WHITAKER LABORATORY, INC.

P.O. Box 7078 2500 Tremont Road Savannah, Georgia 31418
(912) 234-0696 Fax (912) 233-5061 Email: info@whitakerlab.net

February 28, 2013

Julie Orr Franklin, AICP |Senior Associate
Carolinas | Town Planning + Architecture
Davidson, NC | p 704.896.1696
Greenville, SC | p 864.616.5644
Beaufort, SC | p 843.593.0204
julie.franklin@thelawrencegroup.com

Referencing: Report of Preliminary Geotechnical Evaluation Services for
Bay Street Marina
Beaufort, South Carolina
Report No.: 2-28-13-1

Dear Ms. Franklin:

As requested, WHITAKER LABORATORY, INC. has performed preliminary geotechnical services at the above referenced site in an effort to gather preliminary geotechnical information related to future construction on this lot. Authorization to perform this investigation was provided by your acceptance of our proposal dated November 2, 2012. At any time, we will be glad to discuss the contents of this report. This includes insuring that you fully consider potential problems for design and construction procedures in respect to interpretations of the data.

We understand that this site will likely be developed for multiple commercial usage including one to four-story structure(s) and paved parking/drive area(s). We have not been provided any specific data regarding foundation loads and/or site grading requirements for any planned structures. In addition, planned structure locations are unknown at this time. Therefore, the scope of this preliminary geotechnical evaluation included a visual reconnaissance and the drilling of five standard penetration test borings, which were randomly scattered throughout the property within accessible locations. Soil test borings were advanced to depths ranging from 37 to 50 feet below the ground surface.

Currently, the majority of the site consists of an existing marina, incorporating building structures and asphalt paved parking and drives areas. Intermittent grassed areas with trees reside on this site. We understand that the southern portion of this site was part of the Beaufort Waterfront Park construction project, which consisted of constructing a bulk head wall in the river and extending the property in this area out to the bulkhead wall utilizing fill soil.

Findings:

Below approximately 1 ½ to 2 ½ inches of asphalt and 4 ½ to 6 inches of aggregate base, the near surface soils across this site predominately consist of very firm to very loose sands (SP and SP-SM) extending to depths reaching 8 ½ to 12+ feet below the ground surface. It appears that the fill utilized to construct the river front park consisted of a clean sandy type soil.

Below the surface sandy stratum, very soft clays and very loose clayey sands (CH and SM-SC) were intermittently encountered bracketing elevations 8 ½ to 27 feet below the ground surface.

Below 27 feet, firm to dense sands, hard clays and dense sand/shell mix were encountered extending to the termination depths of the soil test borings at 37 to 50 feet below the ground surface. Please note that auger refusal was met due to rock being encountered within borings B-3 and B-5 at 37 and 38 feet respectively below the ground surface.

Groundwater was measured at each boring location at the time of drilling. Groundwater was encountered to range from 3 ½ to 6 feet below the ground surface elevation at the time of drilling. Please note that ground water elevations should be expected to fluctuate with the season of the year, surrounding ground surface conditions, and with recent rainfall amounts. Thus, ground water elevations encountered on this site and on this date, should be considered valid only for the date of observation.

Construction Related Concerns:

1. The inter-bedded stratifications of very loose sands and very soft clays encountered at depths bracketing elevations 3 to 27 feet below existing grades across this site are of concern. Lightly loaded structures (maximum 12 kip column loads and/or 3 kip/linear foot wall loads) that do not require the building pad to be elevated (site grades being raised 12 inches or less above existing grades to achieve finished floor slab elevations for slab-on-grade type construction) may be capable of being supported on conventional shallow spread footing foundation systems within areas of this site. Provisions should be made to utilize pile foundation systems for support of those planned structures that do not meet the criteria underlined above within the previous sentence.

2. Please note that boring B-4 would not accept backfill above a depth of 3 ½ feet below the ground surface when attempting to backfill our borehole. This is indicative of possible void space in the area at a depth approximating 3 ½ feet below the ground surface (possible utility line or stone bed). Although this possible void was present, Whitaker did not observe any ground surface depressions within the immediate area of the boring location, therefore this phenomenon does not appear to be concerning at the present time. Whitaker does recommend however, further geotechnical evaluation be performed within the area of boring B-4 prior to final site design in an effort to determine the cause of this occurrence and its impact on construction.

Earthwork Considerations:

- We recommend that the building sites plus a minimum of 10 feet beyond the perimeter of all structural areas be stripped of any existing pavement sections, organics, stumps, roots and unsuitable surface soils. Stripping depths should be anticipated to extend 8 inches or more to effectively remove all unsuitable surface materials.

- After stripping, the exposed subgrade soils should be thoroughly compacted in-place to 95% of ASTM-D-1557 and pass proof-rolling inspections prior to filling operations begin. Areas found to pump or deflect should be undercut to a competent material and backfilled with an approved compacted material. The exposed subgrade soils should be inspected, tested and approved by Whitaker Laboratory personnel prior to fill placement begins.

- Any fill or backfill required to level or raise the site should be placed in 8 to 10 inch thick, loose lifts and compacted by appropriate compaction equipment to 95% density in accordance with ASTM D-1557.

- All of the fill and backfill (including utility line backfill) for this project should consist of clean, free draining granular soils. The fill should be free of objectionable roots, clay lumps, organics and other debris. The fill should be readily compactable during placement. Soils classified as SW, SP, SP-SM or SM with a maximum of 15% passing a #200 sieve may be acceptable. Soils with the minus #200 fraction classified as MH, CH, OH, ML, CL or SC may be rejected. Soils with a maximum plasticity index of 25 and a maximum liquid limit 40 may be acceptable for use only beneath building pads which are situated well above the groundwater table with approval from the geotechnical engineer. Soils classified as SC or CL, exhibiting moisture sensitivity, soils with excessive clay content, or excessive moisture should not be used without approval from the geotechnical engineer. Approved sands will also need to be moisture conditioned as necessary to facilitate proper compaction throughout its entire depth. If utility trenches cannot be sufficiently dewatered to readily allow compaction of the specified pipe bedding material, then a class I (ASTM-D-2321) gravel or gravel mixture will be required.

Preliminary Foundation Recommendations:

Additional soil test borings shall be performed within each building pad footprint area, a full geotechnical evaluation performed and a final geotechnical report submitted prior to final design of the structures on this site. The final geotechnical report shall ultimately specify the recommended foundation system to support each individual structure on this site. The following recommendations shall be considered preliminary and utilized for budgeting purposes only.

Shallow Spread Footing Foundations:

Areas of the subject site could potentially be made suitable for construction of light weight commercial construction (maximum foundation loads of 12 kips per column and/or 3 kips per linear foot for walls and finished floor slab elevations residing a maximum of 12 inches above existing grades), utilizing shallow spread footing foundations with slab-on-grade flooring. If shallow foundation systems are deemed feasible, bearing pressures of 1500 should be anticipated. Any individual or strip footing should have a minimum plan dimension of 24 inches. Bearing elevations of foundations should be at least 12 inches below grade, a maximum of 18 inches below existing grades and above the groundwater table.

Bottom of footing excavations should be thoroughly compacted to meet or exceed 95% of the soils modified proctor maximum dry density in accordance with ASTM-D-1557. Footing inspections should also be conducted by performing dynamic cone penetrometer testing within bottom of footing excavations to verify adequate bearing material is present. Subsurface bearing soils deemed unsuitable based upon dynamic cone penetrometer testing or visual classification should be undercut to a competent material and backfilled with an approved material.

Pile Foundation Systems:

Structures having foundation loads that exceed 12 kips per column and/or 3 kips per linear foot for walls shall be budgeted to be supported on a pile foundation system. In addition, if site grades require being raised by more than 12 inches, slabs-on-grade shall be designed as structural slabs (pile supported). Please note that depending upon the magnitude of foundation loads and if site grades require being elevated more than 12 inches, surcharge loading the building pad prior to utilizing shallow spread footing foundations may be feasible to eliminate the necessity to utilize pile foundations for support of structures. We have discussed surcharge loading below for your information.

Please view the below chart for anticipated performance of various pile types:

Pile Type	Length	Capacity: (axial)	(Uplift)	(Lateral)
14" Auger-Cast	40 - 50 feet	40 - 60 tons	5 to 10 tons	3 tons
14" Pre-stressed Concrete	37 - 45 feet	40 - 60 tons	5 to 10 tons	3 tons
12" Timber	25 - 37 feet	25 tons	2 to 5 tons	1 ton

Notes:

14" Auger-Cast:

- Grout fill should have a minimum 28-day strength of 4000 psi.
- Auger cast piles should be installed with a minimum grout factor of 1.5, unless otherwise proven by load testing.
- Minimum reinforcing should consist of at least one full length # 8 bar, installed after the grout fill, and a reinforcing cage in the upper 20 feet of pile.

14" Pre-Stressed Concrete:

- Piles should be precast, a minimum of 14 inches square, and adequately reinforced to withstand all handling and driving stresses.
- Concrete should have a minimum 28-day compressive strength of 5000 psi.

Timber Piles:

- Timber piles should have a minimum tip dimension of 8 inches and a minimum butt dimension of 12 inches, measured 3 feet from the butt.
- Piles should be preservative treated to meet the applicable building codes.

General:

- Lateral capacities provided are for loads applied at the ground surface (assuming a "free head" condition) producing deflections approximating ½ of an inch also at the ground surface. Any fixity afforded at the pile top by embedment in a concrete pile cap will reduce both the deflection and the bending moment.
- For auger cast piles, at least 4 probe piles should be performed at various locations across the site to verify materials encountered are consistent with those found within the soil test boring and the equipment utilized is adequate to penetrate a minimum of 5 feet beyond planed termination depths. For all other piles, at least 4 indicator piles should be driven prior to ordering final pile lengths for the project. These indicator piles should be long enough to penetrate at least 5 feet longer than the lengths mentioned above. Indicator piles could be driven in permanent pile locations.
- For each pile type and/or capacity we recommend that a minimum of one full-scale load test be performed. The load test locations should bracket the site, and be selected after the initial probe or indicator piles are driven. Load tests should be in accordance with the "quick" procedures of ASTM D-1143.
- Piles should be installed utilizing properly sized power hammers. Compatibility of the pile hammer, cushioning material, and pile should be evaluated by wave equation analyses and submitted to the engineer for approval prior to initiating pile driving operations on site.
- Piling contractors should be responsible for ordering piles of proper length, as well as, (1) cutting off piles not driven to grade, and (2) extending piles driven below cut-off elevation.

- Unanticipated circumstances often arise during pile installation. We recommend that our engineers be retained to provide on-site installation surveillance, inspection, and testing, thereby being readily available to assist in the evaluation of any events or conditions encountered, that differ from those anticipated. Installation records, to include all probe or indicator pile data, load test results, and production pile installation or driving records, should be maintained by Whitaker Laboratory, Inc personnel.

Surcharge Loading:

If site grades require being raised by more than 12 inches above existing grades to achieve finished floor slab elevations and/or if foundation loads exceed 12 kips per column and/or 3 kips per linear foot, surcharge loading building pads may be required and/or could become an option to mitigate settlement potential. Surcharge loading may also allow shallow spread footing foundation elements to be utilized for support of structures instead of utilizing pile foundation systems. Due to the preliminary nature of this report, specific requirements cannot be provided for surcharge loading at this time, however we offer the following:

Surcharge loading building sites prior to foundation construction is typically performed in an effort to reduce potentially damaging settlement to the structure. Surcharge loading, also known as "pre-loading", in general, consists of adding sufficient weight "surcharge" to the building pad area utilizing stockpiled soil (placed above finished floor slab elevations) prior to construction. This surcharge loading will be in addition to the weight of any permanent structural fill placed on the site. The weight of the stockpiled soil will allow the very loose and very soft soils encountered below the ground surface to compress/consolidate. Once it is determined that the subsurface soils have consolidated fully under the weight of the stockpiled soil, the stockpiled soil can be removed and the building can be constructed within the pad area on shallow spread footing foundation elements.

The surcharge fill thickness is dependent upon foundation loads, foundation bearing elevations, bearing pressures, and depth to compressible soil stratifications. For estimation purposes, surcharge fill thicknesses typically range from 5 to 7 feet above finished floor slab elevations.

Settlement monitoring plates are installed within the mass of the permanent fill and extended above the surface of the surcharge fill. Settlement readings are made and recorded during the construction of the surcharge fill, and at one-week intervals after completion of fill. The surcharge fill remains in-place until settlement readings indicate the total consolidation of the site, and continuing rate of consolidation, has reached an acceptable level. The removal of the surcharge fill shall be when and as directed by the geotechnical engineer. Typically surcharge fill requires to remain in-place 60 to 90 days, but the decision to remove the fill will is based on the data collected from the settlement monitoring plates.

Pavement Considerations:

Subgrade for driveways and parking areas should consist of a minimum of 24-inches of clean sand subgrade compacted to a density of 95% of its maximum dry density as determined by ASTM-D-1557. Pavement designs should also provide a minimum of 24-inches separation between the bottom of the base course material and the seasonal high ground water table. Undercutting, re-compacting, and/or replacing of existing surface soils will be required unless subgrade consists of organic free, virgin sandy soils that are proven to be a minimum of 24-inches thick, 24-inches above the seasonal high ground water table, compacted to 95% of ASTM D-1557 and passes a proof-roll. Final grades and elevations will determine the extent of any filling, undercutting and backfilling that may be required.

The pavement design must provide for the pavement subgrade soils to drain and not ever become saturated by surface water, perched groundwater or groundwater table.

Due to groundwater residing 3 ½ + feet below existing grades across this site, combined with near surface soil conditions consisting of sandy soils on this site, the in-situ sandy soils can be made suitable for use as pavement subgrade material as log as the in-place sandy soils are compacted for a full 24-inch depth below bottom of pavement section elevations. In addition, the use of under drains should not be necessary as long as pavement grades are not lowered below existing ground surface elevations.

All proof rolling, construction observations, compaction testing of paved areas must be in accordance with the SITE WORK section above.

If a rain event of 0.5 inches or more, occurs after initial proof rolling and prior to subsequent placement of base or surface wearing course, the proof roll testing must be repeated just prior to additional work.

The below recommended pavement sections should be considered standard and typical for the area. We have not been provided traffic data and/or been instructed to perform CBR testing on subgrade soils, therefore these pavement sections should not be considered a pavement design. The below recommended pavement sections are based upon the assumption that the sandy subgrade soils will yield a minimum CBR value of 10 if compacted to 95% ASTM D-1557 for a full 24-inch depth. In addition, the below recommended light duty pavement sections should be considered for car traffic areas only. Below recommended heavy duty sections should be utilized for all areas receiving truck traffic (delivery trucks and garbage trucks with 18-kip axle loads). In addition the heavy duty sections recommended below are for low volume truck traffic (15 to 20 trucks per day).

LIGHT DUTY PAVEMENT (CARS & LIGHT TRUCKS)

SUBGRADE:	Minimum – 24-inches of drained, compacted, coarse grained soil
BASE COURSE:	Minimum - 6 inches of graded aggregate base course
SURFACE COURSE:	Minimum - 2 inches of Hot Mix Asphalt Surface Course Type 1C

HEAVY DUTY PAVEMENT (LOADED TRUCKS WITH 18+ kip AXLE LOADS)

SUBGRADE:	Minimum – 24-inches of drained, compacted, coarse grained soil
BASE COURSE:	Minimum - 8 inches of graded aggregate base course
BINDER COURSE:	Minimum - 2.0 inches of Hot Mix Asphalt Binder Course Type 1
SURFACE COURSE:	Minimum - 2.0 inches of Hot Mix Asphalt Surface Course Type 1C

In all projects, a minimum mat temperature of 185° F must be maintained through final roller pass.

Please note that specifications for above mentioned base course, binder course and surface course can be found under division 300, 402 and 403 respectively of the South Carolina Department of Transportation Standard Specification for Highway Construction, Edition of 2000. The mix design must include "lime".

PORTLAND CEMENT CONCRETE PAVEMENT

SUBGRADE:	Minimum – 24-inches of drained, compacted, coarse grained soil
HEAVY DUTY:	8 inches of Portland cement concrete with minimum compressive strength of 4000 psi.
LIGHT DUTY & RESIDENTIAL:	5 inches of Portland cement concrete with minimum compressive strength of 4000 psi

Whitaker Laboratory recommends incorporating a minimum of 4-inches of graded aggregate base course below the above concrete pavement sections for maintaining a smooth and level surface during placement of the pavement section.

Joints must be placed a MAXIMUM spacing in FEET of 2.5 times the pavement thickness in inches, and in no case more distant apart than 15 feet.

Pavement Design should include:

- Requirements to seal all pavement joints to prevent surface water entry into base / subgrade. Such provision should minimize pumping failures at joints.

- Requirements that pavement sections and panels subject to repetitive braking and/or acceleration should be designed with lug anchors or tie-bars to minimize separation or misalignment at the joints.

- Provisions for load transfer across construction joints by dowels or other acceptable means.

- In general, the design should follow the recommendations and practices for all components as described in ACI 330.1 and/or ACI 330R as applicable.

Liquefaction:

Liquefaction typically occurs when very loose to loose non-cohesive soils encountered below the groundwater table experience a significant loss of shear strength due to the increase in porewater pressure resulting from seismic vibrations.

Based upon the design earthquake (Charleston, SC earthquake with magnitude 7.3 and a 2% probability of exceedance in 50 years) and characteristics of subsurface soils, the liquefaction analysis indicated that the encountered sand stratifications present below the groundwater table have potential to liquefy during the design seismic event. The amount of settlement estimated during and shortly after a seismic event of this magnitude ranged from 1 inch (within B-1) to 6 inches (within B-3).

If the risk of anticipated settlements due to liquefaction are unacceptable to the owner, extensive ground modification would need to be performed on the liquefiable soil stratums or supporting the structure on pile foundation systems bearing below the potentially liquefiable soil zones would be required.

Seismic Parameters for Structural Design:

In accordance with International Building Code 2006 (IBC 2006), this site would be defined as both a Site Class "D" and a Site Class "E". The classification is determined by weighted average soil properties in the top 100 feet of the soil profile, including standard penetration test N values, shear wave velocities, in-situ shear strengths and moisture contents, as specified by IBC 2006.

Seismic parameters are provided below:

Site Class D **B-1**	Site Class E **B-2**
S_s = 0.690	**S_s = 0.690**
S_1 = 0.183	**S_1 = 0.183**
F_a = 1.248	**F_a = 1.32**
F_v = 2.069	**F_v = 3.252**
S_{MS} = 0.861	**S_{MS} = 0.911**
S_{M1} = 0.378	**S_{M1} = 0.594**
S_{DS} = 0.574	**S_{DS} = 0.607**
S_{D1} = 0.383	**S_{D1} = 0.396**

Borings performed within actual building footprint areas will dictate which site class the building will fall under. Shear wave velocity testing can be performed during the final phase of geotechnical services in an effort to arrive at a site class "D" for each building site on this property.

Please note that structures having a period of vibration in excess of 0.5 second will require a site specific seismic evaluation to be performed to arrive at site specific values for S_{DS} and S_{D1}.

General:

Due to the limited information collected across the site, the above recommendations should be considered preliminary, and utilized as such. Whitaker Laboratory recommends that each individual structure on this site have an appropriate amount of soil test borings performed within actual footprint areas of the structures prior to final design and construction. Final foundation recommendations shall be made after these additional borings are performed.

We have included a site vicinity plan, boring location plan, boring logs, and liquefaction data within the appendix of this report for your information.

It is a pleasure to continue service to you and we look forward to further opportunities to assist you on this and other projects.

Respectfully submitted,
WHITAKER LABORATORY, INC.

Jason H. Follo, P.E.
SC Registered Engineer
20225

J. M. Whitaker

Joseph M. Whitaker
President

APPENDIX

Site Vicinity Plan

Boring Location Plan

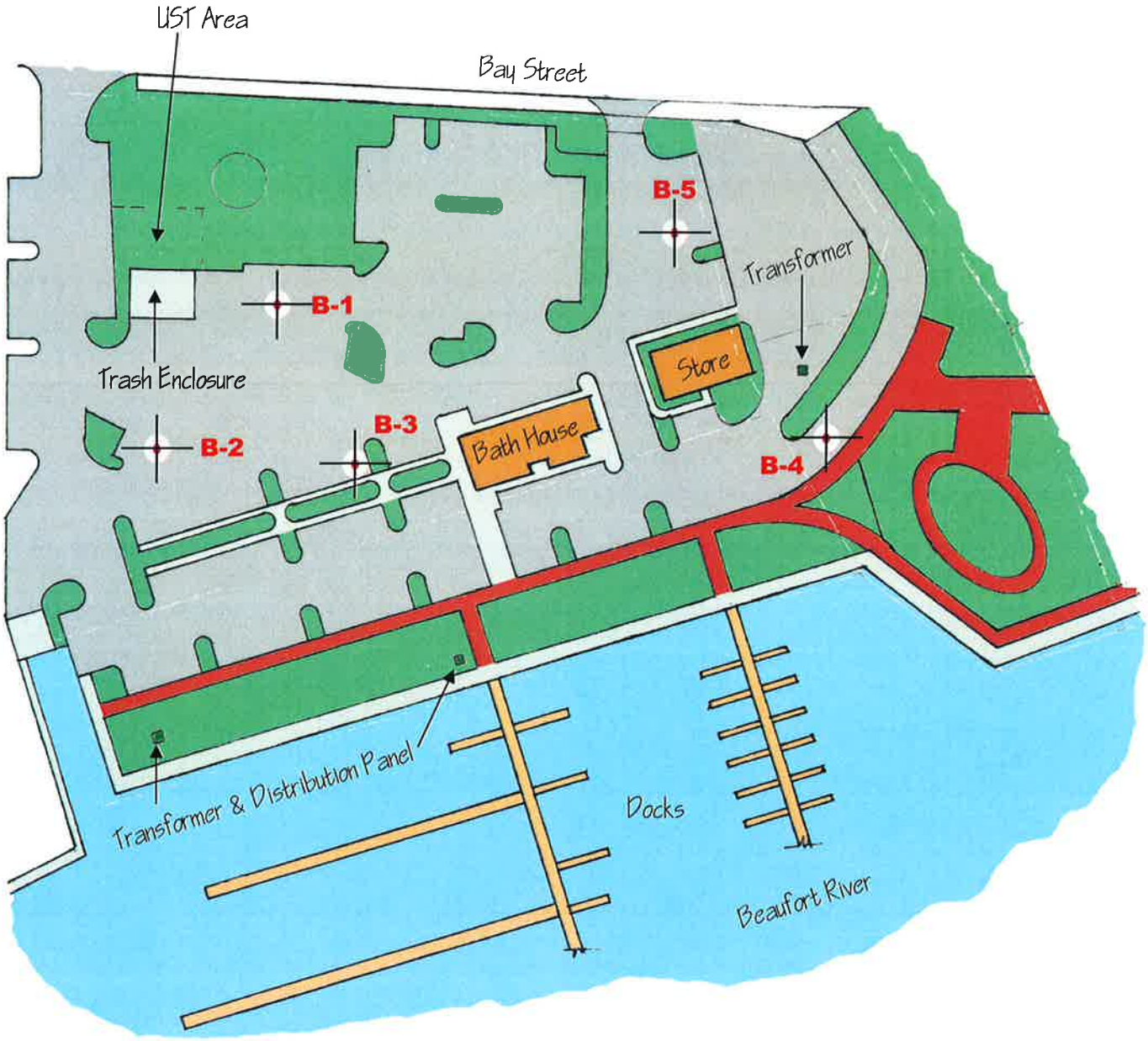
Boring Logs (B-1 through B-5)

Liquefaction Results

Site Vicinity Map

Bay Street, Beaufort Marina
Beaufort, Beaufort County, South Carolina

N



Boring Location Plan

Bay Street, Beaufort Marina
Beaufort, Beaufort County, South Carolina

N

ALL BORING LOCATIONS ARE APPROXIMATE, & ARE BASED ONLY ON FIELD ESTIMATES.

Client: Lawrence Group

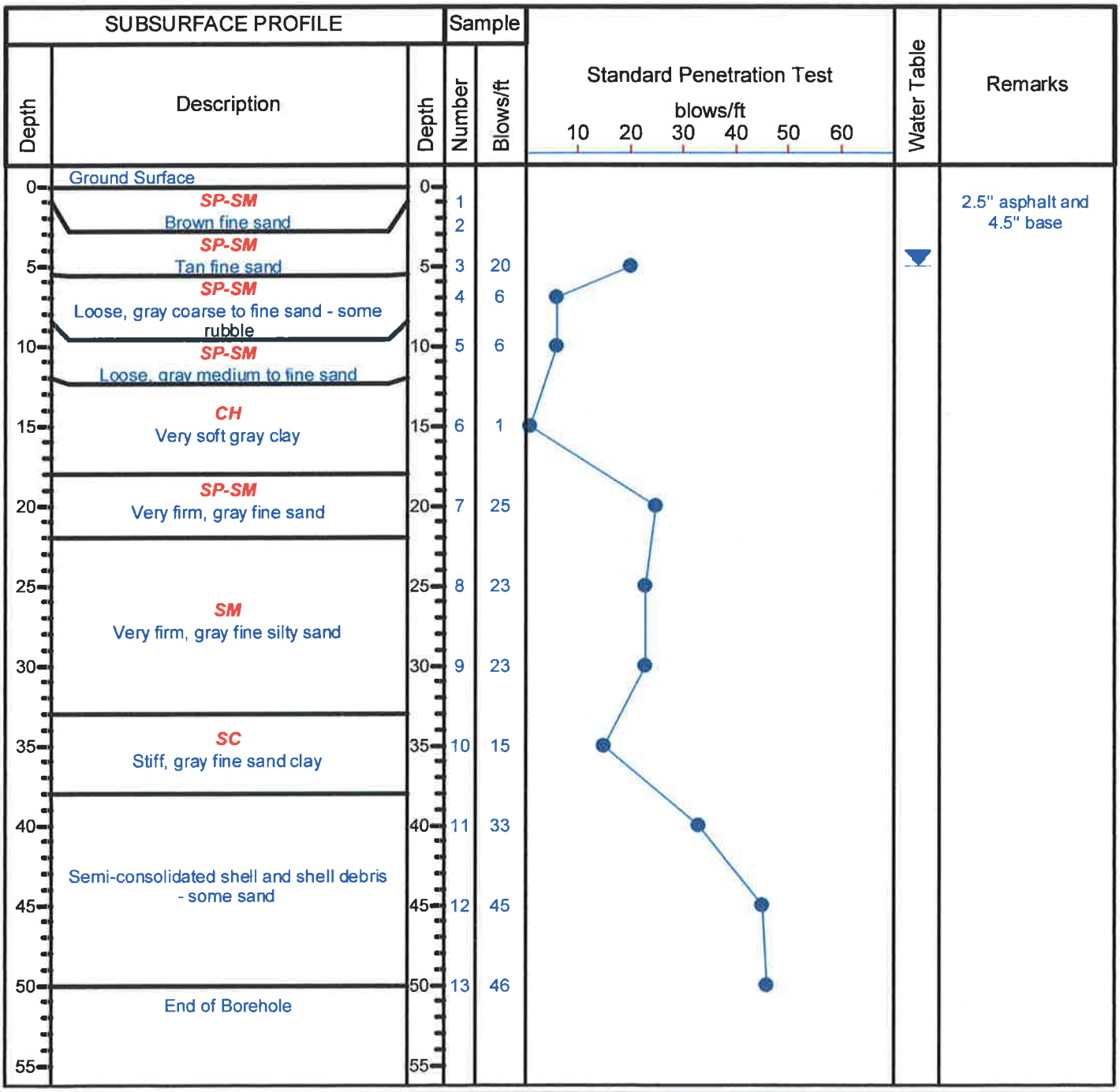
Boring No. B-1

Project: Bay Street Marina

Date: 2/20/13

Location: Beaufort, SC

Engineer: Follo



Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 2/20/13

WHITAKER LABORATORY INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: Lawrence Group

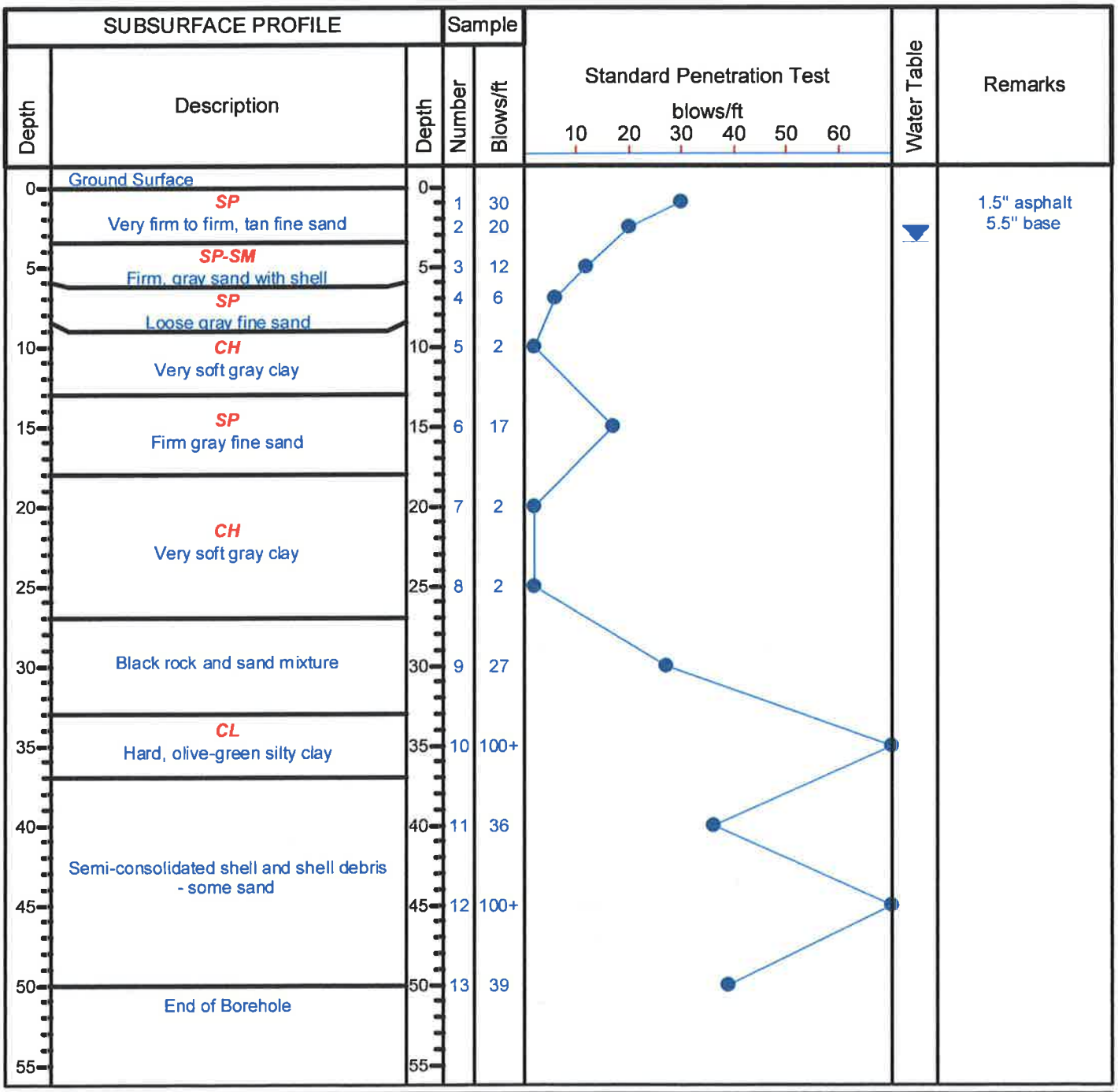
Boring No. B-2

Project: Bay Street Marina

Date: 2/21/13

Location: Beaufort, SC

Engineer: Follo



Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 2/21/13

WHITAKER LABORATORY INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: Lawrence Group

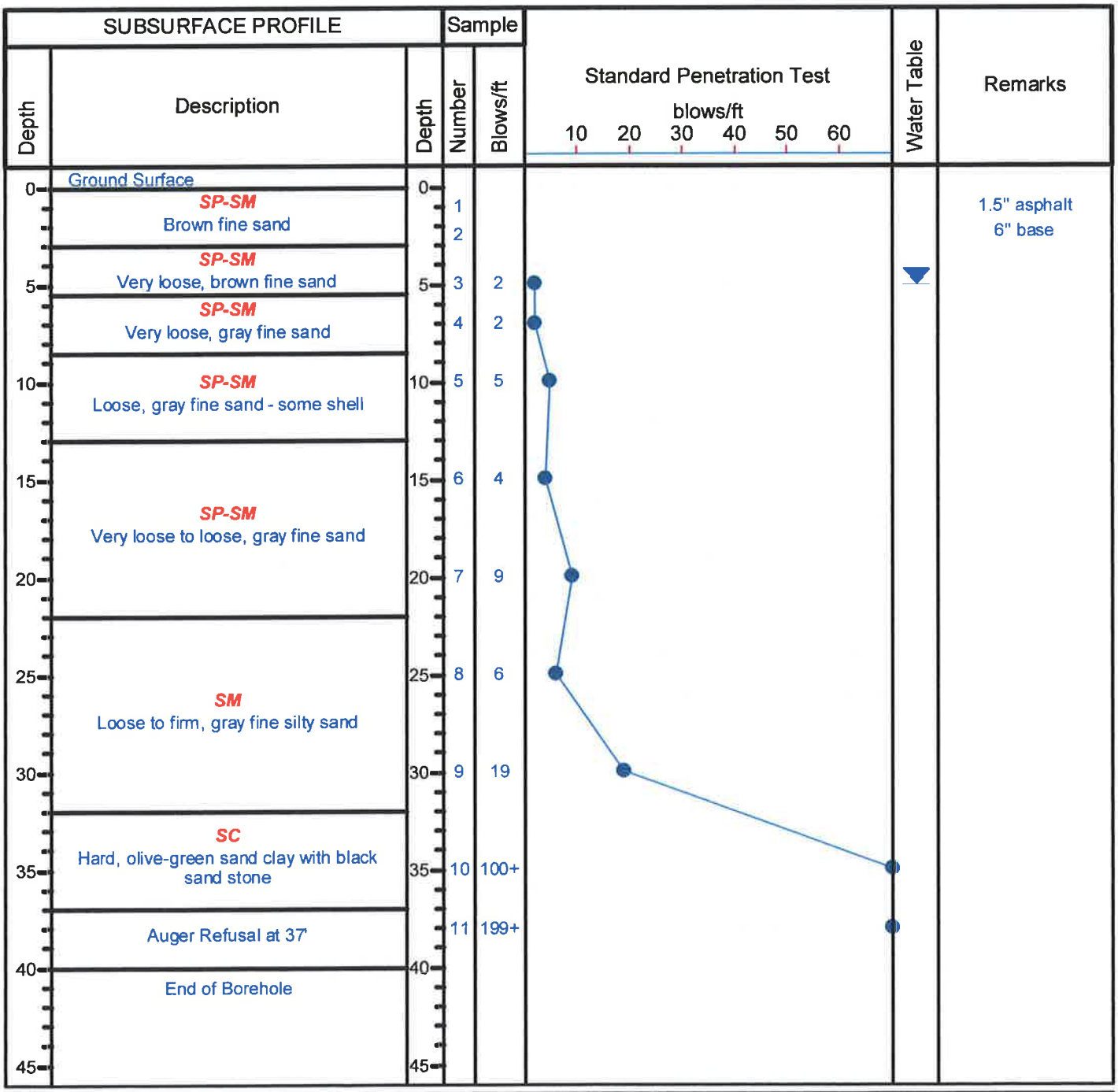
Boring No. B-3

Project: Bay Street Marina

Date: 2/20/13

Location: Beaufort, SC

Engineer: Follo



Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 2/20/13

WHITAKER LABORATORY INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: Lawrence Group

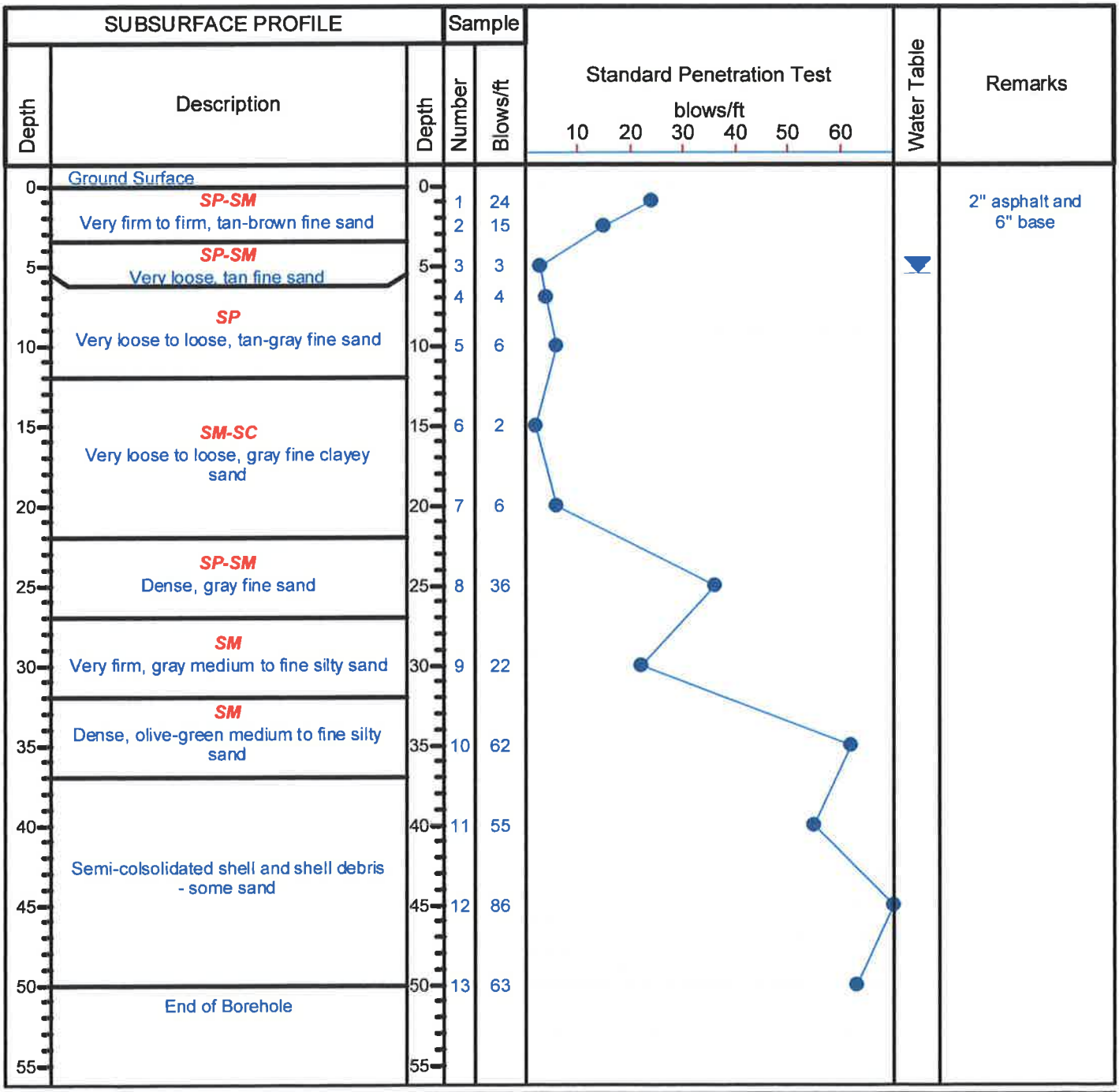
Boring No. B-4

Project: Bay Street Marina

Date: 2/20/13

Location: Beaufort, SC

Engineer: Follo



Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 2/20/13

WHITAKER LABORATORY INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

Client: Lawrence Group

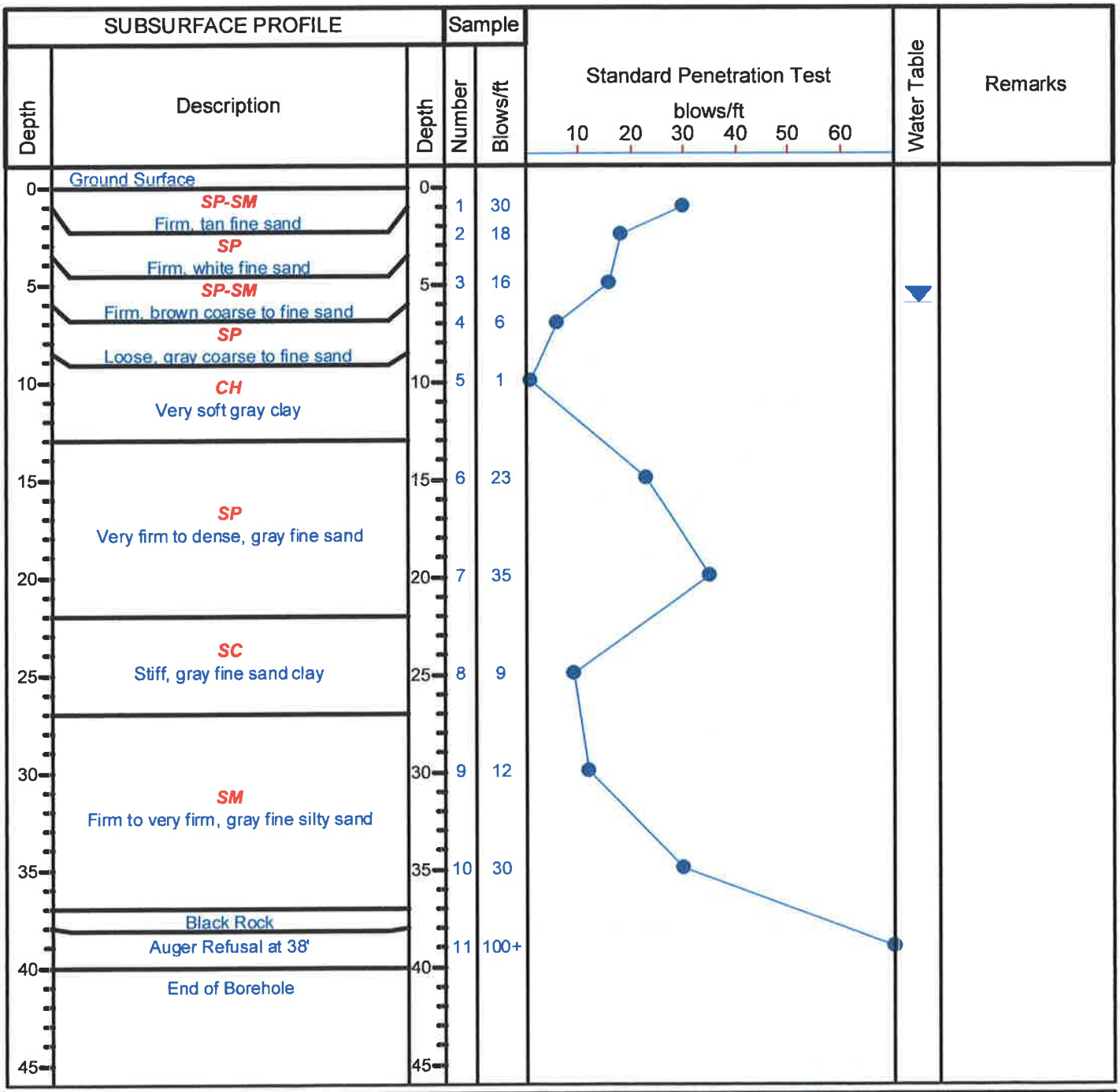
Boring No. B-5

Project: Bay Street Marina

Date: 2/19/13

Location: Beaufort, SC

Engineer: Follo



Drilled By: Wilkerson

Drill Method: H. S. Auger

Drill Date: 2/19/13

WHITAKER LABORATORY INC.
2500 Tremont Road
Savannah, GA 31405

Hole Size: 6.5"

Datum:

Sheet: 1 of 1

LIQUEFACTION ANALYSIS

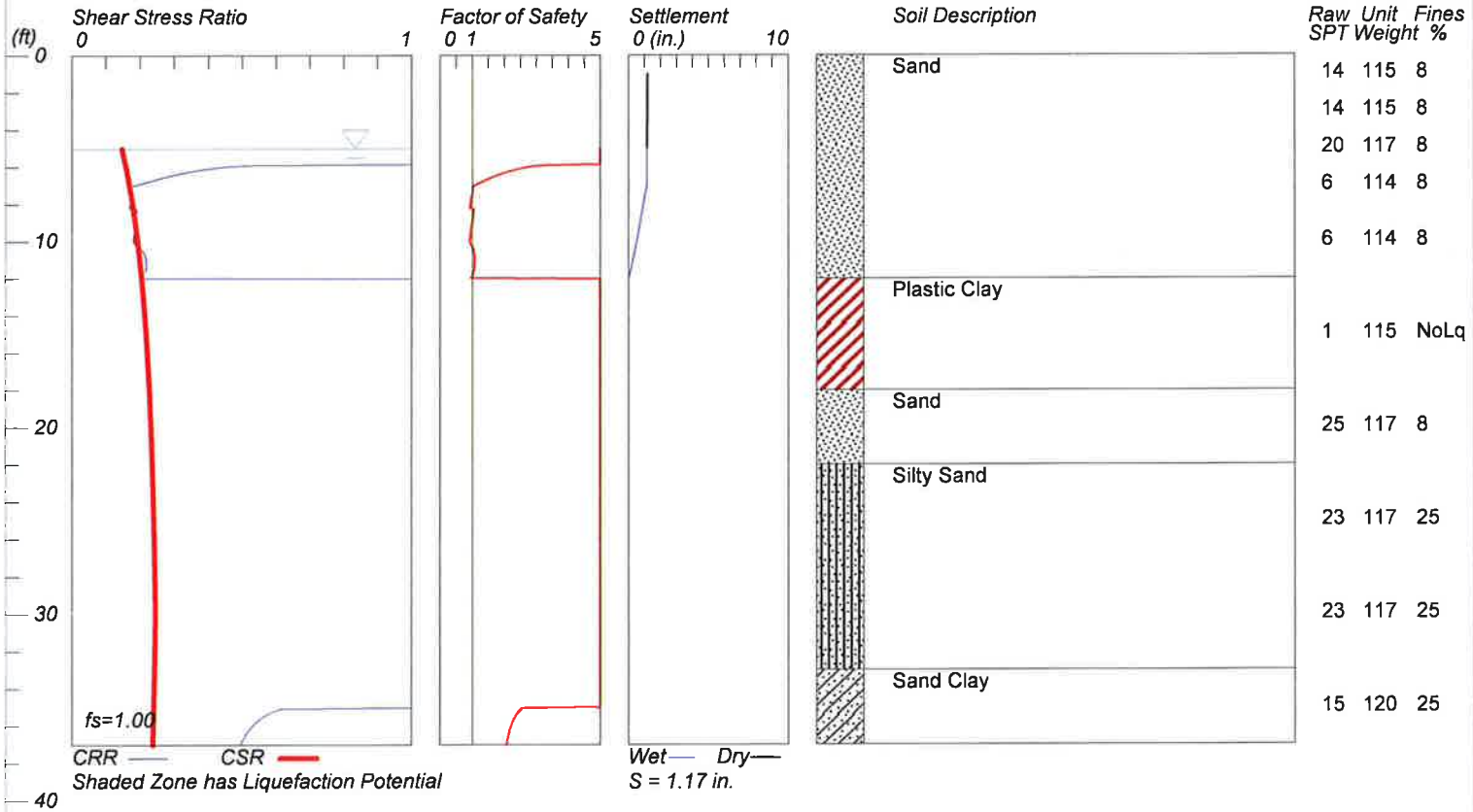
Beaufort Marina

Hole No.=B-1 Water Depth=5 ft

Ground Improvement of Fill=1 ft

Magnitude=6.9

Acceleration=0.23g



Raw SPT	Unit Weight	Fines %
14	115	8
14	115	8
20	117	8
6	114	8
6	114	8
1	115	NoLq
25	117	8
23	117	25
23	117	25
15	120	25

LIQUEFACTION ANALYSIS

Beaufort Marina

Hole No.=B-3 Water Depth=5 ft

Ground Improvement of Fill=1 ft

Magnitude=6.9

Acceleration=0.23g