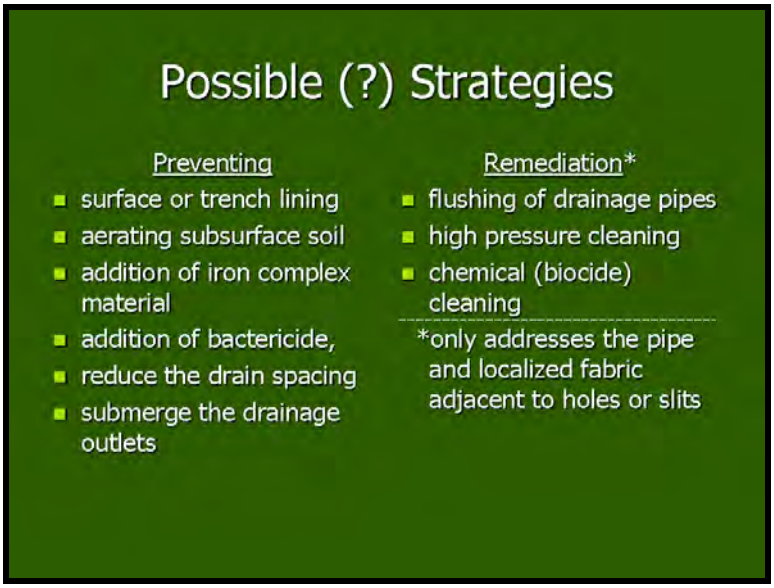

Exhibit 3.d Some remedial methods

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

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FIGURES

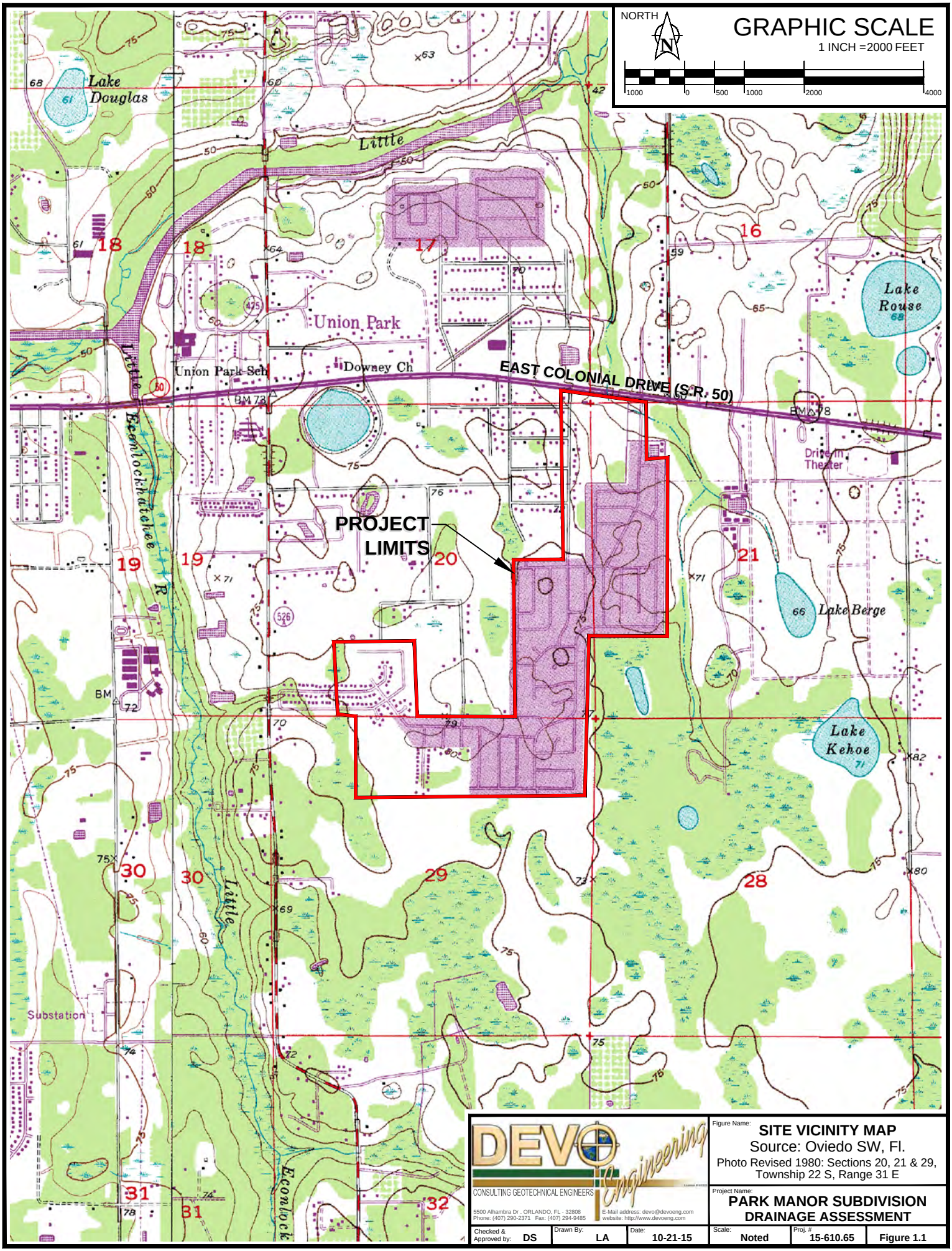

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Figure Name: **SITE VICINITY MAP**
Source: Oviedo SW, Fl.
Photo Revised 1980: Sections 20, 21 & 29, Township 22 S, Range 31 E

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

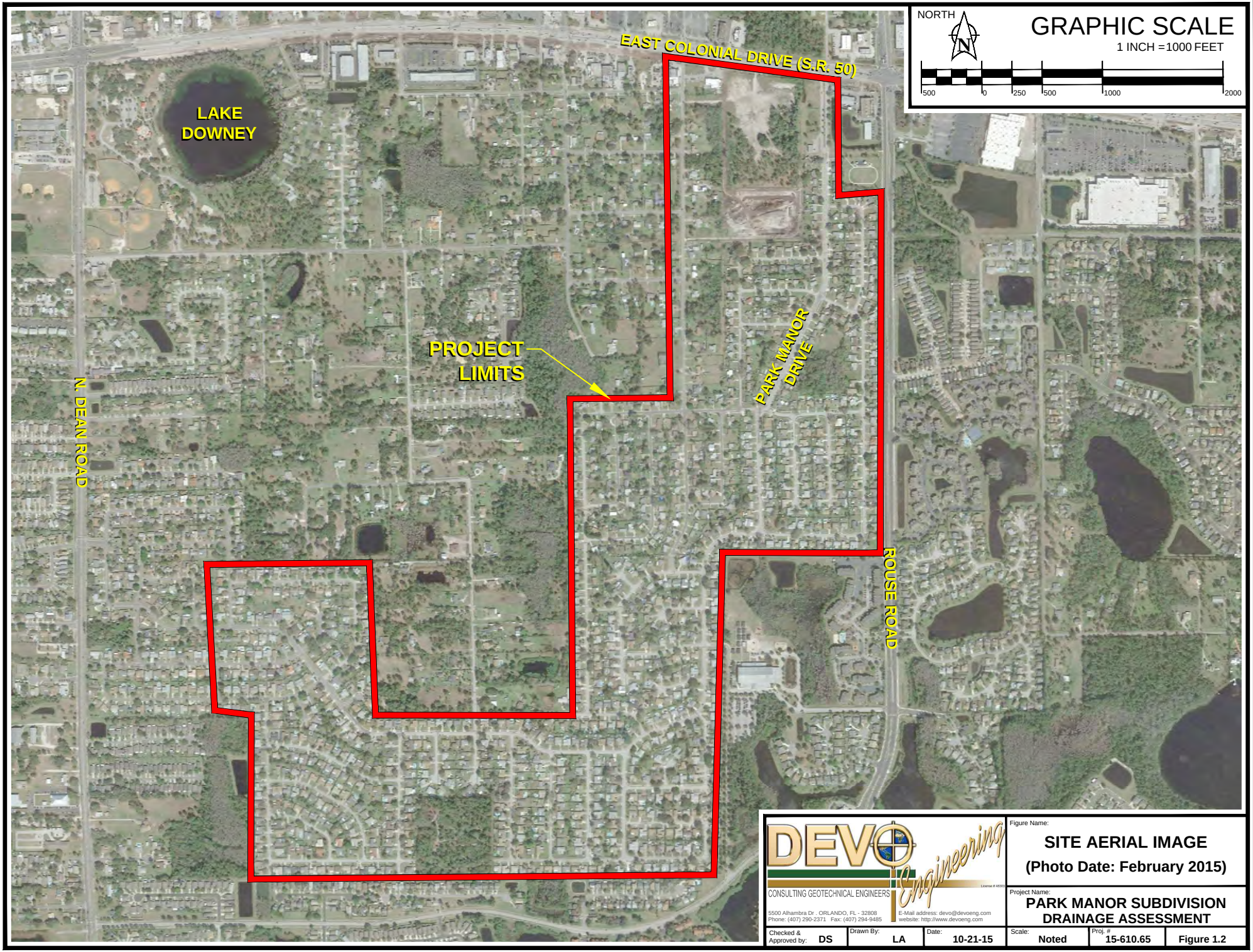

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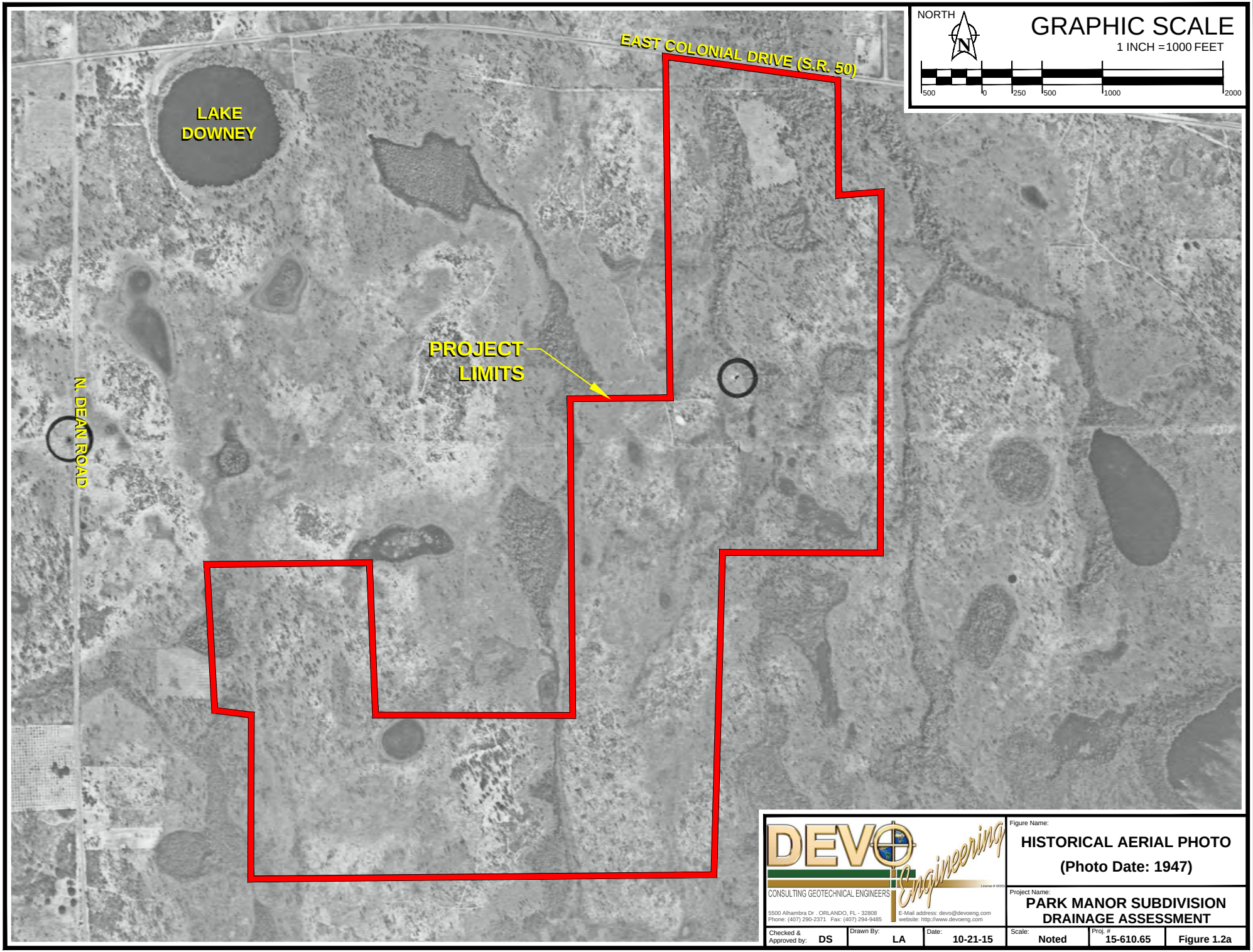
Figure Name:
SITE AERIAL IMAGE
(Photo Date: February 2015)

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

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Figure Name:

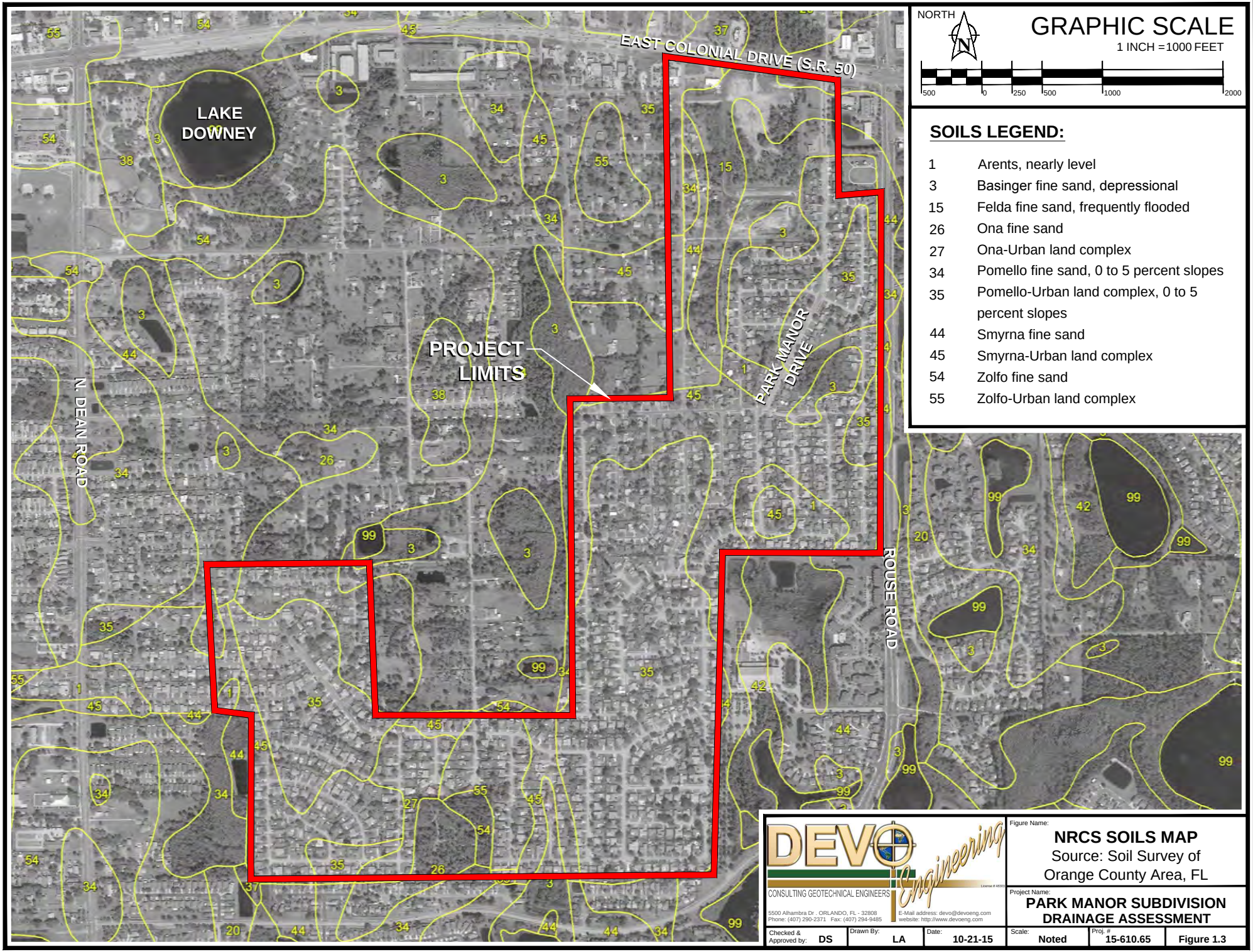
HISTORICAL AERIAL PHOTO

(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

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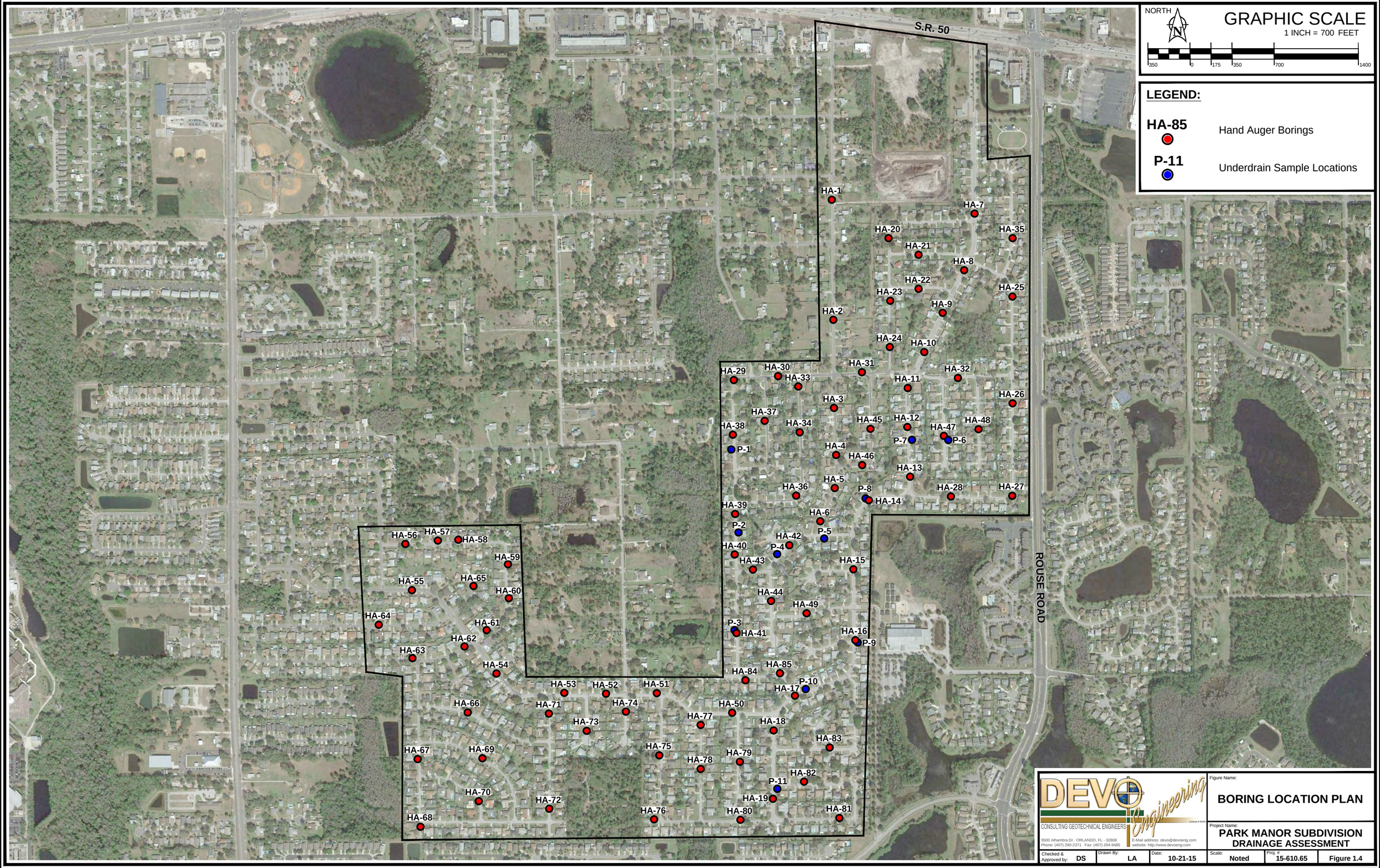
Figure Name:
NRCS SOILS MAP
Source: Soil Survey of Orange County Area, FL

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

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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.

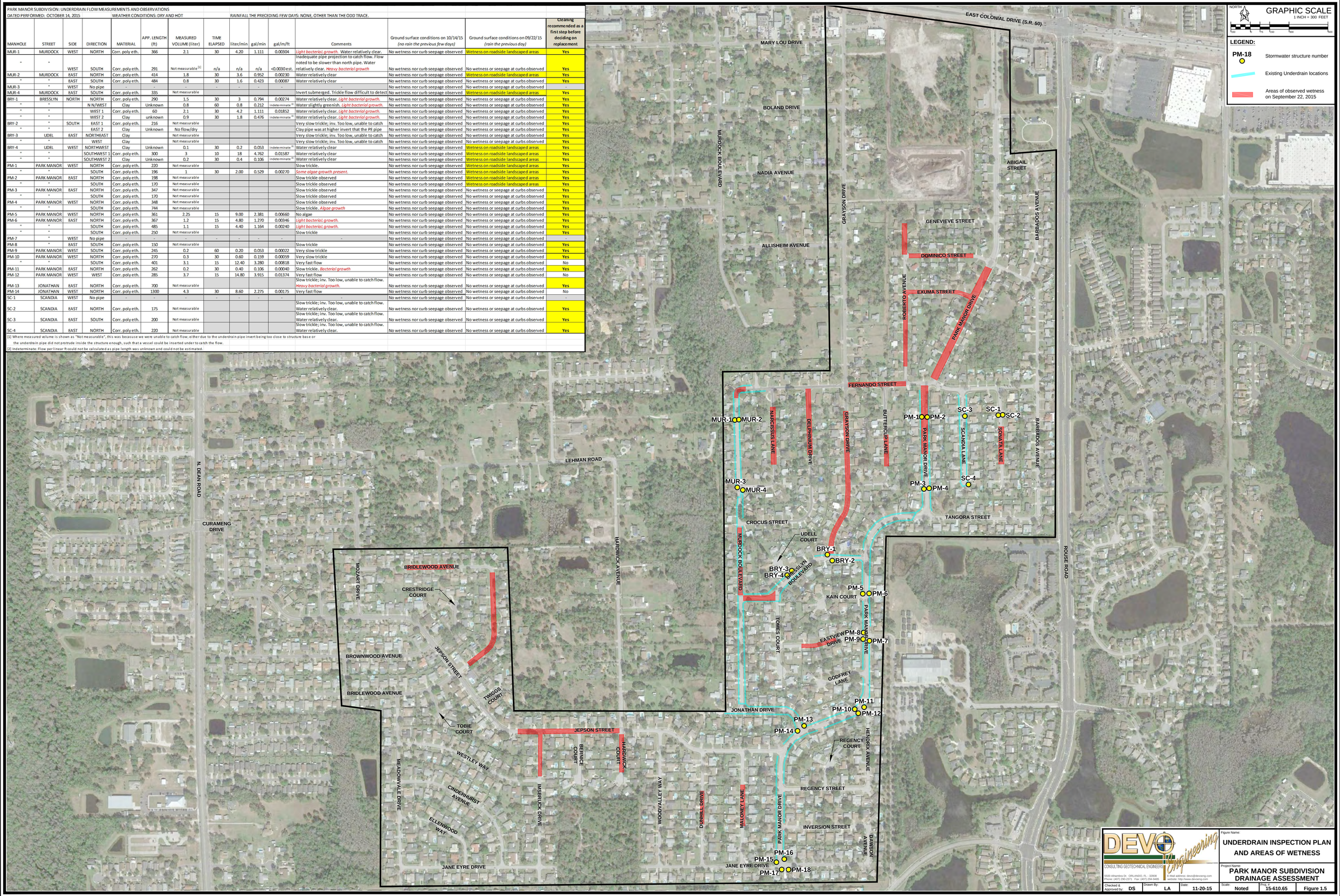

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Figure Name: **UNDERDRAIN INSPECTION PLAN AND AREAS OF WETNESS**

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

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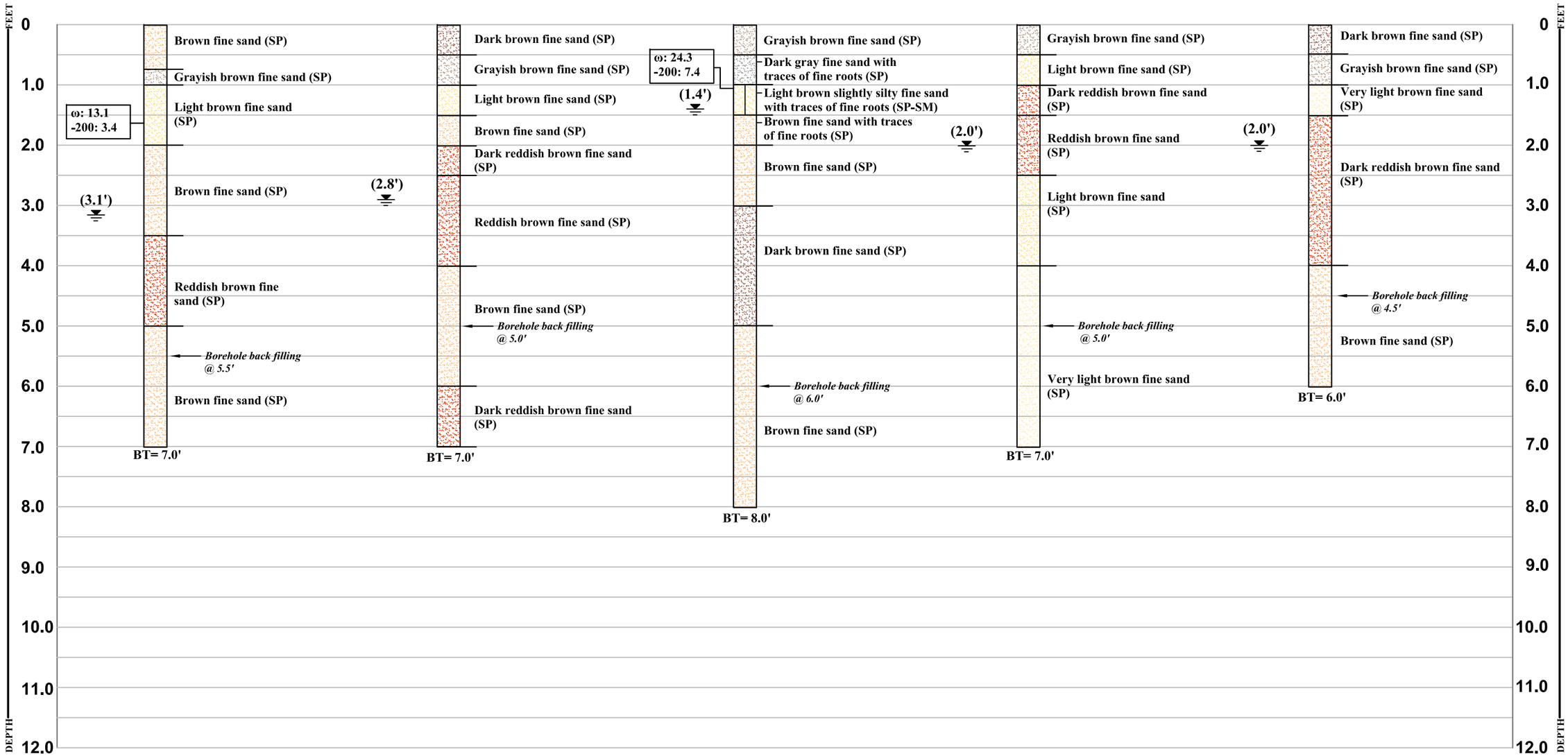

LEGEND

▽	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)

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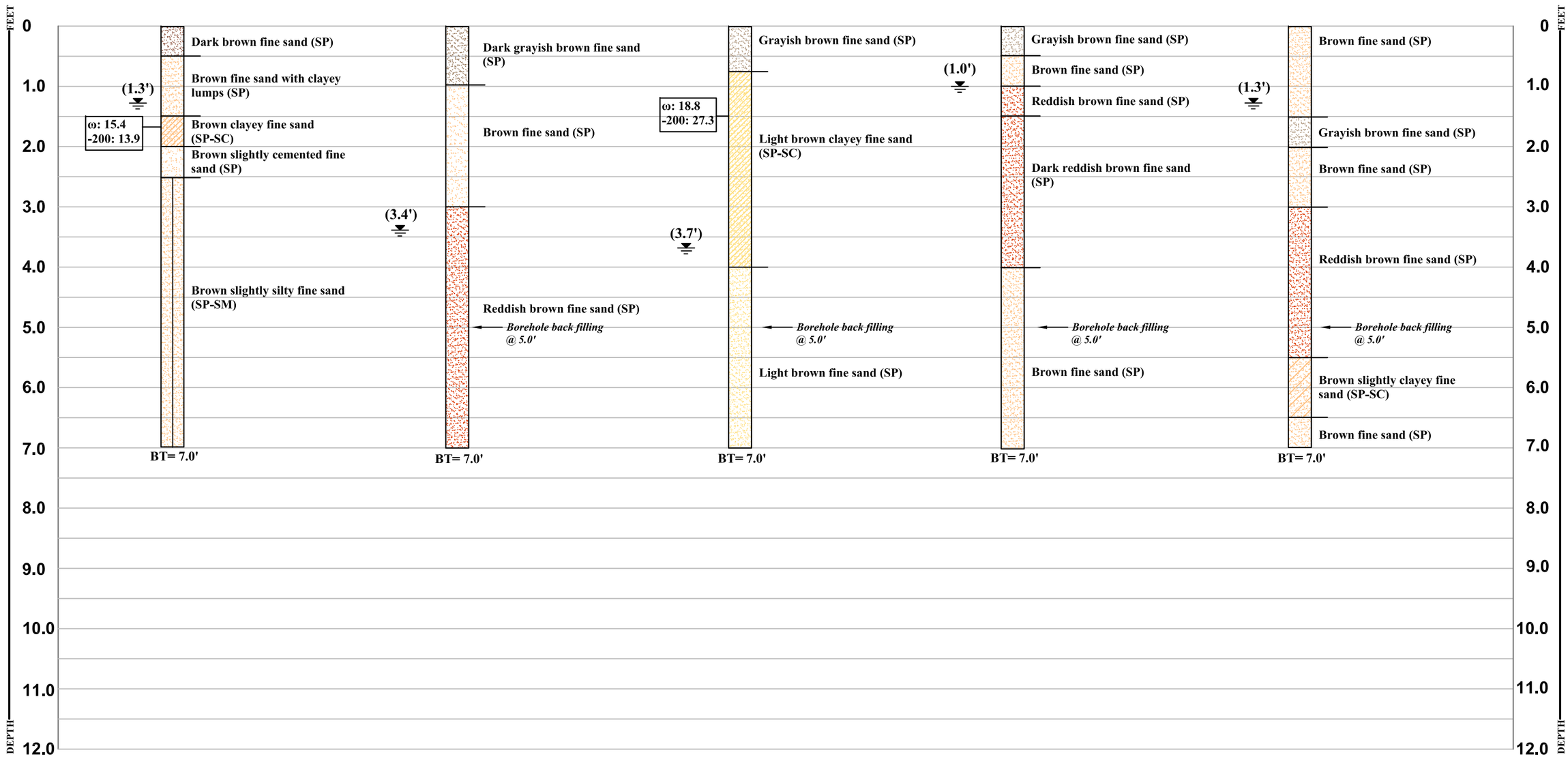
Figure Name:
SOIL PROFILES FOR BORINGS HA-1 TO HA-5

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)

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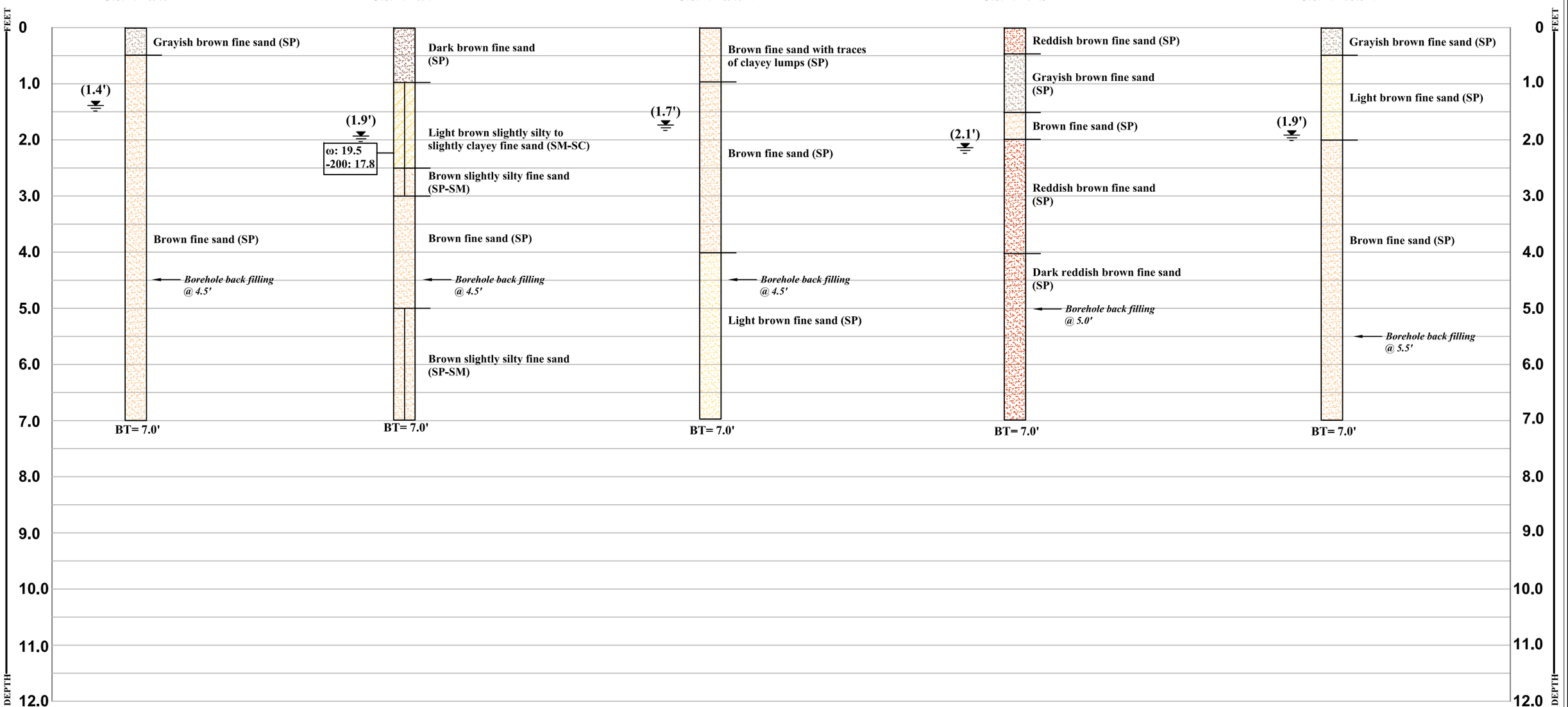
Figure Name:
SOIL PROFILES FOR BORINGS HA-6 TO HA-10

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)

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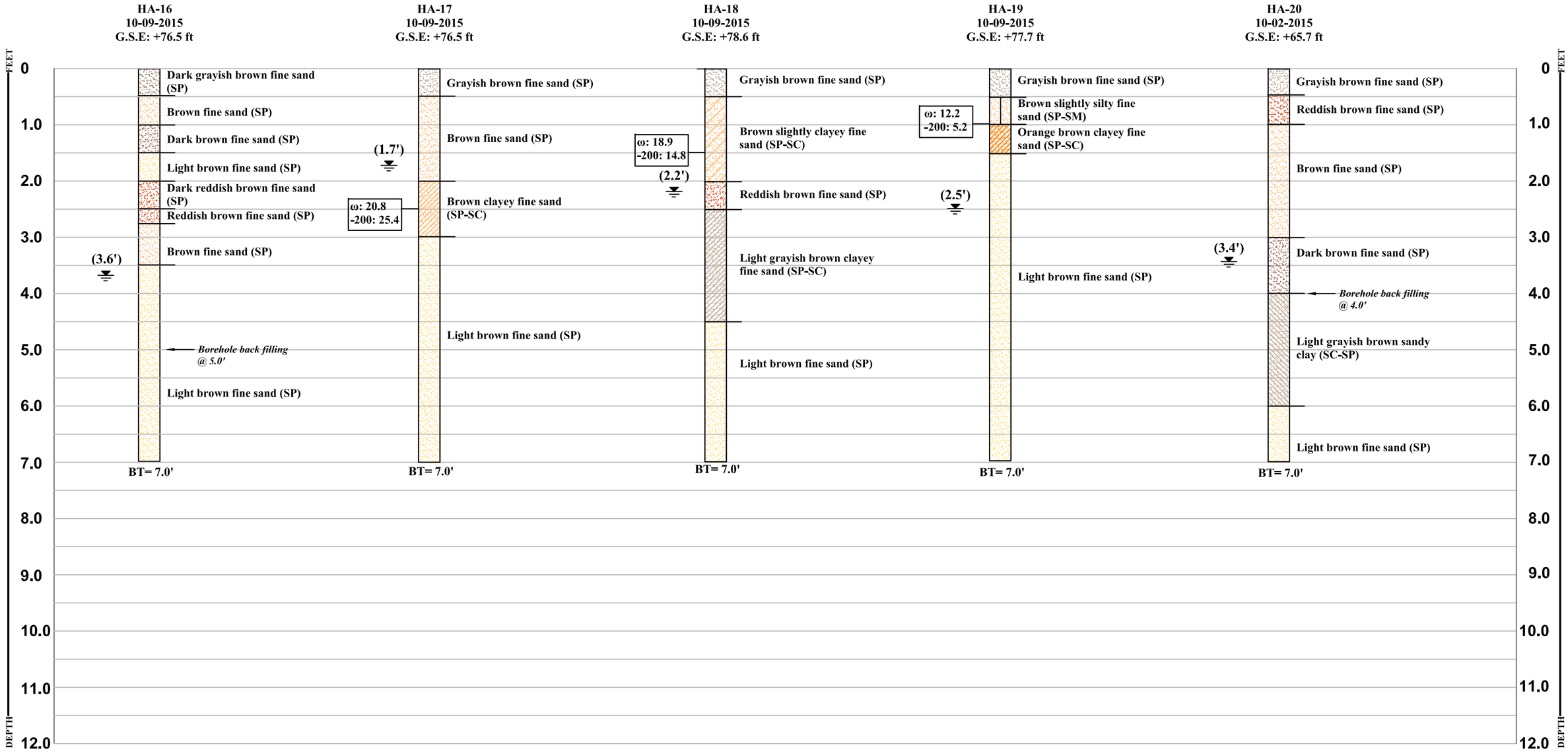
Figure Name: **SOIL PROFILES FOR BORINGS HA-11 TO HA-15**

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)

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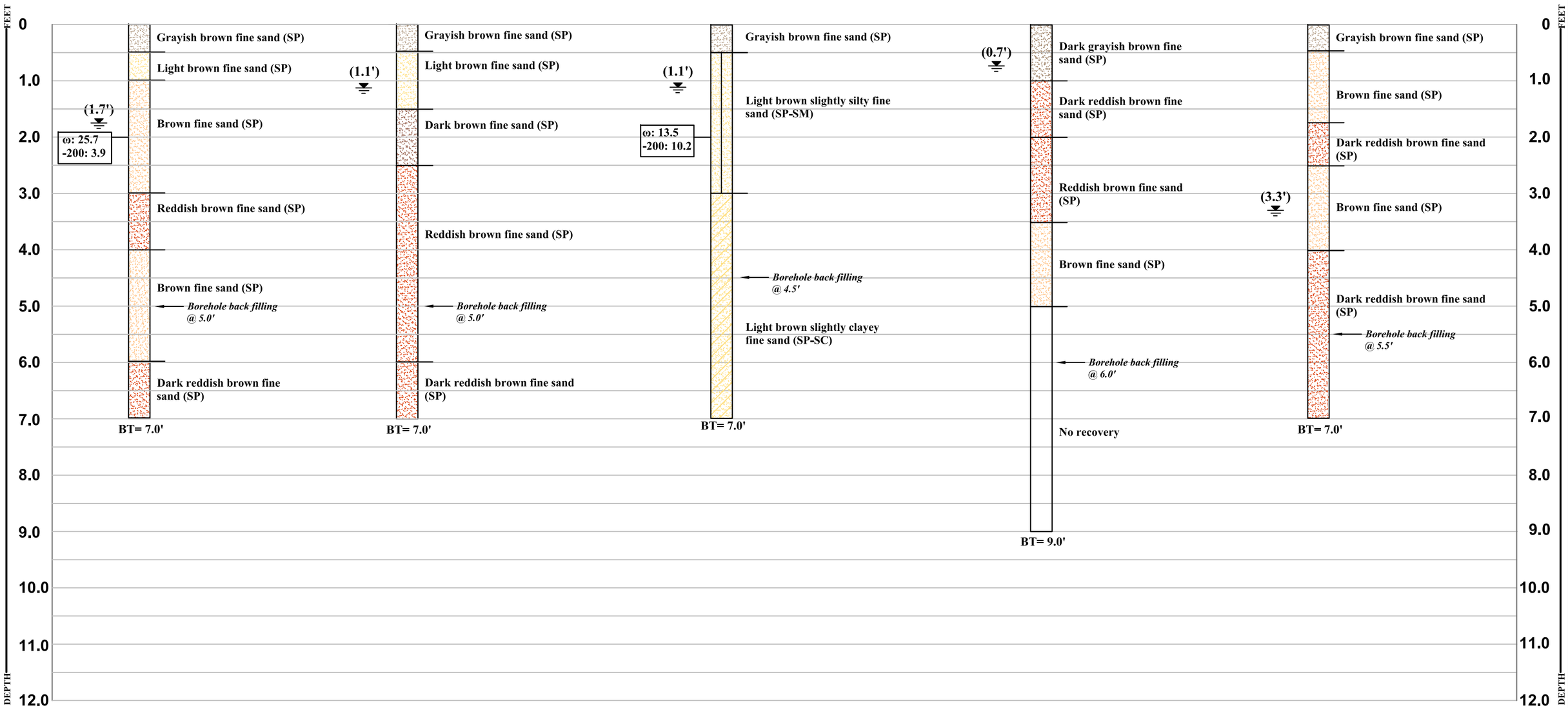
Checked & Approved by: DS	Drawn By: DS	Date: 10-02-15	Scale: Noted	Proj. # 15-610.65	FIgure 2.04

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)

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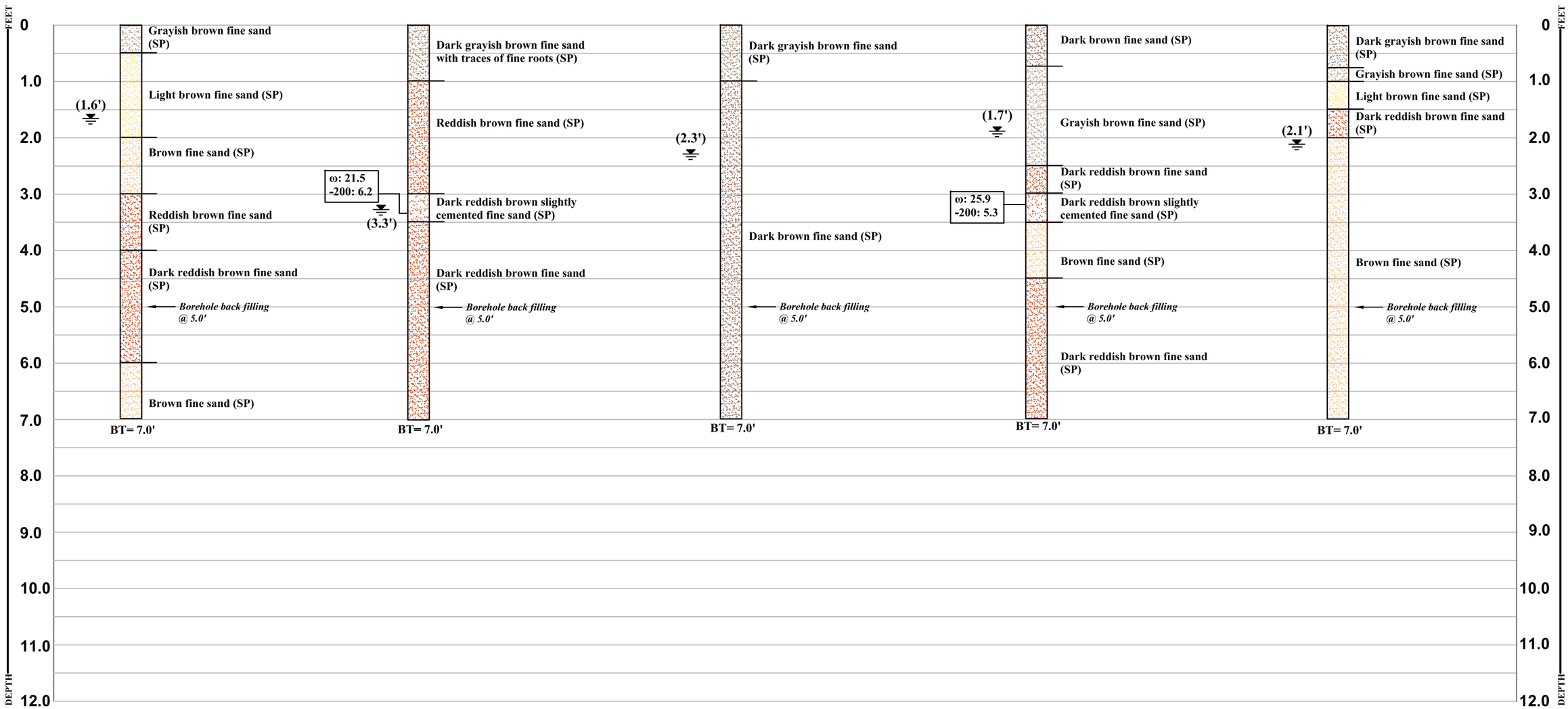
website: http://www.devoeng.com

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)

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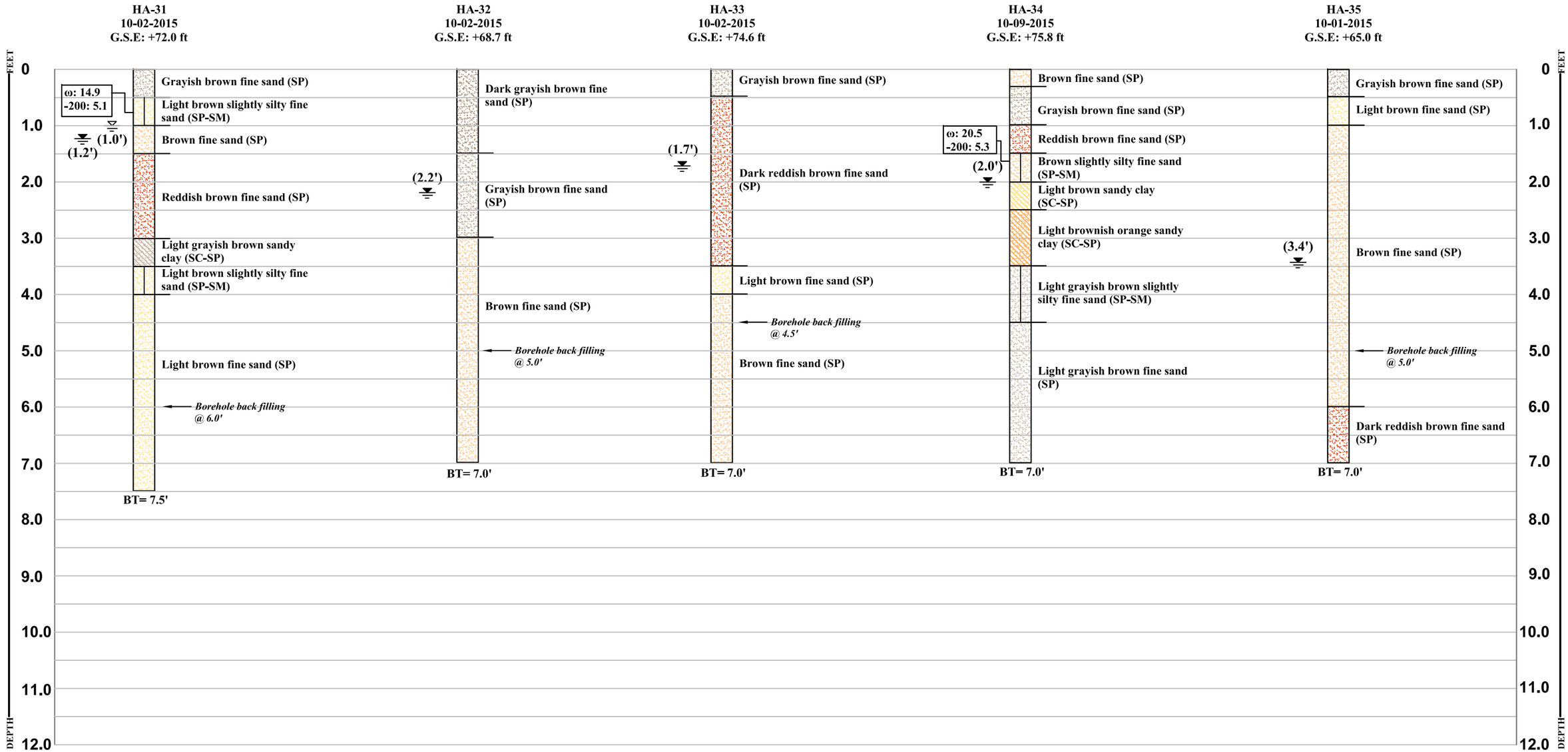
Figure Name:
SOIL PROFILES FOR HA-26 TO HA-30

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)

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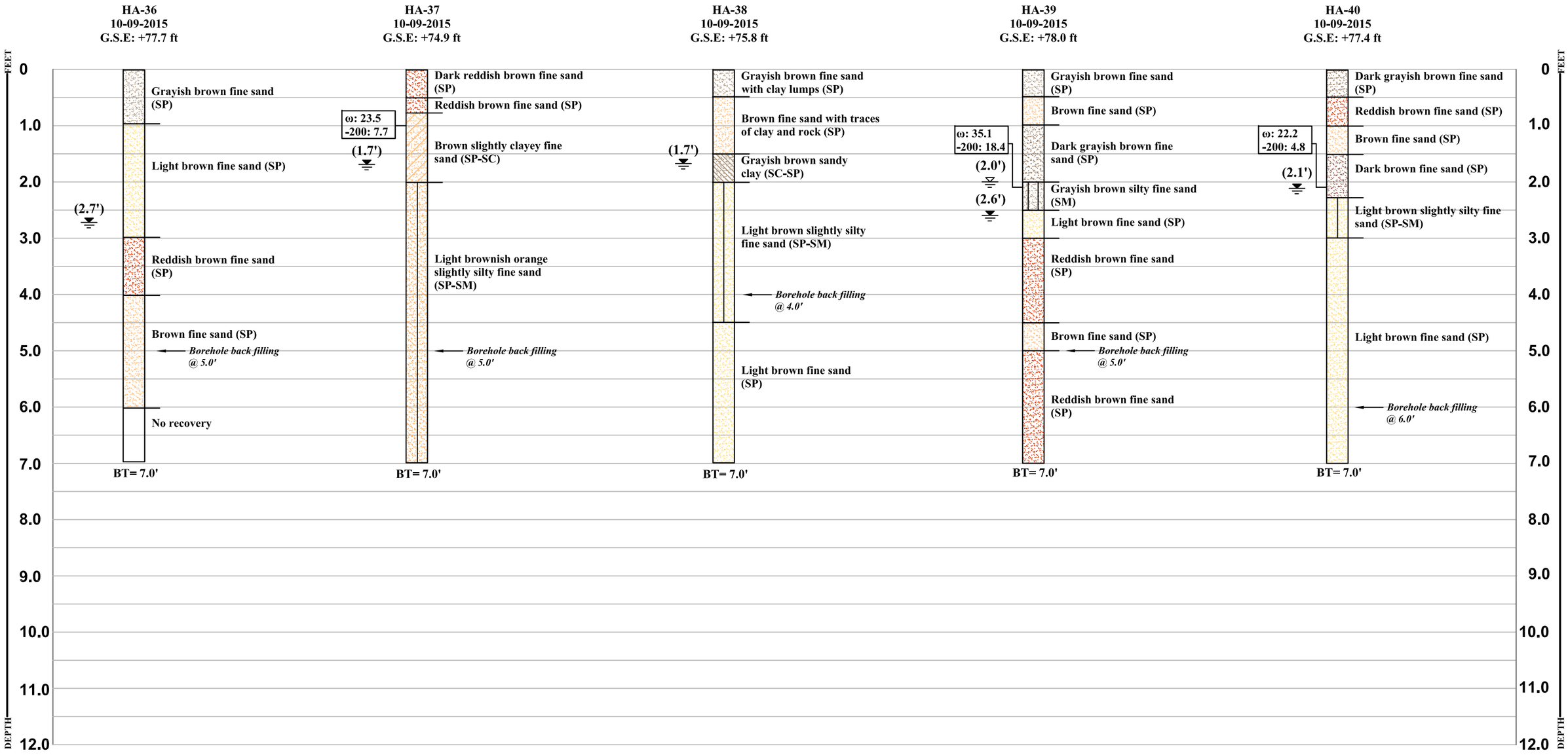
website: http://www.devoeng.com

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)

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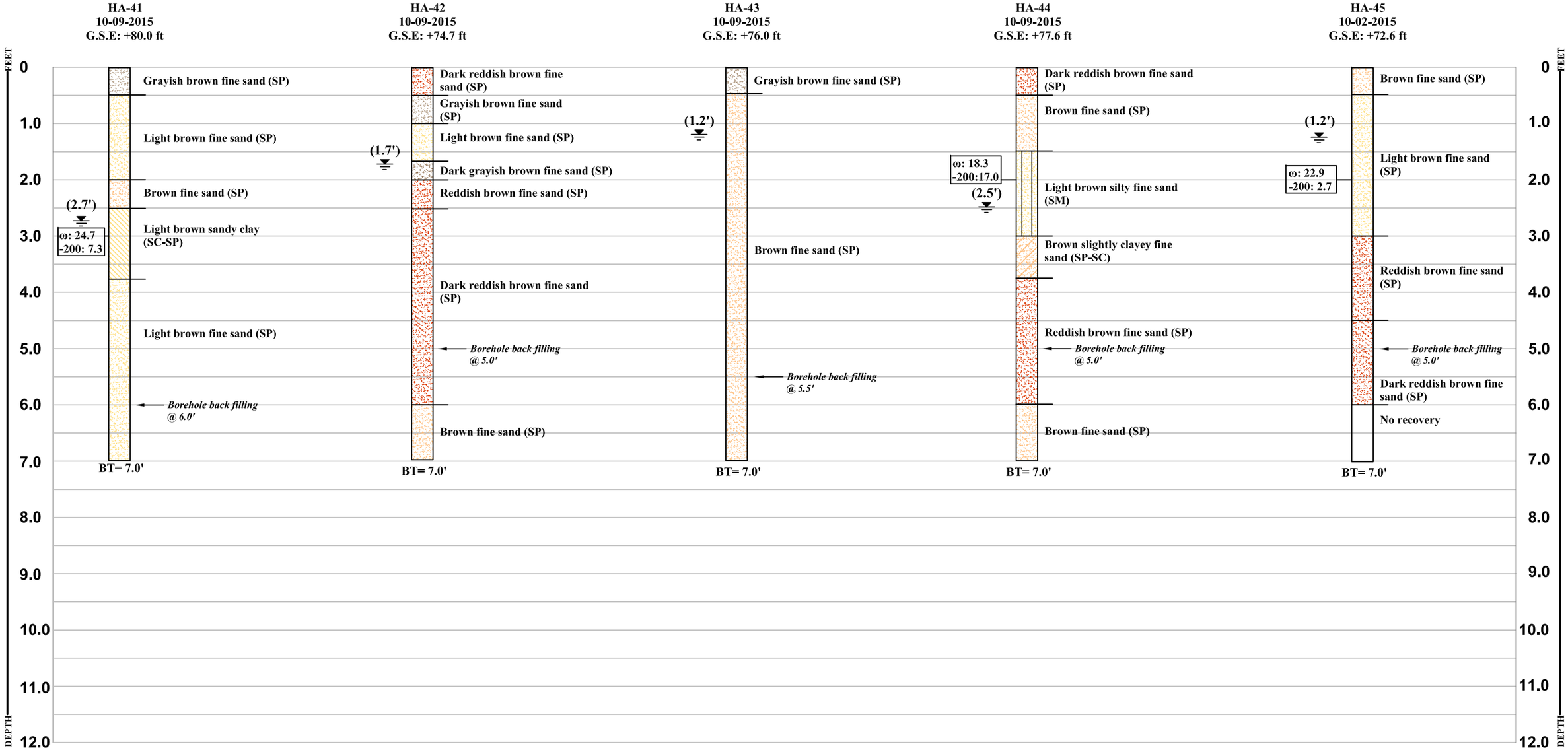
website: http://www.devoeng.com

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)

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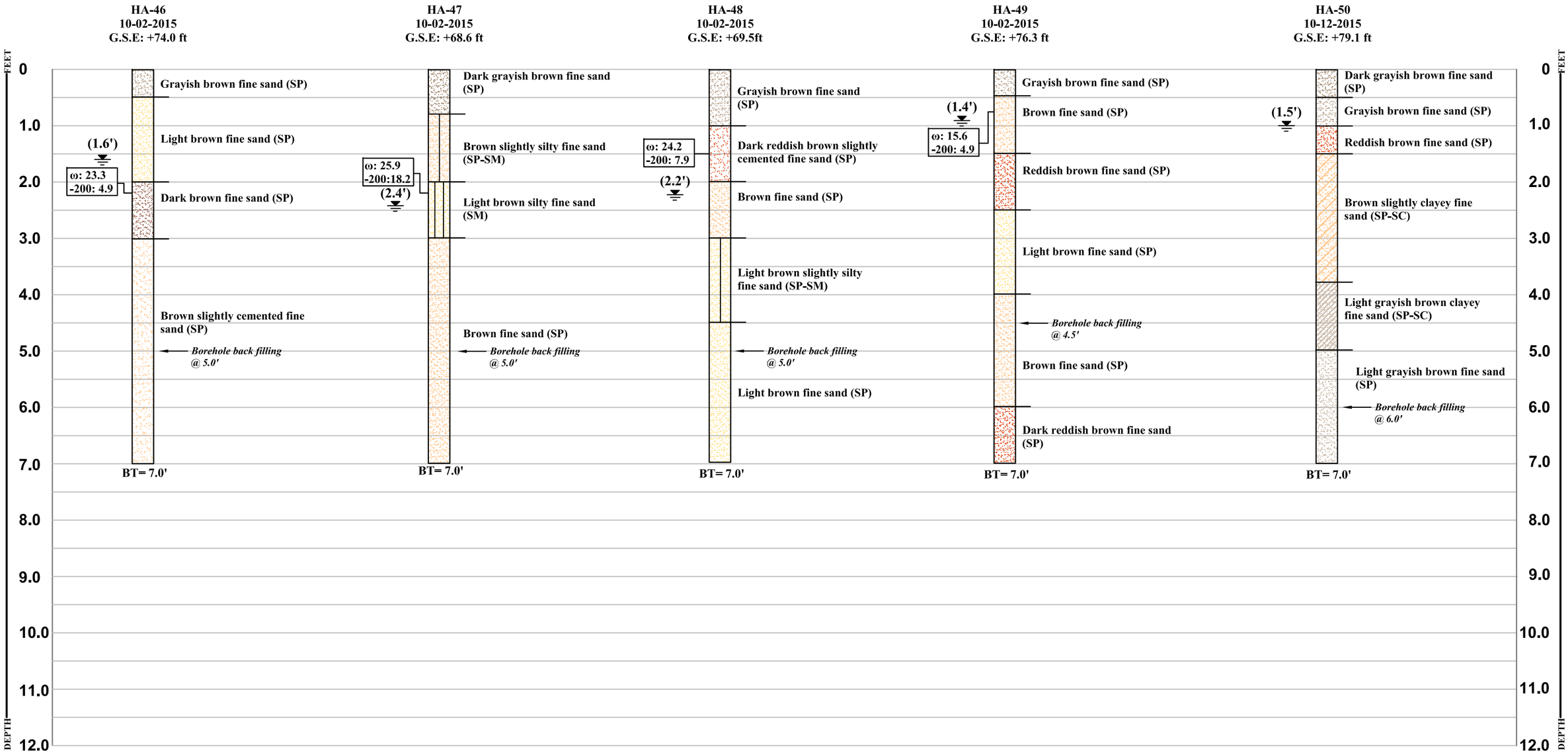
Figure Name:
SOIL PROFILES FOR HA-41 TO HA-45

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)

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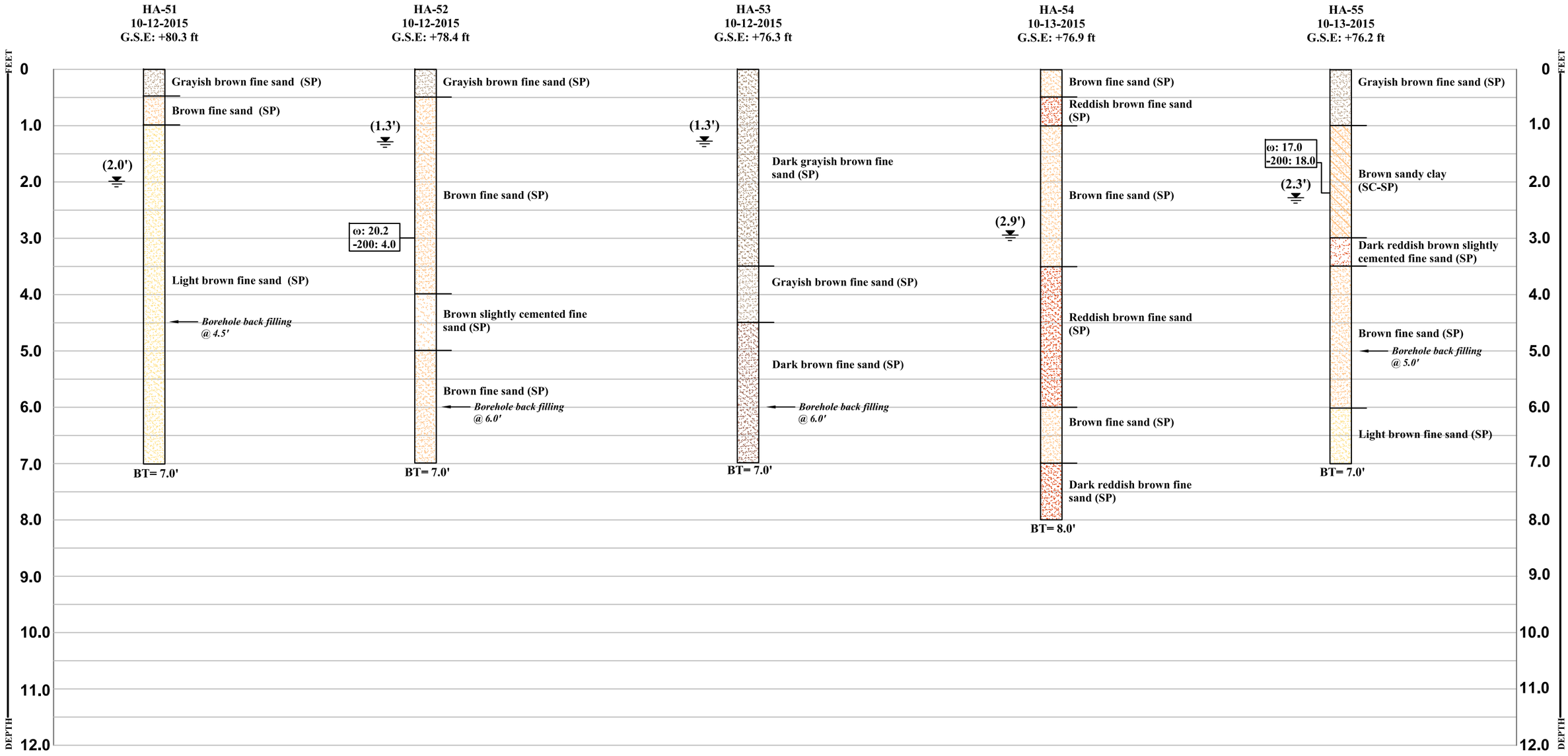
Figure Name:
SOIL PROFILES FOR HA-46 TO HA-50

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)

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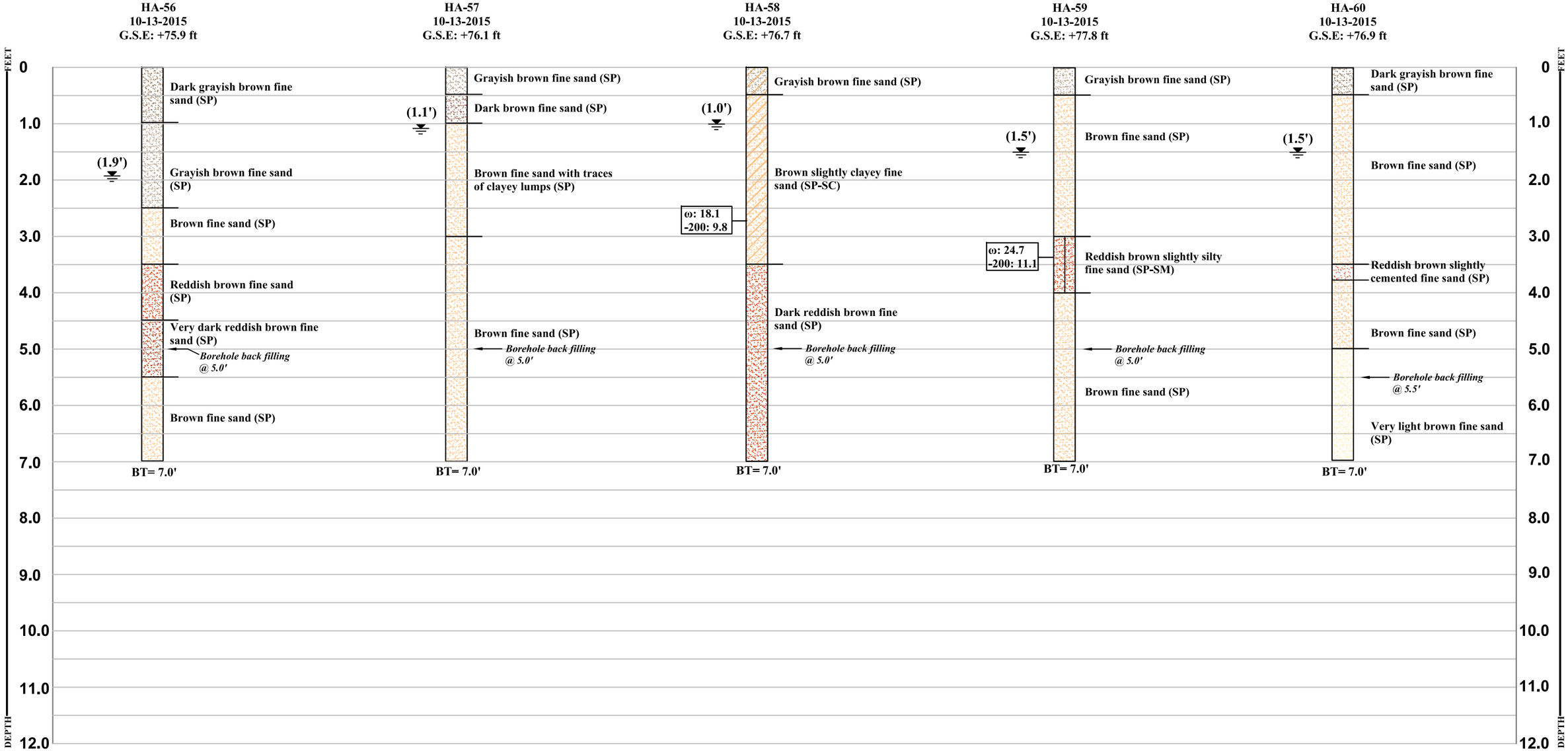
Figure Name:
SOIL PROFILES FOR HA-51 TO HA-55

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)

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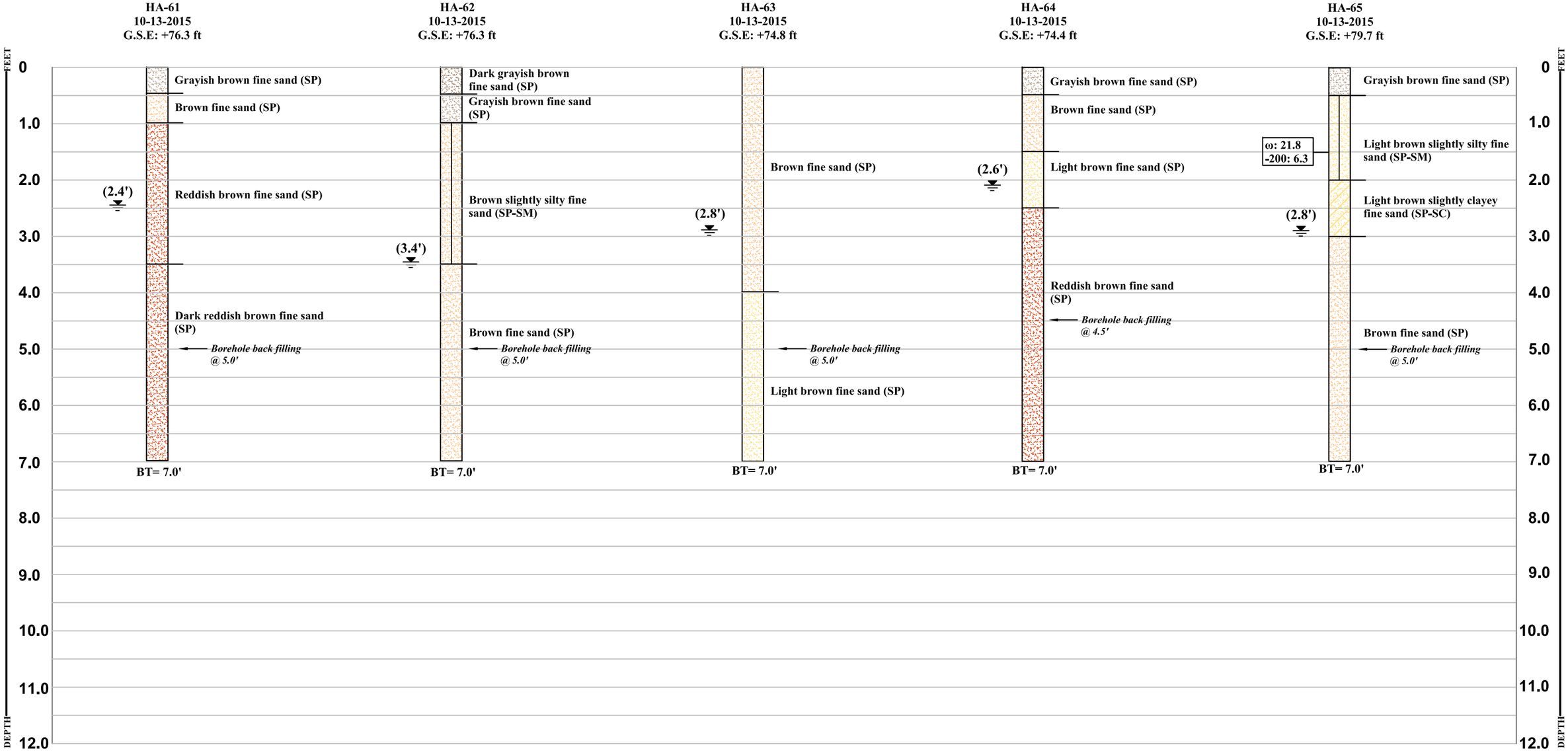
Figure Name:
SOIL PROFILES FOR HA-56 TO HA-60

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)

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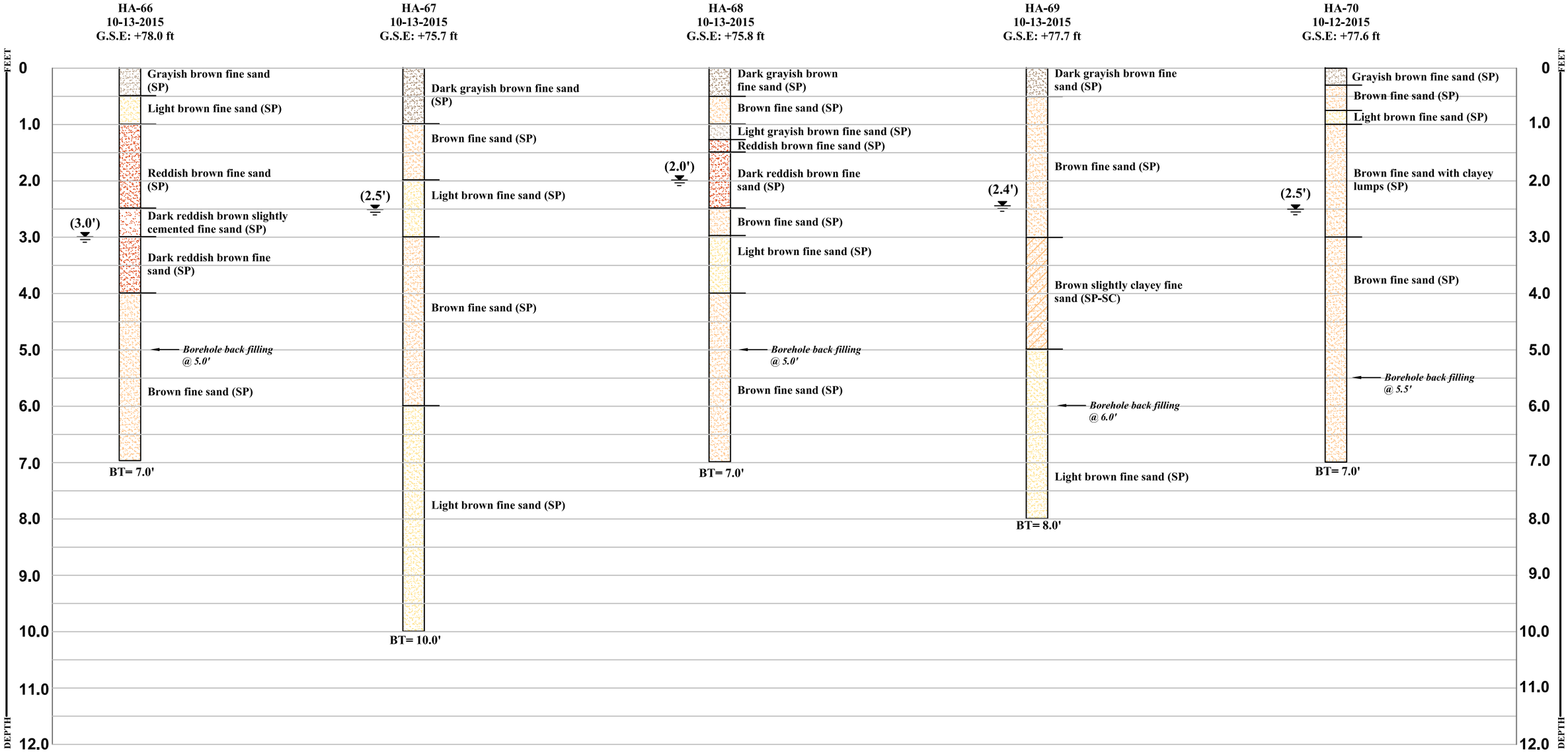
Figure Name:
SOIL PROFILES FOR HA-61 TO HA-65

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)

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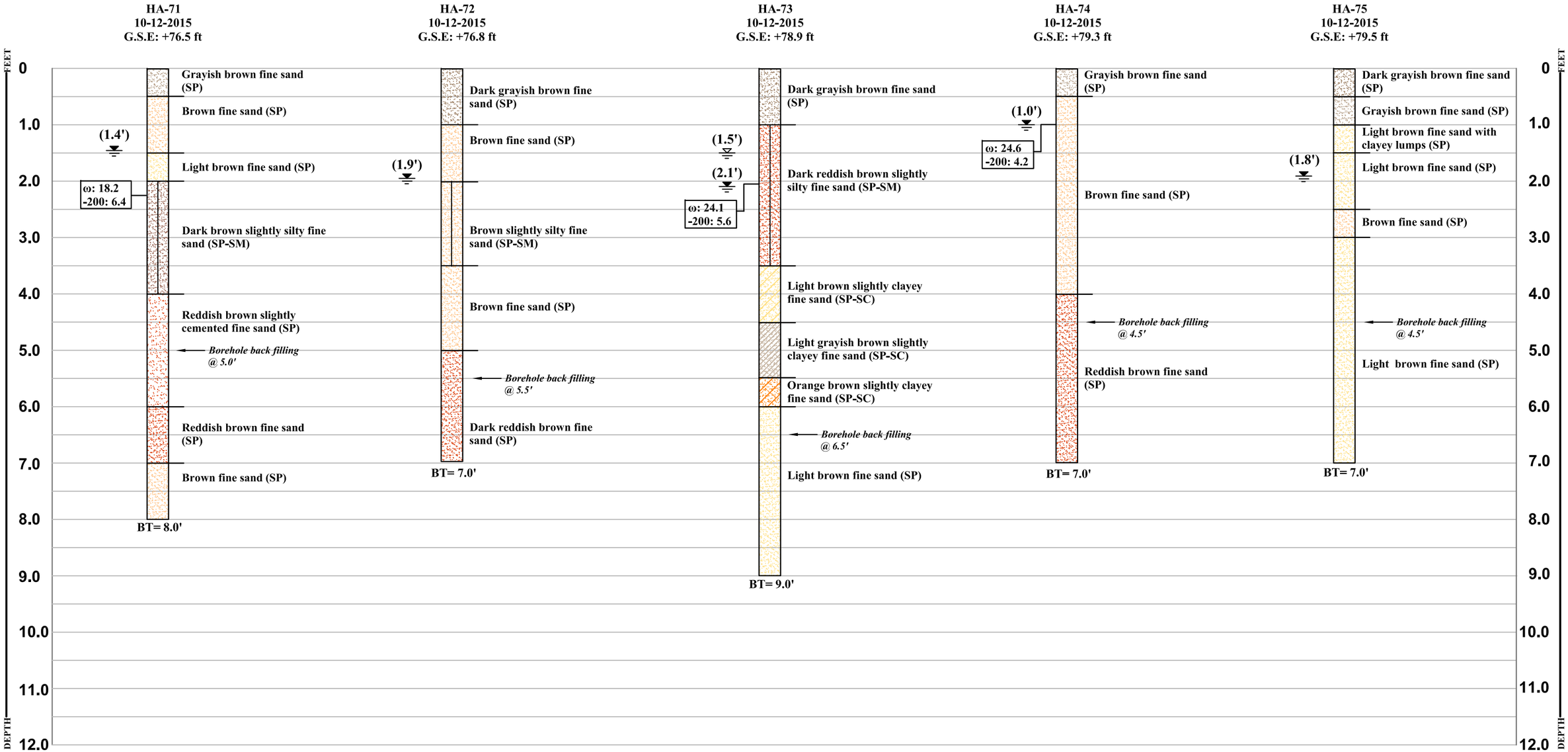
Figure Name: **SOIL PROFILES FOR HA-66 TO HA-70**

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)

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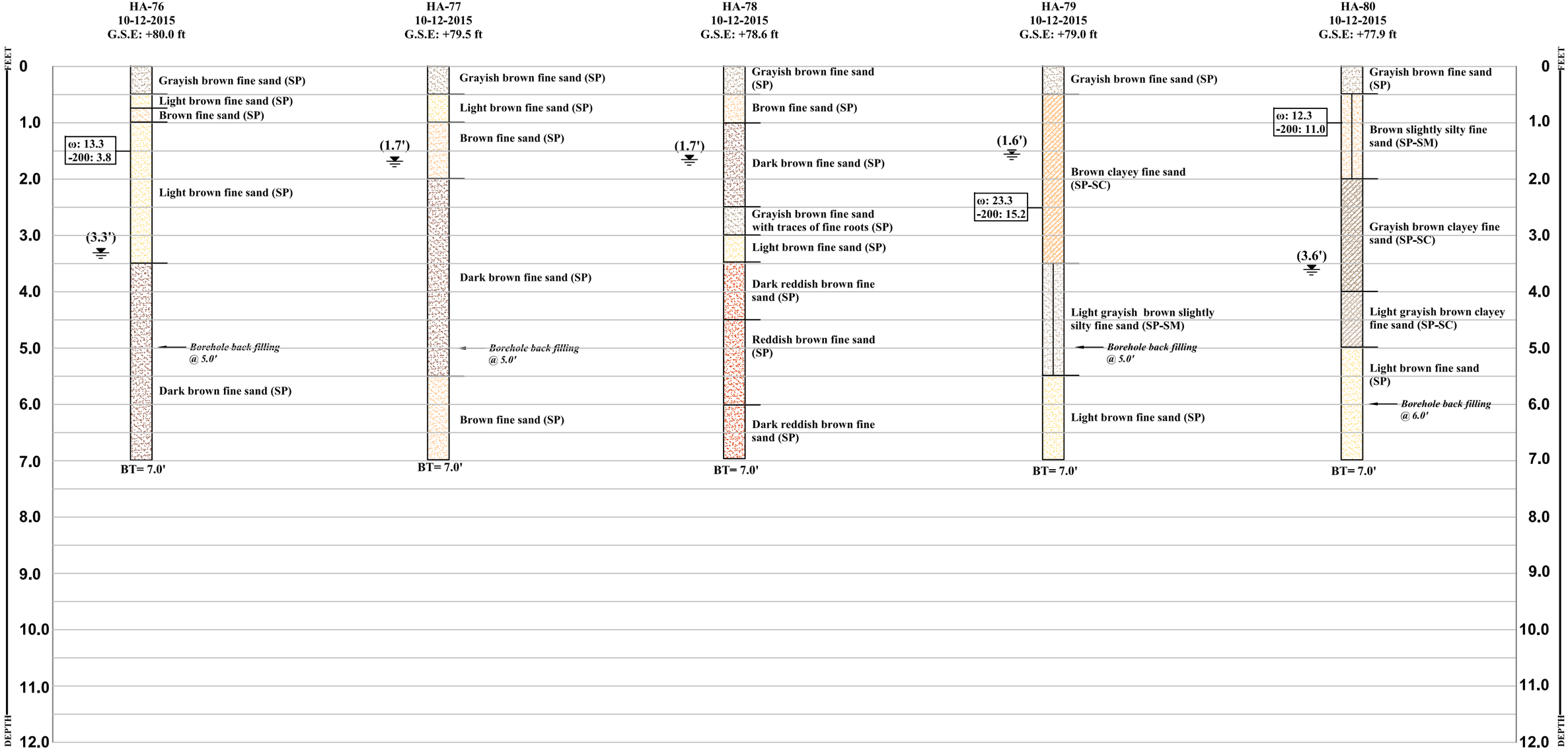
Checked & Approved by: DS	Drawn By: DS	Date: 10-12-15	Scale: Noted	Proj. # 15-610.65	Figure 2.15

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)

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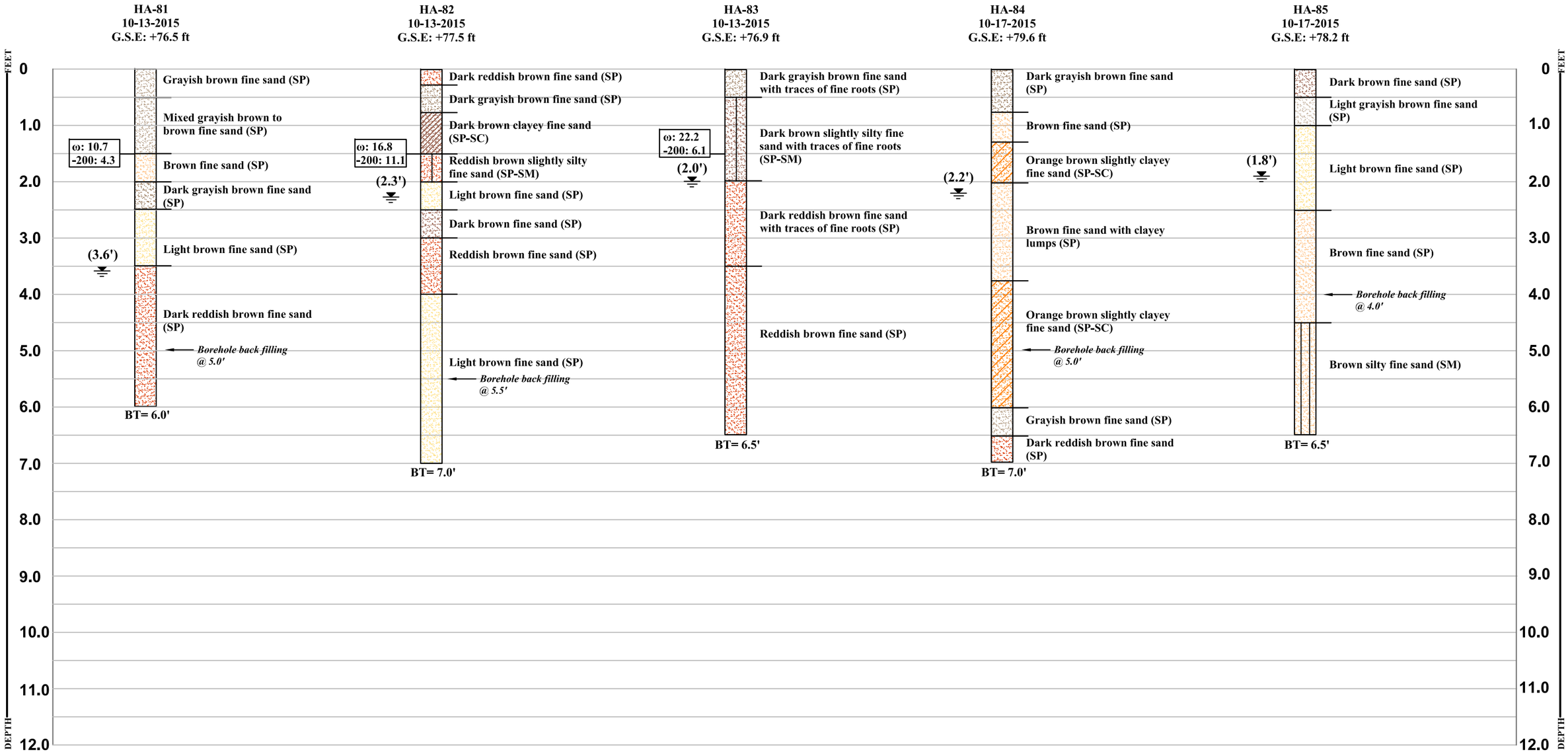
Figure Name:
SOIL PROFILES FOR HA-76 TO HA-80

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)

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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

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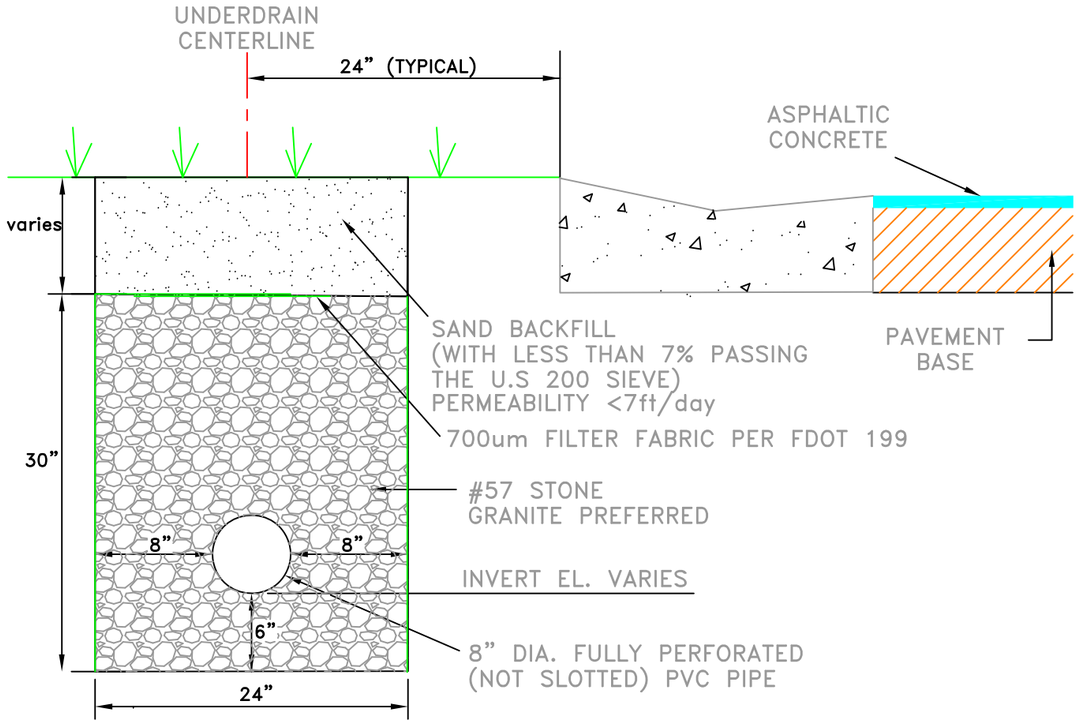
Figure Name:
RECOMMENDED UNDERDRAIN LOCATIONS

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

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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.