

ADDENDUM NUMBER 1:
Bid#45-16
Leary Field & Portsmouth High School Lighting
Issued: May 5, 2016
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This Addendum forms part of the original document marked: Bid#45-16 Leary Field & Portsmouth High School Lighting.

Please acknowledge this addendum within your proposal. Failure to do so may subject a bidder to disqualification.

1. The Technical Specifications for this project have been revised and are attached.
2. The drawings have been revised and replace the previously posted drawings. Addendum 1 drawings will be posted on the webpage as a separate posting.
3. Pre-bid meeting list of attendees.

The following questions have been asked and answered:

1. Can the Contractor eliminate the use of mats and provide restoration of the turf as necessary?
The Contractor can eliminate the use of the mats outside of playing areas. The mats are recommended for the protection of the turf, but any turf damaged during construction is the contractor's responsibility to restore. Mats must be used on playing areas. Please provide in base bid and adjustments can be made with owner's agreement after award of contract.
2. Will a site work / landscape contractor qualify for a turf restoration contractor?
Depends on their qualifications.
3. Will the City pay for any Eversource charges directly?
No. See note General Electric Note 5 on sheet EL 1.00
4. Will Portsmouth be providing an allowance to carry for the Eversource costs?
No. Contractor will get a price from Eversource
5. Will the electrical permit fee for this project be waived?
An Electrical Permit is required, but the City will waive the fee.
6. The only description of the sports lighting is on the legend for drawing L3.02 which says "Musco Lighting with New Light Pole Foundation"
Please refer to the technical specification section 16668 and section 16669 for further details on the sports lighting.
7. Is there a model number or description of the lights?
Please refer to the technical specification section 16668 and section 16669 for further details on the sports lighting.
8. How many lights are on each pole?
Please refer to the technical specification section 16668 and section 16669 for further details on the sports lighting.
9. What is the height of the poles?
Please refer to the technical specification section 16668 and section 16669 for further details on the sports lighting.
10. Can a drawing or detail of the light pole foundation be provided for bidding purposes?
Please refer to the technical specification section 16668 and section 16669 for further details on the sports lighting and the light pole foundation.
11. What is the NEMA rating of the new electrical cabinet for Leary Field? Is it steel or stainless steel? *The cabinet should be NEMA 4 stainless steel.*

12. What is the NEMA rating for the enclosure of Panelboard “PPL1”?

NEMA 4

13. What is the NEMA rating for Cabinet #1 and Future Cabinet #2 and Leary Field?

NEMA 4

14. What is the NEMA rating for Panel #1(shed #2) and Panel #2(shed #1) at the high school? These are existing panels. NEMA 1 rated.

Leary Field And High School Sports Lighting

PRE BID MEETING

4/27/2016

Attendees Sign in list

Company Name	Mailing address	Office Phone
INTERSTATE ELECTRICAL	15 COTE LANE Bedford	603-607-3030
Your Name RYAN STONE	email rstone@iesci.com	Cell Phone 603-562-8655
Company Name MARINI CORP	Mailing address 14 ASPEN AVE. NEWTON MA 02466	Office Phone 617-964-9605
Your Name MAAN SINDO	email MAAN@MARINI.CORP @G.MAIL.COM	Cell Phone 508-455-8143
Company Name Scarponi Electric	Mailing address 26 Commercial Way Barrington, NH 03825	Office Phone (603) 332-5011
Your Name Tom Ferland	email tom@scarponielectric.com	Cell Phone (603) 817-9258
Company Name MARINI	Mailing address	Office Phone 617-964-9605
Your Name Ronald Marini	email rmarini@corp@aol.com	Cell Phone 857-829-0999
Company Name North Atlantic Excavation	Mailing address 76 Depot rd N H 33042	Office Phone
Your Name Michael Yergan	email mike@northatlanticservice.com	Cell Phone (603) 793-2859
Company Name Carenu Const Co	Mailing address 270 West Road	Office Phone 603-436-1006
Your Name Ben Carenu	email Build@CarenuConstruction.com	Cell Phone 603 231-8508
Company Name Carenu Const	Mailing address 270 West Rd Route	Office Phone 603 436-1006
Your Name Don Kiebaso	email BUILD@CARENUCONSTRUCTION.COM	Cell Phone 603 988 4834

CITY OF PORTSMOUTH, NH
Department of Public Works

LEARY FIELD AND HIGH SCHOOL LIGHTING

TECHNICAL SPECIFICATIONS WITH INDEX

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SECTION 00890

PERMITS

PART 1 – GENERAL

1.01 DESCRIPTION:

This Section provides specific information and defines specific requirements of the Contractor regarding the preparation and acquisition of permits required to perform the work of this project.

1.02 RELATED WORK:

- A. Section 01110, CONTROL OF WORK AND MATERIALS
- B. Section 01562, DUST CONTROL
- C. Section 01570, ENVIRONMENTAL PROTECTION
- D. Section 02240, DEWATERING
- E. Section 02300, EARTHWORK

1.03 GENERAL REQUIREMENTS:

- A. The Owner has obtained the permits listed below, which are required for this project. The Contractor shall obtain and pay for all other permits required which are listed below or required by local, state, or federal requirements.

<u>Permits by Owner</u>	<u>Status</u>
NHDES Wetlands/Shoreland Permit	Approved (Attached)
City Conditional Use Permit	Approved (Attached)

<u>Permits by Contractor</u>	<u>Status</u>
Local Building/Code Permits	*
NPDES Construction General Permit (If Applicable)	*

*Contractor shall prepare permit application and obtain the permit after contract is awarded, bearing all expenses.

PART 2 - PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 PERFORM WORK IN ACCORDANCE WITH REQUIREMENTS:

- A. The Contractor shall perform the work in accordance with the Contract Documents, including the attached permits/order of conditions, and any applicable municipal requirements.
- B. Prior to commencing any construction activities, the Contractor shall demonstrate to the Owner and the Engineer, through on-site inspection and submitting copies of permits or approvals, that it is in full compliance with the terms and conditions of all permits specified herein. The Contractor shall maintain full compliance with all permits throughout the performance of the work, and upon request, grant access to permitting authorities to inspect the site for the purpose of verifying such compliance.
- C. Contractor shall be responsible to determine and apply for a NPDES Construction General Permit. Contractor shall be responsible for all requirements of the permit. Documentation of permit status and required responsibilities shall be made available to the owner upon request.

END OF SECTION

SECTION 01010

SUMMARY OF WORK

PART 1- GENERAL:

1.01 PROJECT DESCRIPTION

The project is the construction of **Leary Field and Portsmouth High School Lighting** as described in the Contract Documents.

1.02 CONTRACT TIME

A. The work of this contract shall be completed by June 16th, 2017.

B. The work shall be phased and scheduled as follows:

Phase	Name	Start Date	Completion Date
Phase 1	Leary Field Lighting	After notice to proceed	June 25, 2016
Phase 2	High School Football/Track, Baseball 2, and Band Practice Field Lighting	June 15, 2016	August 29, 2016
Phase 3	High School Lower Soccer, 1 and 2, Softball, and Tennis:	June 15, 2016	August 29, 2016

C. The Contractor shall submit shop drawings, data and samples or place his/her order sufficiently early to permit consideration and approval by the Engineer before materials are necessary for incorporation into the Work. Any delay resulting from the Contractor's failure to do so shall not be used as a basis of a claim against the Owner. The contractor may make submittals for any or all awarded phases of work after the Notice to Proceed is issued at the beginning of the project.

1.03 CONTRACT DOCUMENTS

The Contract Documents are enumerated in the Agreement, and include these Specifications and the Drawings, as prepared for the City of Portsmouth by Weston & Sampson Engineers, Inc.

1.04 INSPECTION OF THE SITE

It is a contract requirement of the Contractor that his/her subcontractor shall have thoroughly inspected the site during the bidding period. By submitting a bid they confirm that they are thoroughly familiar with the site and all existing conditions which impact and affect their work. Requests for extra compensation will not be considered for any work which could have been foreseen by a visual inspection of

the site.

1.05 CONTRACTOR'S USE OF THE SITE

- A. The contractor will have full access to the site shown within the Contract Limit of Work Line.
 - 1. The Contractor, his/her Subcontractors, and their employees may park on the site inside the Contract Limit of Work Line, given that no such on-site parking interferes with the site work.
 - 2. The Contractor shall furnish his/her own toilet facilities on-site.
- B. The Contractor shall take all precautions necessary to protect all abutting properties during construction. Any and all damage caused by construction operations shall be repaired.
 - 1. The project site shall be kept clean and free from accumulation of waste material and debris.
 - 2. The Contractor, his/her Subcontractors, and their employees shall be respectful and courteous of the neighborhood while working on site.

1.06 ENCLOSURES

Provide at the earliest practical time temporary enclosure of materials, work in progress and completed portions of the work to provide protection to the work and the employees.

1.07 SAFETY AND SECURITY

- A. The Contractor shall be responsible for the safety and security of the site within the Contract Limit of Work Line and for the safety of all persons who enter within the Contract Limit of Work Line.
- B. The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions & programs in connection with the work. He/she shall promulgate safety regulations and shall notify the Owner of particular hazards.
- C. The Contractor shall erect and maintain, as required by existing conditions and progress of work, all reasonable safeguards for safety and security. This includes the construction of barriers and the posting of danger signs and other warnings against hazards. By these and other necessary methods the Contractor shall stop unauthorized entry within the Contract Limit of Work Line.
- D. The Contractor shall cooperate with and maintain a close liaison with the Portsmouth Police Department, Fire Department, Recreation Department, School Department and Department of Public Works and he/she shall abide by safety or security related requests from any of these authorities.

1.08 WORK TO BE DONE

The work of this Contract includes improvements to City of Portsmouth owned Leary Field Lighting and the City of Portsmouth High School Lighting and other related site improvements located within the confines of the Limit of Work Line at each site and

includes, but is not necessarily limited to the following:

1. Excavation, trenching, backfill and grading
2. Replacement of existing fencing
3. Replacement of existing and installation of new lighting for Leary baseball field and the Portsmouth High School.
4. Seeding and or sodding and other restoration of lawn areas as designated
5. Installation of associated utilities & amenities
6. Installation of other miscellaneous site improvements as designated in the Contract Documents

END OF SECTION

SECTION 01140

SPECIAL PROVISIONS

1. Water for Construction Purposes
2. Pipe Location
3. Dimensions of Existing Structures
4. Occupying Private Property
5. Existing Utility Locations – Contractor’s Responsibility
6. Coordination of Work
7. Time for Completion of Contract
8. Maintenance of Trench Surface
9. Project Sign
10. Compliance with Permits
11. Cutting, Fitting and Patching
12. Connections to Existing System
13. Contractor’s Representative
14. Visual Recording
15. Hours of Construction Activity
16. Construction Crews
17. Surveys
18. Certified Tennis and Track Builders

1. Water for Construction Purposes

- A. In locations where water is in sufficient supply, the Contractor may be allowed to use water for jetting backfill and other construction purposes. The express approval of the Owner shall be obtained before water is used. Waste of water by the Contractor shall be sufficient cause for withdrawing the privilege of unrestricted use.
- B. If no water is available, the Contractor shall supply water at no additional cost to the Owner.

2. Pipe Location

Pipe shall be located substantially as indicated on drawings. The Owner reserves the right, acting through the Engineer, to make such modifications as may be deemed desirable to avoid interference with existing structures or for other reasons.

3. Dimensions of Existing Structures

Where the dimensions and locations of existing structures are of critical importance in the installation or connections of new work, the Contractor shall verify such dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

4. Occupying Private Property

The Contractor shall not enter upon nor occupy with men, equipment or materials any property outside of the public highways or Owner's easements, except with the written consent of the property owner or property owner's agent.

5. Existing Utility Locations - Contractor's Responsibility

- A. The location of existing underground services and utilities shown on the drawings is based on available records. It is not warranted that all existing utilities and services are shown, nor that shown locations are correct. The Contractor shall be responsible for having the utility companies locate their respective utilities on the ground prior to excavating.
- B. To satisfy the requirements of New Hampshire law, the Contractor shall, at least 72 hours, exclusive of Saturdays Sundays and holidays, prior to excavation in the proximity of telephone, gas, cable television and electric utilities, notify the utilities concerned by calling **"DIG SAFE" at telephone number: 1-888-344-7233.**
- C. The Contractor shall coordinate all work involving utilities and shall satisfy himself as to the existing conditions of the areas in which he is to perform his work. He shall conduct and arrange his work so as not to impede or interfere with the work of other contractors working in the same or adjacent areas.

6. Coordination of Work

The General Contractor shall be responsible for coordinating his own work as well as that of any subcontractors. He shall be responsible for notification of the Engineer when each phase of work is expected to begin and the approximate completion date.

The General Contractor shall also coordinate his/her work with that of other work to be performed by others within the same geographic project area as necessary.

7. Time for Completion of Contract

The time for completion of this contract is stipulated in the Form of General Bid. The Bidder shall base his bid on completing the proposed work by the completion date stipulated in the Invitation to Bid of the Contract Documents.

8. Maintenance of Trench Surface

After backfilling and compacting the trench, the Contractor shall be responsible for keeping the ground surface dry and passable at all times until the surface has been restored to original conditions.

9. Project Sign

- A. The project sign shall be as shown per SECTION 01580 of the specifications. The signs shall be erected within ten (10) days after the construction contract is awarded. The Owner shall indicate the location of the project sign. The signs shall be fabricated, erected, and maintained by the Contractor.
- B. The Contractor shall provide adequate support for the sign as determined by the Engineer. All supports, trim, and back of sign shall be painted with at least two coats of exterior paint.
- C. The project sign shall be maintained by the Contractor in good condition at all times for the duration of construction. The Contractor shall remove the sign upon completion of construction.

10. Compliance with Permits

The Contractor shall perform all work in conformance with requirements of the Permits, which appear in Section 00890, PERMITS.

11. Cutting, Fitting and Patching

- A. The Contractor shall do all cutting, fitting, or patching of his work that may be required to make its several parts come together properly and fit it to receive or be received by work of other Contractors, as shown upon or reasonably implied by the drawings and the specifications for the completed structure, including all existing work.
- B. The Contractor shall not endanger any work by cutting, digging, or otherwise and shall not cut or alter the work of any other Contractor, save with the consent of the Engineer.
- C. All holes or openings required to be made in new or existing work, particularly at pipe, conduit, or other penetrations not covered by escutcheons or plates shall be neatly patched. All such holes shall be made completely watertight as approved by the Engineer.
- D. Size and locations of holes required in steel, concrete, or other structural or finish materials for piping, wiring, ducts, etc., which have not been located and detailed on the drawings shall be approved by the Engineer prior to layout and cutting thereof. All holes shall be suitably reinforced as required by the Engineer.
- E. Workmanship and materials of patching and repair work shall match the adjacent similar work and shall conform to the applicable sections of the specification. Patches and joints with existing work shall provide, as applicable in each case, visual, structural, and waterproofing continuity.

12. Connections to Existing Water Systems

- A. The Owner will, upon 48-hour notice from the Contractor, assist the Contractor by locating and opening or closing any and all valves required for draining or admitting water to the

various sections of the water main as required to perform the proposed work. No damages shall be claimed by the Contractor for delays in dewatering pipelines nor shall any damages be claimed because of water leaking through closed valves after dewatering is completed.

- B. Connections to the existing distribution system shall be made with the mains under pressure unless the lines can be temporarily taken out of service as approved by the Owner.
- C. The Contractor will be required to make test excavations to ascertain that the proposed position of the connections will be clear of joints, fittings, or other obstructions.
- D. If any failure occurs in connection to existing mains, service shall be restored in the shortest possible time, the Contractor working around the clock, if necessary. He shall cooperate with the Owner in notifying the consumers or supplying emergency water. If required by Owner, the Contractor shall make connections to water mains during night hours, on Sunday or at other times of off-peak demand for water.

13. Contractor's Representative

The Contractor shall designate a representative who will be available to respond to emergency calls by the Owner at any time day and night and on weekends and holidays should such a situation arise.

14. Visual Recording

Before beginning construction, the Contractor shall make a color DVD recording along the entire work area. One complete recording, for the entire area length, shall be furnished to the Engineer prior to the start of the work. The visual recording shall be identified as "South Mill Pond Tennis Courts Existing Conditions".

15. Hours of Construction Activity

- A. The Contractor shall conduct all construction activity between 7:00 a.m. and 5:00 p.m., Monday through Friday. No construction work shall be allowed on Saturdays, Sundays or Holidays without written authorization from the Owner.
- B. The Owner will provide personnel for assistance in locating and operating valves at no cost to the Contractor during the Owner's normal working hours (Monday through Friday 7:00 a.m. to 5:00 p.m.). When this assistance is required by the Contractor outside of the Owner's normal working hours the cost will be incurred by the Contractor at the prevailing overtime rate of pay for the personnel providing the assistance. The Owner will bill the Contractor directly. In addition, if uniformed officers are required for traffic control, the Contractor shall pay at the prevailing overtime rate of pay for the officers overtime hours.

16. Construction Crews

The Contractor shall not increase the number of construction crews assigned to the work without providing one week advance notice to the Engineer.

17. Surveys

The Contractor shall retain the services of a surveyor licensed in the State of New Hampshire to complete all layouts, surveys, benchmark transfers, etc. required for construction of the project.

18. Certified Tennis Court Builders.

The Contractor shall retain the services or employ a Certified Tennis Court Builder as certified by the American Sports Builders Association (ASBA) who will be present at the site regularly throughout the project to supervise and inspect all phases of the Tennis and Basketball Court reconstruction. The identity of the certified builders and documentation of their credentials will be provided prior to the start of construction.

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 - GENERAL:

1.01 GENERAL PROVISIONS

Attention is directed to the General Conditions of the Contract, all Divisions of the specifications, and the Contract Drawings, all of which apply to work of this section.

1.02 SCOPE OF WORK

Work included: To enable orderly review during progress of the Work, and to provide for systematic discussion of problems, as long as deemed necessary by the Engineer and Owner throughout the construction period.

Related work: The Contractor's relations with his subcontractors and materials suppliers and discussions relative thereto, are the Contractor's responsibility and normally are not part of Project Meetings content.

1.03 QUALITY ASSURANCE

For those persons designated by the Contractor to attend and participate in Project Meetings, provide required authority to commit the Contractor to solutions agreed upon in the Project Meetings.

1.04 MEETING NOTES

The Engineer will compile minutes of each Project Meeting and will furnish copies to all the attendees, Contractor, and the Owner before next scheduled meeting.

PART 2 - EXECUTION:

2.01 MEETING SCHEDULE

- A. Except as noted below for Preconstruction Meeting, frequency of Project Meetings will be weekly, or as determined by the Owner, depending on work progress.
- B. Coordinate as necessary, to establish mutually acceptable schedule for meetings.

2.02 MEETING LOCATIONS

Project Meetings will be held at the job sites.

2.03 PRECONSTRUCTION MEETING

- A. The contractor shall arrange for a Preconstruction Meeting within 5 days after the award of contract. The limitations on the use of the premises, as outlined in SECTION 01010, SUMMARY OF WORK, will be discussed, and the Owner will describe the parking assignment, delivery procedures, toilet facilities, and other provisions he/she may wish to establish.
- B. Contractor is to coordinate attendance by authorized representatives of the Owner, the Contractor, site work subcontractors, and the Engineer.
- C. Minimum agenda: Data will be distributed and discussed on at least the following items:
 - 1. Organizational arrangement of Contractor's forces and personnel, and those of subcontractors, materials suppliers, and Owner.
 - 2. Channels and procedures for communication.
 - 3. Construction schedule, including sequence of critical work.
 - 4. Contract Documents and revisions.
 - 5. Processing of Shop Drawings and other data submitted to the Owner for review.
 - 6. Processing of Bulletins, field decisions, and Change Orders.
 - 7. Procedures for safety, first aid, security, quality control, housekeeping, and related matters.
 - 8. Submittal of Construction Fence layout.
 - 9. Submittal of Progress Schedule, Tabulation of Submittals and
 - 10. Schedule of Values.

2.04 PROJECT MEETINGS

- A. Frequency: Project Meetings shall, in general, be held once a week. Meetings shall be chaired by the Engineer, who will also prepare the meeting agenda issued prior to the meeting.

B. Attendance:

1. To the maximum extent practicable, assign the same person or persons to represent the Contractor at Project Meetings throughout progress of the Work.
2. Site work subcontractors, material suppliers, and others may be required to attend those Project Meetings in which their aspect of the Work is involved.

C. Minimum agenda:

1. Review progress of the Work since last meeting, including status of submittals for approval.
2. Identify problems which impede planned progress.
3. Develop corrective measures and procedures to regain planned schedule.
4. Complete other current business.

D. Revisions to Minutes:

1. Unless published minutes are challenged in writing prior to the next regularly scheduled Project Meeting, they will be accepted as properly stating the activities and decisions of the meeting.
2. Persons challenging published minutes shall reproduce and distribute copies of the challenge to all indicated recipients of the particular set of minutes.
3. Challenge to minutes shall be settled at start of the next regularly scheduled meeting.

END OF SECTION

SECTION 01330

SUBMITTALS

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. The Contractor shall provide the Engineer with submittals as required by the contract documents.

1.02 RELATED WORK:

- A. Divisions 1 – 16 of these specifications that require submittals.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL:

- A. As required by the General Conditions, Contractor shall submit a schedule of shop and working drawing submittals.
- B. The Contractor shall submit the shop and working drawing submittals either electronically or hard copy.

3.02 ELECTRONIC SUBMITTALS:

- A. In accordance with the accepted schedule, the Contractor shall submit promptly to the Engineer by email (KalbererT@wseinc.com) or on Compact Disc (mail to Weston & Sampson Engineers, attention: Travis Kalberer), one electronic copy in Portable Document Format (PDF) of shop or working drawings required as noted in the specifications, of equipment, structural details and materials fabricated especially for this Contract.
- B. Each electronic copy of the shop or working drawing shall be accompanied by the Engineer's standard shop drawing transmittal form, included as Exhibit 1 of this section (use only for electronic submittals), on which is a list of the drawings, descriptions and numbers and the names of the Owner, Project, Contractor and building, equipment or structure.
- C. The Contractor shall receive a shop drawing memorandum with the Engineer's approval or comments via email.

3.03 HARD COPY SUBMITTALS:

- A. In accordance with the accepted schedule, the Contractor shall submit promptly to the Engineer, by mail to Weston & Sampson, 427 Main Street, Worcester, MA, 01608 attention: T. Kalberer, six (6) copies each of shop or working drawings required as noted in the specifications, of equipment, structural details and materials fabricated especially for this Contract.
- B. Each shipment of drawings shall be accompanied by the Engineer's (if applicable) standard shop drawing transmittal form on which is a list of the drawings, descriptions and numbers and the names of the Owner, Project, Contractor and building, equipment or structure.

3.04 SHOP AND WORKING DRAWINGS:

- A. Shop and working drawings shall show the principal dimensions, weight, structural and operating features, space required, clearances, type and/or brand of finish of shop coat, grease fittings, etc., depending on the subject of the drawings. When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer or fabricator as correct for this Contract.
- B. All shop and working drawings shall be submitted to the Engineer by and/or through the Contractor, who shall be responsible for obtaining shop and working drawings from his subcontractors and returning reviewed drawings to them. All shop and working drawings shall be prepared on standard size, 24-inch by 36-inch sheets, except those, which are made by changing existing standard shop or working drawings. All drawings shall be clearly marked with the names of the Owner, Project, Contractor and building, equipment or structure to which the drawing applies, and shall be suitably numbered. Each shipment of drawings shall be accompanied by the Engineer's (if applicable) standard shop drawing transmittal form on which is a list of the drawings, descriptions and numbers and the names mentioned above.
- C. Only drawings that have been prepared, checked and corrected by the fabricator should be submitted to the Contractor by his subcontractors and vendors. Prior to submitting drawings to the Engineer, the Contractor shall check thoroughly all such drawings to satisfy himself that the subject matter thereof conforms to the Contract Documents in all respects. Shop drawings shall be reviewed and marked with the date, checker's name and indication of the Contractor's approval, and only then shall be submitted to the Engineer. Shop drawings unsatisfactory to the Contractor shall be returned directly to their source for correction, without submittal to the Engineer. Shop drawings submitted to the Engineer without the Contractor's approval stamp and signature will be rejected. Any deviation from the Contract Documents indicated on the shop drawings must be identified on the drawings and in a separate submittal to

the Engineer, as required under subsection 6.17 Shop Drawings and Samples; D. Submittal Procedures, Paragraph 3 of the 1996 General Conditions.

- D. The Contractor shall be responsible for the prompt submittal and resubmittal, as necessary, of all shop and working drawings so that there will be no delay in the work due to the absence of such drawings.
- E. The Engineer will review the shop and working drawings as to their general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Corrections of comments made on the drawings during the review do not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. The review of the shop drawings is general and shall not relieve the Contractor of the responsibility for details of design, dimensions, code compliance, etc., necessary for interfacing with other components, proper fitting and construction of the work required by the Contract and for achieving the specified performance. The Engineer will review submittals two times: once upon original submission and a second time if the Engineer requires a revision or corrections. The Contractor shall reimburse the Owner amounts charged to the Owner by the Engineer for performing any review of a submittal for the third time or greater.
- F. With few exceptions, shop drawings will be reviewed and returned to the Contractor within 30 days of submittal.
- G. No material or equipment shall be purchased or fabricated especially for this Contract nor shall the Contractor proceed with any portion of the work, the design and details of which are dependent upon the design and details of equipment or other features for which review is required, until the required shop and working drawings have been submitted and reviewed by the Engineer as to their general conformance and compliance with the project and its Contract Documents. All materials and work involved in the construction shall then be as represented by said drawings.
- H. Two copies of the shop and working drawings and/or catalog cuts will be returned to the Contractor. The Contractor shall furnish additional copies of such drawings or catalog cuts when he needs more than two copies or when so requested.

3.05 SAMPLES:

- A. Samples specified in individual Sections include, but are not necessarily limited to, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual

effect, graphic symbols, and units of work to be used by the Engineer or Owner for independent inspection and testing, as applicable to the work.

- B. The number of samples submitted shall be as specified. Submittal and processing of samples shall follow the procedures outlined for shop and working drawings unless the specifications call for a field submittal or mock-up.
- C. Acceptance of samples will be acknowledged via a copy of the transmittal noting status. When samples are not acceptable, prompt resubmittal will be required.

3.06 OPERATING AND MAINTENANCE MANUALS AND SPARE PARTS LISTS:

- A. Where reference is made in technical specification sections to operating and maintenance manuals and/or spare parts lists, the Contractor shall submit four copies to the Engineer for review in accordance with the instructions furnished under "Shop and Working Drawings." If the submittal is complete and does not require any changes, an acknowledgement (copy of transmittal) will be returned noting status. If the submittal is incomplete or does require changes, corrections, additions, etc., two copies of the submittal will be returned with a copy of transmittal noting status. Four copies of the final operating and maintenance manuals and/or spare parts list shall be delivered to the Engineer prior to or with the equipment when it is delivered to the job site. For systems requiring field adjustment and balancing, such as heating and ventilating, the Contractor shall submit separate test results and adjustment data on completion of the work, to be incorporated into the system manual.
- B. The information included in the manual shall be as described in the specification sections, but as a minimum shall contain clear and concise instructions for operating, adjusting, lubricating and maintaining the equipment, an exploded assembly drawing identifying each part by number and a listing of all parts of the equipment, with part numbers and descriptions required for ordering spare parts. Spare parts lists shall include recommended quantity and price.
- C. Operating and maintenance manuals shall be in durable loose-leaf binders, on 8½-inch by 11-inch paper, with diagrams and illustrations either on 8½-inch by 11 inch or multiple foldouts. The instructions shall be annotated to indicate only the specific equipment furnished. Reference to other sizes or models of similar requirement shall be deleted or neatly lined out.

END OF SECTION

EXHIBIT 1 TO SECTION 01330 SUBMITTALS
SHOP DRAWING TRANSMITTAL FORM

Shop Drawing Transmittal

Weston & Sampson
ENGINEERS, INC.

Instructions for Preparing Transmittal

No action will be taken on any item unless accompanied by this form. Type or print all entries.

TRANSMITTAL NOS. to be consecutive (1, 2, 3, etc.).

Each resubmittal of same item shall use same number with suffix letter (A, B, etc.).

SPEC. SECT. NO: Only one spec. section no. to each transmittal.

DESCRIPTION: Complete identification of document or group of documents.

SOURCE: Originator of document(s) being submitted.

DRAWING NO: Identification of document(s).

NO. of COPIES: Usually 6 or as directed/specified.

CONTRACT DRAWING REFERENCE: Contract drawing number(s) showing details of document(s) being submitted.

SPECIAL INSTRUCTIONS: Special cases and emergencies, changes in distribution and special handling requests, etc. should be entered here.

SIGNATURE OF CONTRACTOR: Signature of individual who reviews and approves material prior to submittal to engineer.

Contractor to retain last copy. Submit original with two pink and two yellow copies.

THIS SECTION TO BE COMPLETED BY CONTRACTOR									
TRANSM. NO.	SPEC. SECT. NO.	DATE / /	CONTRACTOR'S JOB NO.	W&S JOB NO.					
PROJECT NAME & CONTRACT NO.					LOCATION				
T O F O R M Attention: CSD Weston & Sampson Engineers, Inc. 5 Centennial Drive Peabody, MA 01960-7985					(CONTRACTOR)				
ITEM NO.	DESCRIPTION	SOURCE	DRAWING NO. CATALOG NO. BROCHURE, ETC.	NO. OF COPIES	CONTRACT DRAWING REF.	ACTION CODE	REVIEWED BY		
1									
2									
3									
4									
THIS CERTIFIES THAT ALL ITEMS SUBMITTED HEREWITH HAVE BEEN CHECKED BY THE CONTRACTOR, ARE IN CONFORMANCE WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS. EXCEPT AS NOTED, AND ARE APPROVED BY THE CONTRACTOR FOR THIS PROJECT.									
SPECIAL INSTRUCTIONS: _____ (FOR CONTRACTOR) SIGNATURE & TITLE: _____									
THIS SECTION TO BE COMPLETED BY W&S									
ACTION CODE 1. NO EXCEPTIONS TAKEN 2. MAKE CORRECTIONS NOTED 3. AMEND AND RESUBMIT 4. REJECTED - SEE REMARKS 5. ACKNOWLEDGMENT					FIELD OFFICE REC'D BY: _____ DATE / / _____ BY: _____ DATE / / _____				

Weston & Sampson
ENGINEERS, INC.

Please! BEAR DOWN WHEN HANDWRITING — THIS IS A 6 COPY FORM & THE LAST COPY IS YOURS!

SECTION 01450

SAMPLING & TESTING

PART I - GENERAL

1.01 SCOPE OF WORK

- A. The work under this Section shall consist of performing or ordering the work of collecting samples for testing, having tests performed by a Certified Testing Laboratory satisfactory to the Engineer, having all test results forwarded to the Engineer for approval, and paying all costs associated with the collection and sampling, transportation, shipping, postage, and testing, and the coordination of test results and approvals.

1.02 SUBMITTALS

- A. In accordance with Section 01330 of these Specifications, submit the names, addresses and certification of laboratories to be utilized for approval by the Engineer.

PART II - MATERIALS

2.01 CONTAINERS AND TOOLS

- A. Utilize tools recommended by the laboratory to obtain samples, packaging or containers suitable to, or furnished by, the laboratory, and collect all samples in the proper number and quantity to permit tests to be conducted.

2.02 TESTS

- A. Refer to section specifications for test requirements and criteria for results; Coordinate with the Owner's Representative.
- B. Compaction testing shall be performed as required by the Owner's Representative. All costs shall be the responsibility of the Contractor.
- C. Cast in place concrete requires a slump and air entrainment test for every load of concrete delivered. All costs shall be the responsibility of the Contractor.
- D. Should the contractor require soil testing for disposal, it is at their full expense. It is expected that the site has typical urban fill component that may include brick, concrete, tires, and the like. These materials are to be disposed of at no additional expense to the owner.

PART III - EXECUTION

3.01 METHODOLOGY

- A. Unless otherwise directed by the Section specifications, sampling and testing will be ordered by the Contractor and approved by the Owner's Representative. Locations, number and quantity of samples shall be submitted for approval as directed in accordance with the Specifications. The Owner's Representative shall be given 24 hour notice prior to sampling and be allowed to observe the sampling.
- B. Sampling and Testing results must be provided to the Owner's Representative and Approved prior to the installation of any work potentially impacted by unacceptable test results.

3.02 PAYMENT

- A. Payment for all sampling and testing efforts shall be included in the lump sum contract price bid.

END OF SECTION

SECTION 01562

DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION:

This section of the specification covers the control of dust via calcium chloride and water, complete.

PART 2 - PRODUCTS

2.01 CALCIUM CHLORIDE:

- A. Calcium chloride shall conform to the requirements of AASHTO-M 144, Type I or Type II and Specification for Calcium Chloride, ASTM D98. The calcium chloride shall be packaged in moisture proof bags or in airtight drums with the manufacturer, name of product, net weight, and percentage of calcium chloride guaranteed by the manufacturer legibly marked on each container.
- B. Calcium chloride failing to meet the requirements of the aforementioned specifications or that which has become caked or sticky in shipment may be rejected by the Engineer.

2.02 WATER:

- A. Water shall not be brackish and shall be free from oil, acid, and injurious alkali or vegetable matter.

PART 3 - EXECUTION

3.01 APPLICATION:

- A. Calcium chloride shall be applied when ordered by the Engineer and only in areas which will not be adversely affected by the application. No Calcium Chloride shall be used within in wetland resource areas.. See Section 01570, ENVIRONMENTAL PROTECTION.
- B. Calcium chloride shall be uniformly applied at the rate of 1-1/2 pounds per square yard or at any other rate as required by the Engineer. Application shall be by means of a mechanical spreader, or other approved methods. The number and frequency of applications shall be determined by the Engineer.
- C. Water may be sprinkler applied with equipment including a tank with gauge-equipped pressure pump and a nozzle-equipped spray bar.

- D. Water shall be dispersed through the nozzle under a minimum pressure of 20 pounds per square inch, gauge pressure.

END OF SECTION

SECTION 01570

ENVIRONMENTAL PROTECTION

PART 1 – GENERAL

1.01 DESCRIPTION:

- A. The work covered by this section of the specifications consists of furnishing all labor, materials, tools and equipment and performing all work required for the prevention of environmental pollution during and as a result of construction operations under this contract.
- B. The requirements set forth in this section of the specifications apply to cross-country areas, river and stream crossings, and construction in and adjacent to wetlands, unless otherwise specifically stated.
- C. All work under this Contract shall be in accordance with the City of Portsmouth Conditional Use Permit and the NHDES Wetlands permit, all of which are attached to Section 00890, PERMITS.
- D. Prior to commencement of work, the Contractor shall meet with representatives of the Engineer to develop mutual understandings relative to compliance of the environmental protection program.

1.02 RELATED WORK:

- A. Section 00890, PERMITS
- B. Section 01330, SUBMITTALS
- C. Section 01562, DUST CONTROL
- D. Section 02240, DEWATERING
- E. Section 02252, SUPPORT OF EXCAVATION
- F. Section 02300, EARTHWORK

1.03 SUBMITTALS:

- A. The Contractor shall submit for approval six sets of details and literature fully describing environmental protection methods to be employed in carrying out construction activities within 100 feet of wetlands or across areas designated as wetlands.

PART 2 - PRODUCTS

2.01 SILT FENCE:

- A. The silt fence shall consist of a 3-foot wide continuous length sediment control fabric, stitched to a 22-foot wide, continuous length support netting, and stapled to preweathered oak posts installed as shown on the drawings. The oak posts shall be 1½-inches by 1½-inches (Minimum Dimension) by 48 inches and shall be tapered. The support netting shall be industrial strength polypropylene. The bottom edge of the sediment control fabric shall be buried as shown on the drawings. The sediment control fabric shall conform to the following properties:

<u>Property</u>	<u>Value</u>	<u>Test Method</u>
1. Grab Strength (lbs.)	124	ASTM D-4632
2. Elongation (%)	15%	ASTM D-4632
3. Puncture Strength (lbs.)	65	ASTM D-4833
4. Burst Strength (psi)	300	ASTM D-3786
5. Trapezoid Tear (lbs.)	60	ASTM D-4533
6. Equivalent Opening Size (U.S. Sieve)	No. 30	ASTM D-4571
7. Permittivity (sec ⁻¹)	0.10	ASTM D-4491
8. Water Flow Rate (gal/min/sf.)	10	ASTM D-4491
9. UV Resistance (%)	70	ASTM D-4355

- B. The silt fence shall be Mirafi Envirofence manufactured by Mirafi, Inc. or approved equal.

2.02 STRAW WATTLES:

- A. Straw wattles shall be AEC Premier Straw Wattles, as manufactured by American Excelsior Company, Arlington, TX (1-866-9FIBERS), or approved equal.
- B. The wattles will be placed in a shallow trench (2-3 inches deep) and staked in the ground using wooden stakes. The wooden stakes will be placed at a minimum depth of 24-inches into the ground.

2.03 TURF PROTECTION MATTING:

- A. Turf Protection matting shall be Matrax 4x4 Composite Event & Turf Protection as manufactured by Matrax, Inc. – www.matrax.com, or approved equal. Refer to the product cut sheet attached at the end of this section.
- B. 4 x 4 panels are engineered thermoplastic products designed for use as temporary flooring, walkways and roadways for pedestrians and rubber-tired vehicles. The 4x4 composite matting system protects the natural and man-made turf it is installed over and provides a stable and uniform flooring surface. Textured interlocking mats and

durable lightweight materials create a versatile and reusable flooring surface. For proper use and care read all instruction and handling precautions to ensure a safe and successful installation.

PART 3- EXECUTION

3.01 NOTIFICATION AND STOPPAGE OF WORK:

- A. The Engineer will notify the Contractor in writing of any non-compliance with the provisions of the Order of Conditions. The Contractor shall, after receipt of such notice, immediately take corrective action. Such notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails to act promptly, the Owner may order stoppage of all or part of the work through the Engineer until satisfactory corrective action has been taken. No claim for an extension of time or for excess costs or damage incurred by the Contractor as a result of time lost due to any stop work orders shall be made unless it was later determined that the Contractor was in compliance.

3.02 AREA OF CONSTRUCTION ACTIVITY:

- A. Insofar as possible, the Contractor shall confine his construction activities to those areas defined by the plans and specifications. All land resources within the project boundaries and outside the limits of permanent work performed under this contract shall be preserved in their present condition or be restored to a condition after completion of construction at least equal to that which existed prior to work under this contract.

3.03 PROTECTION OF WATER RESOURCES:

- A. The Contractor shall not pollute streams, lakes or reservoirs with fuels, oils, bitumens, calcium chloride, acids or other harmful materials. It is the Contractor's responsibility to comply with all applicable Federal, State, County and Municipal laws regarding pollution of rivers and streams.
- B. Special measures should be taken to insure against spillage of any pollutants into public waters.

3.04 CONSTRUCTION IN AREAS DESIGNATED AS WETLANDS ON THE DRAWINGS:

Work will not occur within wetland resource areas.

3.05 PROTECTING AND MINIMIZING EXPOSED AREAS:

- A. The Contractor shall limit the area of land which is exposed and free from vegetation during construction. In areas where the period of exposure will be greater than two

(2) months, temporary vegetation, mulching or other protective measures shall be provided as specified.

- B. The Contractor shall take account of the conditions of the soil where temporary cover crop will be used to insure that materials used for temporary vegetation are adaptive to the sediment control. Materials to be used for temporary vegetation shall be approved by the Engineer.

3.06 LOCATION OF STORAGE AREAS:

- A. The location of the Contractor's storage areas for equipment and/or materials shall be upon cleared portions of the job site or areas to be cleared as a part of this project, and shall require written approval of the Engineer. Plans showing storage facilities for equipment and materials shall be submitted for approval of the Engineer.
- B. No excavated materials or materials used in backfill operations shall be deposited within a minimum distance of one hundred (100) feet of any watercourse or any drainage facility. Adequate measures for erosion and sediment control such as the placement of straw wattles around the downstream perimeter of stockpiles shall be employed to protect any downstream areas from siltation.
- C. There shall be no storage of equipment or materials in areas designated as wetlands.
- D. The Engineer may designate a particular area or areas where the Contractor may store materials used in his operations.

3.07 PROTECTION OF LANDSCAPE:

- A. The Contractor shall not deface, injure, or destroy trees or shrubs nor remove or cut them without written authority from the Owner. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorages unless specifically authorized by the Engineer. Excavating machinery and cranes shall be of suitable type and be operated with care to prevent injury to trees which are not to be removed, particularly overhanging branches and limbs. The Contractor shall, in any event, be responsible for any damage resulting from such use.
- B. Branches, limbs, and roots shall not be cut except by permission of the Engineer. All cutting shall be smoothly and neatly done without splitting or crushing. When there is unavoidable injury to branches, limbs and trunks of trees, the injured portions shall be neatly trimmed and covered with an application of grafting wax or tree healing paint as directed.
- C. Where, in the opinion of the Engineer, trees may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment or by his blasting or other operations, the Engineer may require the Contractor to adequately protect such trees by placing boards, planks, poles or fencing around them. Any trees or landscape feature scarred or damaged by the Contractor's equipment or operations shall be

restored as nearly as possible to its original condition at the expense of the Contractor. The Engineer will decide what method of restoration shall be used, and whether damaged trees shall be treated and healed or removed and disposed.

- D. Cultivated hedges, shrubs, and plants which could be injured by the Contractor's operations shall be protected by suitable means or shall be dug up, balled and temporarily replanted and maintained. After construction operations have been substantially completed, they shall be replanted in their original positions and cared for until growth is re-established. If cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish their beauty or usefulness, they shall be replaced by items of a kind and quality at least equal to that existing at the start of the work.

3.08 CLEARING AND GRUBBING:

- A. The Contractor shall clear and grub only on the Owner's land or the Owner's easements, and only the area required for construction operations, as approved by the Engineer.

3.09 DISCHARGE OF DEWATERING OPERATIONS:

- A. Any water that is pumped and discharged from the trench and/or excavation as part of the Contractor's water handling shall be filtered by an approved method prior to its discharge into a receiving water or drainage system.
- B. Under no circumstances shall the Contractor discharge water to the areas designated as wetlands.
- C. The pumped water shall be filtered through filter fabric and baled **straw**, a vegetative filter strip or a vegetated channel to trap sediment occurring as a result of the construction operations. The vegetated channel shall be constructed such that the discharge flow rate shall not exceed a velocity of more than 1 foot per second. Accumulated sediment shall be cleared from the channel periodically.

3.10 DUST CONTROL:

- A. During the progress of the work, the Contractor shall conduct his operations and maintain the area of his activities, including sweeping and sprinkling of streets as necessary, to minimize creation and dispersion of dust. If the Engineer decides it is necessary to use calcium chloride for more effective dust control, the Contractor shall furnish and spread the material, as directed. Calcium chloride shall be as specified under Section 01562, DUST CONTROL.
- B. Calcium Chloride shall not be used for dust control within a drainage basin or in the vicinity of any source of potable water.

3.11 SEPARATION AND REPLACEMENT OF TOPSOIL:

Not applicable.

3.12 ERECTION AND MAINTENANCE OF SILT FENCE:

- A. Where indicated on the drawings or where required by the Engineer, the Contractor shall erect and maintain a temporary silt fence. In areas designated as wetlands, the Contractor shall line the limits of the construction easement with a silt fence. The silt fence shall be used specifically to contain sediment from runoff water and to minimize environmental damage caused by construction.

3.13 CATCH BASIN PROTECTION:

- A. Catch basin protection shall be used for every catch basin, shown on the plans or as required by the Engineer, to trap sediment and prevent it from clogging drainage systems and entering wetlands. Siltation fabric shall be securely installed under the catch basin grate. Care shall be taken to keep the siltation fabric from breaking apart or clogging. All deposited sediment shall be removed periodically and at times prior to predicted precipitation to allow free drainage flow. Prior to working in areas where catch basins are to be protected, each catch basin sump shall be cleaned of all debris and protected. The contractor shall properly dispose of all debris at no additional cost to the Owner.

3.14 STRAW WATTLES:

- A. The wattles will be placed in a shallow trench (2-3 inches deep) and staked in the ground using wooden stakes. The wooden stakes will be placed at a minimum depth of 24-inches into the ground.

3.15 TURF PROTECTION MATTING

- A. Install the turf protection matting in conformance with the manufacturers installation requirements. Turf protection matting may be relocated throughout the site as needed during construction

END OF SECTION

Matrax 4x4 Composite Event Flooring & Turf Protection

THE MOST VERSATILE MAT IN ITS CLASS.

FEATURES

- Closed-back design for lower degree of heat stress
- Translucent quality promotes photosynthesis
- Vertical locking system with reinforced structural ribbing
- Uniform lateral load transfer between panels
- Driveable and pedestrian friendly
- Easy installation, handling, and transport
- 100% recyclable
- Made in the USA

APPLICATIONS

The Matrax high-performance system is custom designed for use in stadiums and other large-scale venues that require vehicular access and capacity for supporting heavy loads such as tractor-trailers, rigging, and equipment staging platforms. Other applications include temporary event parking, tent flooring, and industrial warehouse flooring.



Specification	Standard	Metric
Net Working Surface	13.5 ft ²	1.25 m ²
Weight	50 lbs	22.68 kg
Compression Strength	450 psi	3,100 kps
Max Wheel Load	300 psi	2,068 kps
Max Allowable Deflection	3 in	7.62 cm
Temperature Range	-4°F – 113° F	-20°C – 45°C
Burn Rating	UL 94-HB	
Surface Texture	Diamond	

ADA compliant ramps and edge support blocks are available to enhance the appearance, function, and protection of the mats.

SECTION 01580

PROJECT SIGN

PART I – GENERAL

1.01 SCOPE OF WORK

- A. Provide all materials, labor, mountings and incidentals for two (3) temporary construction signs, four feet by eight feet (4' x 8'), installed in a location directed by the Owners Representative.

PART II – MATERIALS

2.01 SIGN

- A. Sign shall be made of durable, exterior plywood or metal, securely mounted to wood posts or attached to existing fencing, as directed by the Owner's Representative. Sign shall be professionally lettered. Wording and layout to be supplied by the Owner. Submit samples of color and a Shop Drawing indicating lettering layouts to Engineer for approval. Electronic file with sign layout to be provided to Contractor and Owner's representative by the Engineer.
 - 1. Two (3) sign shall be a project sign (or banner) and will include color renderings of the final park layout and other pertinent information to be provided by the Owner's Representative. See example included herein. Note: the sign for the High School will contain other graphics to be supplied by the owner.

SOUTH MILL POND TENNIS COURTS

CITY OF PORTSMOUTH
PORTSMOUTH, NEW HAMPSHIRE

City Manager | John P. Bohenko
Director of Public Works | Peter Rice
Facilities Project Manager | Dan Hartrey

LANDSCAPE ARCHITECT / ENGINEER
WESTON & SAMPSON

CONTRACTOR
TO BE DETERMINED

FOR QUESTIONS CONTACT:
Dan Hartrey
Facilities Project Manager
Email: dhartrey@cityofportsmouth.com
Phone: (603) 610-7299
Fax: (603) 427-1593
1 Junkins Ave
Portsmouth, NH 03801

PRECEDENTS

- MULTI SPORT COURT COLOR PATTERN
- SHADE STRUCTURE
- HANGING NET DIVIDER
- COLOR SCHEME
- MULTI SPORT GOALS
- BLACK VINYL CHAINLINK FENCE WITH CUT CORNERS AND GATES

SOUTH MILL POND COURTS PLAN | SPRING 2016 COMPLETION
7 Junkins Avenue, Portsmouth, New Hampshire
The city's vision for the South Mill Pond Courts in conveyed as comprising use areas for:

- 4 devoted tennis courts
- 2 multiuse tennis/ street hockey courts with a hanging divider net
- 1 devoted basketball court
- 1 multisport court
- ADA accessible pathways
- Handicap parking
- Portable restrooms and shade shelter

SPORTS & RECREATION | **Weston & Sampson**
WESTON & SAMPSON, INC. (INCORPORATED)

- B. Sign shall be securely mounted with galvanized metal attachments and shall be framed so as to be durable. All attachments and mountings shall be child safe and vandal resistant. Should a project banner be provided, it may be securely attached to construction fencing.

PART III – EXECUTION

3.01 PLACEMENT

- A. Sign shall be installed facing the street or access point to the construction area so as to be visible and inform the general public. Where possible, the sign should be located so as not to conflict with the construction activity nor to require moving during the construction process.
- B. The construction sign shall be maintained in satisfactory condition during construction and then removed and disposed of legally by the Contractor just prior to the final acceptance of the work.

END OF SECTION

SECTION 01720

CONSTRUCTION LAYOUT

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The work under this section shall consist of field staking the horizontal and vertical alignment of all essential features and proposed work, including pathways boardwalks, walls, and other related features as shown on the plans, by a **Registered Engineer or Land Surveyor**. The Contractor shall familiarize himself with the existing conditions and shall be responsible for locating or re-establishing survey field ties, property lines, and benchmarks indicated on the plans.
- B. Existing survey tie information if available shall be provided by the town, or the Owner's Representative upon request.

1.02 QUALIFICATIONS & SUBMITTALS

- A. The Contractor shall engage the services of a **Professional Engineer or Land Surveyor Registered in the State of New Hampshire** and shall submit the name, address, and registration number of such person or persons to the Engineer in writing.
- B. Whenever reference is made on the plans or in these specifications to a Land Surveyor registered in the State of New Hampshire, the Contractor may substitute a Registered Professional Engineer, except that only a Registered Land Surveyor will be permitted to conduct property line or boundary surveys.

PART 2 - MATERIALS

2.01 LAYOUT AND STAKING

- A. The Contractor shall be responsible for furnishing all stakes, pins, and grade markings as required to implement the work of layout and staking and shall make all field adjustments ordered by the Engineer at no extra cost to the Owner.
- B. Upon request by the Engineer, the Contractor shall make available to the Owner survey instruments necessary to check the proposed vertical and horizontal alignments at no extra cost.

PART 3 - EXECUTION

3.01 SURVEY LAYOUT

- A. The Contractor shall use the alignments shown on the plans to establish the layout of all proposed features and shall perform field adjustments as recommended by the Engineer.
- B. The Surveyor shall lay out the essential or necessary grades and locations of site furnishings, footings, pavements, utilities, structures and other proposed elements. The surveyor shall verify the location of any existing spikes, stakes, pipes, drill holes, etc. and shall be responsible for their accuracy. Proposed features shall be located in relation to dimensions shown on the drawings and as adjusted by the Engineer.
- C. The Contractor shall inform the Engineer when the general layout is completed and shall not begin excavation until the Engineer approves the various alignments. Any discrepancies encountered in field conditions shall be reported to the Engineer immediately and shall be adjusted as required.
- D. The Contractor shall be responsible for maintaining the correct vertical and horizontal alignment of all elements, which responsibility shall not be waived by the Engineer's approval of basic layout and stakeout.

END OF SECTION

SECTION 02058

CONTROLLED DENSITY FILL (CDF)

PART 1 - GENERAL

1.01 DESCRIPTION:

- A. Controlled Density Fill is to be used where indicated on the contract drawings.

1.02 RELATED WORK:

- A. Section 00890, PERMITS
- B. Section 01110, CONTROL OF WORK AND MATERIALS
- C. Section 01270, MEASUREMENT AND PAYMENT
- D. Section 01330, SUBMITTALS
- E. Section 02300, EARTHWORK
- F. Section 02252, SUPPORT OF EXCAVATION
- G. Section 02755, HMA with Seal Coat

1.03 REFERENCES:

New Hampshire Department of Transportation's 2010 Standard Specification for Road and Bridge Construction.

Massachusetts Department of Transportation (MassDOT) Standard Specifications for Highways and Bridges - Subsection M4.08.0, CONTROLLED DENSITY FILL.

1.04 SUBMITTALS:

Proposed Mix Designs for the type(s) of Controlled Density Fill shall be submitted for review and approval from the Contractor's Ready Mix provider in accordance with Section 01330.

PART 2 - PRODUCTS

2.01 MATERIALS:

Materials employed in the Controlled Density Fill shall meet the requirements as described below.

2.02 TYPE OF CONTROLLED DENSITY FILL:

Controlled Density Fill for this project shall be (Type 1 - Very Flowable (Non-excavatable), Type 1E - Very Flowable (Excavatable), Type 2 - Flowable (Non-excavatable) or Type 2E - Flowable (Excavatable).

CDF Strength and Slump Requirements

Controlled Density Fill	Type 1 & 2	Type 1E & 2E
Compressive Strength @ 28 Days	30-150 psi	30-80 psi
Compressive Strength @ 28 Days	200 psi maximum	100 psi maximum
Slump	10-12 inches	10-12 inches

PART 3 - EXECUTION

3.01 GENERAL:

- A. Controlled Density Fill shall be batched at a ready mix plant and is to be used at a high or very high slump of approximately 10- to 12-inches. It shall be flowable, require no vibration and after it has been placed for Type 1E and 2E, be excavatable by hand tools and/or small machines.
- B. Controlled Density Fill shall be placed so as to not disturb adjacent structures, utilities or the sidewalls of trenches.
- C. Controlled Density Fill shall be installed to the limits shown on the drawings, or required by permit and shall be kept below the top of the trench to allow for the placement of the required depth of pavement as specified in these documents or as indicated in the contract drawings.
- D. Steel road plates shall protect the Controlled Density Fill until the fill reaches a point that it will not be deformed by traffic passing over it. Plates are not to be removed until the day that paving operations are performed.

END OF SECTION

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SECTION 02223

SITE DEMOLITION

PART 1 - GENERAL

1.01 SCOPE OF WORK:

- A. Work under this Section shall consist of the careful removal, storage for reuse, transportation off-site, or demolition, of all structures and site features encountered or noted to be removed or abandoned to a minimum of three feet below finished grade, and the removal and disposal of all materials not called for to be reused or salvaged, in accordance with the contract drawings, these specifications, and Engineer's requirements. Provide all labor, equipment, materials and transportation necessary to complete the work.
- B. Items plan referenced to be removed and stored shall be carefully removed and stored on site in a manner and location designated by the Engineer for reinstallation later as shown on the plans or as indicated by the Engineer.
- C. Items plan referenced, or as indicated by the Engineer to be removed and disposed of shall be removed from the site and properly and legally disposed of by the Contractor.
- D. Items indicated on the contract drawings or in the specifications to be removed and salvaged, or other items required to be removed by the Engineer, shall be transported to a municipal storage facility, located within the Town confines, and unloaded and stacked as required by the Engineer.
- E. Items indicated on the contract drawings or in the specification to be removed and reset shall be carefully removed and reset in the same location as existing according to the specification and details.
- F. The following scope describes the general work/demolition requirements of this Section.
 - 1. Bituminous concrete pavements.
 - 2. Appurtenances and all related concrete footings complete.
 - 3. The contractor shall remove and reset fencing at Leary Field and the High School as needed for the installation of the athletic field lighting whether shown on the construction plans or not.
 - 3. Other features as indicated on the drawings.

1.02 PROTECTION:

- A. The Contractor shall assume complete responsibility and liability for the safety and structural integrity of all work and utilities to remain during demolition.
- B. Provide safeguards including, but not limited to, warning signs, barricades, temporary fences, warning lights and other items required for protection of personnel and the general public during performance of all work.
- C. All features related to protection shall be maintained until that work has been completed to the point when such safeguards are no longer required.

1.03 SPECIAL REQUIREMENTS:

- A. The Contractor shall salvage items labelled to be salvaged onsite in a designated location, unless these are called for to be reused or required by the Engineer to be disposed of.
- B. Install erosion controls to protect adjacent areas from eroded materials likely to enter wetlands, resource areas, or drainage ways/systems, downstream of areas disturbed by work activities.
- C. Where items to be demolished are located within or adjacent to pavements to remain, the Contractor shall make provisions to protect that pavement to remain. Cut concrete pavement back to score line and cut bituminous concrete pavement back far enough so as not to allow disturbance to base course materials. Pavements damaged as a result of Contractor activities shall be replaced to the extent determined by the Engineer at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 BACKFILL:

- A. The Contractor shall provide suitable backfill as specified under Section 02300 of these Specifications, to fill voids left by removal or abandonment of site features, and shall provide all pipe cap ends, mortar, brick and other material needed to cap off or plug pipes of various sizes and kinds.
- B. Suitable materials shall be used as base course fill and topsoil to the depth as specified herein. Restore disturbed areas with similar materials blended to match the line and grades of adjacent surfaces.

2.02 TEMPORARY FENCE:

- A. The work shall include temporary installation of chain link fence around the perimeter of the work limits where shown on the plans, and as required by the

Engineer, and as Contractor sees fit to protect work.

- B. Temporary fence shall consist of 6 foot high chain link fence anchored into a base that is both stable and movable to allow access and adjustment as needed. Reclaimed existing fence fabric and materials may be used with the approval of the Engineer. The Contractor shall submit a shop drawing to the Engineer for approval prior to installation.

PART 3 - EXECUTION

3.01 SALVAGEABLE MATERIAL:

- A. Frames, grates and other salvageable material shall be carefully removed to minimize damage and stored for later reuse, transport, or removal from site.

3.02 ABANDONED STRUCTURES:

- A. All inlets and outlets shall be plugged with at least eight (8) inches of brick and mortar masonry. Upper portions of masonry structures shall be removed to a depth of three feet. The bottoms of all structures shall be broken to allow drainage, and the structure shall be filled with suitable backfill material placed in six (6) inch layers and thoroughly compacted at each level.
- B. The Engineer shall review work related to abandoned structures before backfilling. Those items not reviewed before backfilling shall be uncovered and backfill procedures observed, at no expense to the Owner.

3.03 ABANDONED PIPES OR CONDUITS:

- A. Plug previously abandoned drainpipes encountered with masonry brick at least eight (8) inches in thickness.
- B. Abandon discontinued water supplies that are encountered during the execution of this contract in accordance with Owner requirements.
- C. Electrical conduits encountered and previously abandoned shall be capped or plugged.

END OF SECTION

SECTION 02240

DEWATERING

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. This section specifies designing, furnishing, installing, maintaining, operating and removing temporary dewatering systems as required to lower and control water levels and hydrostatic pressures during construction; disposing of pumped water; constructing, maintaining, observing and, except where indicated or required to remain in place, removing of equipment and instrumentation for control of the system.
- B. Geotechnical probes and boring logs are attached at the end of Section 02300, EARTHWORK

1.02 RELATED WORK:

- A. Section 01570, ENVIRONMENTAL PROTECTION
- B. Section 02300, EARTHWORK
- C. Section 02252, SUPPORT OF EXCAVATION

1.03 SYSTEM DESCRIPTION:

- A. Dewatering includes lowering the water table and intercepting seepage which would otherwise emerge from the slopes or bottom of the excavation; increasing the stability of excavated slopes; preventing loss of material from beneath the slopes or bottom of the excavation; reducing lateral loads on sheeting and bracing; improving the excavation and hauling characteristics of sandy soil; preventing rupture or heaving of the bottom of any excavation; and disposing of pumped water.
- B. Normal dewatering is defined as using conventional pumps installed in open excavations, ditches, or sumps.

1.04 QUALITY ASSURANCE:

- A. The Contractor is responsible for the adequacy of the dewatering systems.
- B. The dewatering systems shall be capable of effectively reducing the hydrostatic pressure and lowering the groundwater levels to a minimum of 2 feet below excavation bottom, unless otherwise required by the Engineer, so that all excavation bottoms are firm and dry.
- C. The dewatering system shall be capable of maintaining a dry and stable subgrade until the

structures, pipes and appurtenances to be built therein have been completed to the extent that they will not be floated or otherwise damaged.

- D. The dewatering system and excavation support (see Section 02252, SUPPORT OF EXCAVATION) shall be designed so that lowering of the groundwater level outside the excavation does not adversely affect adjacent structures, utilities or wells.

1.05 SUBMITTALS

- A. Contractor shall submit a plan indicating how they intend to control the discharge from any dewatering operations on the project, whether it is discharge of groundwater from excavations or Stormwater runoff during the life of the project.

PART 2 - EXECUTION

2.01 DEWATERING OPERATIONS:

- A. All water pumped or drained from the work shall be disposed of in a manner which will not result in undue interference with other work or damage to adjacent properties, pavements and other surfaces, buildings, structures and utilities. Suitable temporary pipes, flumes or channels shall be provided for water that may flow along or across the site of the work. All disposal of pumped water shall conform to the requirements of the owner, and to the provisions of SECTION 01570 AND 00890.
- B. Dewatering facilities shall be located where they will not interfere with utilities and construction work to be done by others.
- C. Dewatering procedures to be used shall be as described below:
 1. Crushed stone shall encapsulate the suction end of the pump to aid in minimizing the amount of silt discharged.
 2. For dewatering operations with relatively minor flows, pump discharges shall be directed into hay bale sedimentation traps lined with filter fabric. Water is to be filtered through the hay bales and filter fabric prior to being allowed to seep out into its natural water course.
 3. For dewatering operations with larger flows, pump discharges shall be into a steel dewatering basin. Steel baffle plates shall in used to slow water velocities to increase the contact time and allow adequate settlement of sediment prior to discharge into waterways.
 4. Where indicated on the contract drawings or in conditions of excess silt suspended in the discharge water, silt control bags are to be utilized in catch basins.
 5. The Contractor shall be responsible for repair of any damage caused by his dewatering operations, at no cost to the Owner.

END OF SECTION

SECTION 02252

SUPPORT OF EXCAVATION

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. This section of the specification covers wood sheeting and bracing for support of excavations. The requirements of this section shall also apply, as appropriate, to other methods of excavation support and underpinning which the Contractor elects to use to complete the work.
- B. The Contractor shall furnish and place timber sheeting of the kinds and dimensions required, complying with these specifications, where indicated on the drawings or required by the Engineer.

1.02 RELATED WORK:

- A. Section 02240, DEWATERING.
- B. Section 02300, EARTHWORK.

1.03 QUALITY ASSURANCE:

- A. This project is subject to the Safety and Health regulations of the U.S. Department of Labor set forth in 29 CFR, Part 1926 and to the New Hampshire Department of Labor. Contractors shall be familiar with the requirements of these regulations.
- B. The excavation support system shall be of sufficient strength and be provided with adequate bracing to support all loads to which it will be subjected. The excavation support system shall be designed to prevent any movement of earth that would diminish the width of the excavation or damage or endanger adjacent structures.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Timber sheeting shall be sound spruce, pine, or hemlock, planed on one side and either tongue and grooved or splined. Timber sheeting shall not be less than nominal 2-inches thick.
- B. Timber and steel used for bracing shall be of such size and strength as required in the excavation support design. Timber or steel used for bracing shall be new or undamaged used material which does not contain splices, cutouts, patches, or other alterations which would impair its integrity or strength.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Work shall not be started until all materials and equipment necessary for their construction are either on the site of the work or satisfactorily available for immediate use as required.
- B. The sheeting shall be securely and satisfactorily braced to withstand all pressures to which it may be subjected and be sufficiently tight to minimize lowering of the groundwater level outside the excavation, as required in Section 02240, DEWATERING.
- C. The sheeting shall be driven by approved means to the design elevation. No sheeting may be left so as to create a possible hazard to safety of the public or a hindrance to traffic of any kind.
- D. If boulders or very dense soils are encountered, making it impractical to drive a section to the desired depth, the section shall, as required, be cut off.
- E. The sheeting shall be left in place where indicated on the drawings or required by the Engineer in writing. At all other locations, the sheeting may be left in place or salvaged at the option of the Contractor. Steel or wood sheeting permanently left in place shall be cut off at a depth of not less than two feet below finish grade unless otherwise required.
- F. All cut-off will become the property of the Contractor and shall be removed by him from the site.
- G. Responsibility for the satisfactory construction and maintenance of the excavation support system, complete in place, shall rest with the Contractor. Any work done, including incidental construction, which is not acceptable for the intended purpose shall be either repaired or removed and reconstructed by the Contractor at his expense.
- H. The Contractor shall be solely responsible for repairing all damage associated with installation, performance, and removal of the excavation support system.

END OF SECTION

SECTION 02290

SEEDING

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. This Section includes furnishing all labor, materials, equipment, seed and incidental materials necessary to accomplish all grass seeding and related work, complete in place, maintained, and accepted, in accordance with the Contact Drawings and Specifications. All grassed areas disturbed by the Contractor's operations shall be repaired as herein specified.
- B. The Contractor shall bear the responsibility and cost of furnishing and applying water or any other substances, as necessary to ensure the sustainability of grass seeded areas, as part of the work of this contract.

1.02 RELATED WORK:

- A. Section 02910, SCREENED LOAM BORROW AND TOPSOIL REUSED.

1.03 SUBMITTALS:

In accordance with requirements of general specifications, the Contractor shall submit the following to the Engineer for review and approval:

- A. Six copies of information for seed mixes including the following:
 - 1. Name and address of the seed supplier.
 - 2. Source of origin and dates of harvest for each of the various types of seed
 - 3. Certification of seed mix composition and proportion, indicating named seed varieties by percent, percent germination, purity, and percent crop seed, percent inert matter, and percent weed seed content.
 - 4. Estimated number of seeds per pound of each type of seed in the mix
 - 5. Ingredients that comprise the hydroseed mix
 - 6. Soil amendments and fertilizers
- B. Six copies of information detailing proposed limestone, fertilizers, mulch materials, hydroseeding materials (as required), and slope protection material (as required) to be applied to seeded areas.
- C. Six copies of watering, fertilizing and maintenance schedule.

- D. Six copies of marked up prints indicating the square footage of all proposed seeded areas with quantities of various soil additives and amendments, and quantities of seed for each area prior to beginning work.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. LOAM BORROW:

- 1. Loam Borrow shall be as specified in Section 02910, SCREENED LOAM BORROW AND TOPSOIL RE-USED.

B. LIMESTONE:

- 1. Lime shall be an approved agricultural limestone containing at least 50 percent total oxides (calcium oxide and magnesium oxide). The material will be ground such that 50 percent of the material will pass through a No. 100 mesh sieve and 98 percent will pass a No. 2 mesh sieve. Lime shall be uniform in composition, dry and free-flowing and shall be delivered to the site in the original sealed containers, each bearing the manufacturer's guaranteed analysis.

C. FERTILIZER:

- 1. Fertilizer shall be a complete, standard commercial fertilizer, homogenous and uniform in composition, dry and free-flowing, and shall be delivered to the site in the manufacturer's original sealed containers, each bearing the manufacturer's guaranteed analysis and marketed in compliance with State and Federal Laws. All fertilizer shall be used in accordance with the manufacturer's recommendations. All fertilizers and soil amendments shall meet these requirements or be an approved equal.

D. SEED:

- 1. Seed shall be of an approved perennial variety mixture, the previous year's crop, clean, and high in germinating value. Weed seed content shall be less than 0.5 percent and include no noxious weeds. Seed shall be obtained from a reliable seed company and shall be accompanied by certificates of compliance relative to mixture purity and germinating value. Seed shall be furnished and delivered in new, clean, sealed and properly labeled containers. All seed shall comply with applicable State and Federal laws. Seed that has become wet, moldy or otherwise damaged shall not be accepted.
- 2. Grass seed for lawn and playing field areas shall conform to the following requirements: TOUCHDOWN 80/20 MIX or approved equal.

Common Names	Proportion by Weight	Germination Rate	Purity Minimum
Touchdown Kentucky Bluegrass	30%	70%	97%
Mercury Kentucky Bluegrass	30%	90%	98%
Armada Bluegrass	20%	80%	85%
Futura 3000 Ryegrass Blend	20%	90%	98%

Refer to Appendix E – for technical information on the seed types

3. Mix for restoration areas shall be “Erosion Control/ Restoration Mix for Dry Sites” and “Erosion Control/ Restoration Mix for Moist Sites” as provided by New England Wetland plants or approved equal. For seed requirements, refer to plans.

E. TEMPORARY COVER CROP:

1. Temporary cover crop shall conform to the following requirements:

Botanical and Common Names	Proportion by Weight	Germination Rate	Purity Minimum
Annual Ryegrass (Lolium multiflorum)	80% min.	85%	%
Creeping Red Fescue (Festuca rubra)	4% min.	85%	95%
Perennial Ryegrass (Lolium perenne)	3% min.	90%	98%
Red Clover (Trifolium pratense)	3% min.	90%	%
Other Crop Grass	0.5% max.		
Noxious Weed Seed	0.5% max.		
Inert Matter	1.0% max.		

F. MULCH

1. Materials to be used in mulching seeded areas shall be free of weed seed and shall conform to the following requirements:
 - a. Hay Mulch shall consist of mowed and properly cured grass, clover or other acceptable plants. No salt hay shall be used.

b. Straw Mulch shall consist of stalks or stems of grain after threshing.

G. HYDROSEED MULCH, TACKIFIERS AND WATER RETENTION AGENTS:

1. Wood fiber mulch for Hydroseed application shall be a manufactured product of natural wood cellulose fibers with a non-toxic green marking dye incorporated to ensure uniform distribution. Mulch shall be packed in sealed original containers, clearly labeled with brand name and manufacturer. It shall have delivered moisture content less than 12 percent.
2. Hydroseed tackifier shall be a powdered starch-based product approved by the Engineer. Hydroseed tackifier shall be applied in conjunction with the hydroseed slurry in accordance with the manufacturer's recommendations.
2. Moisture retention agent shall be a powdered starch-based product, approved by the Engineer, and shall be capable of retaining up to 400 times their weight in water. Moisture retaining agents shall be added to the hydroseed slurry in accordance with the manufacturer's recommendations. Moisture retention agent shall be 'Hydro-Gel', as manufactured by Finn Corporation, Fairfield, OH.
3. Contractor to submit mix ingredients prior to installation of hydroseed.

H. SLOPE EROSION PROTECTION:

1. Erosion control blanket shall be 100 percent biodegradable mesh with 100 percent biodegradable straw or straw/coconut fill. Fill shall be held together by biodegradable fastening. Weight shall be 0.50 pounds per square yard. Erosion control blankets shall be applied parallel to direction of water flow. The erosion control blankets shall be by North American Green, Evansville, IN or approved equal. For slopes 4:1 or greater, erosion control blanket shall be composed of 70 percent straw 30 percent coconut fiber, Model SC150. For slopes less than 4:1, erosion control blanket shall be high velocity straw matting, Model S150.
2. Six-inch wire staples shall be placed in accordance with the manufacturer's recommendations to anchor the mesh material. Staples shall be biodegradable.

I. WATER:

1. Water shall be furnished by the Contractor, unless otherwise specified, and shall be suitable for irrigation and free from ingredients harmful to plant growth and viability. The delivery and distribution equipment required for the application of water shall be the furnished by the Contractor, at no additional cost to the Owner.

PART 3 - EXECUTION

3.01 GENERAL:

- A. All work shall be performed by skilled workers with a minimum of 2 years of seeded lawn construction and establishment experience and under the full-time supervision of a qualified foreman.
- B. Seeding operations shall not begin less than 4 days after the application of lime and fertilizer and the seedbed areas are reviewed and approved by the Engineer.
- C. Seeding shall be done when soil and weather conditions permit in early spring, until June 15, or from September 10 to October 15, unless otherwise approved. If it becomes necessary for seed to be sown after June 15, provisions shall be made for supplementary water and using mulch cover over lawn areas.
- D. If there is a delay in seeding, during which weeds grow, or soil is washed out, the Contractor shall eliminate the weeds by physical means, or replace the soil before sowing the seed, without additional compensation. Immediately before seeding is begun, the soil shall be lightly raked.
- E. Seed shall be sown at the approved rate, on a non-windy day by machine, or as approved by the Engineer.
- F. The surface shall be kept moist by a fine spray until the seed shows uniform germination over the entire area. Wherever poor germination occurs in areas larger than 3 square feet, the Contractor shall reseed, roll, straw and water as necessary to obtain proper germination.
- G. If there is insufficient time in the planting season to complete soil preparations, fertilizing, and seeding, permanent seeding may be left until the following planting season, at the option of the Contractor, or on order of the Engineer. In that event, a temporary cover crop shall be sown. This cover crop shall be cut and watered as necessary until the beginning of the following planting season, at which time it shall be plowed or harrowed into the soil, the area shall be fertilized and the permanent seed crop shall be sown as specified.
- H. Protection of all newly loamed and graded areas is required and shall be accomplished by whatever means necessary such as mulch applied with a tackifier, or by other means approved by the Engineer. The Contractor shall be responsible for the prevention of siltation in areas beyond the limit of work and for all means of protection throughout the maintenance period at no additional cost to the Owner.

3.02 ROOT ZONE MIX TESTING REQUIREMENTS

- A. Root zone mix (vegetative support layer) samples shall be collected from in-place loam at a minimum of every 1000 cubic yards and analyzed for grain size (ASTM D422), pH (Astm D6276) and organic content (ignition test).

3.03 BROADCAST SEEDING, PLACING MULCH AND SLOPE EROSION PROTECTION:

- A. The seed mix shall be broadcast at 6 pounds per 1000 square feet, as recommended by the seed supplier, or as directed by the Engineer. Seed shall be divided into 2 equal amounts and uniformly distributed in 2 applications at right angles to each other. Seed shall then be raked lightly into the soil to a depth of 1/4 inch.
- B. If mulch is not necessary the seed shall be directly firmed into the soil with a roller that will apply pressure between 75 and 100 pounds per linear foot of width.
- C. Hay or Straw Mulch shall be used based on time of seeding as previously specified over all seeded areas, as designated on the plans, or as otherwise directed. If mulch is to be used, it shall be loosely spread to a uniform depth at a rate of 4-1/2 tons per acre to provide 1/4 inch of cover, or as otherwise directed. The seed and mulch shall then be firmed into the soil with a roller that will apply a pressure between 75 and 100 pounds per foot of width.
- D. Hay or Straw Mulch may be applied by mechanical apparatus, if in the judgment of the Engineer, the apparatus spreads the mulch uniformly and forms a suitable mat to control slope erosion. The apparatus shall be capable of spreading at least 80 percent of the hay or straw in lengths of 6-inches or more, otherwise it shall be spread by hand without additional compensation.
- E. Slope erosion control blankets shall be placed as indicated on the plans or as directed by the Engineer.

3.04 HYDROSEEDING:

- A. The application of lime, fertilizer, grass seed and mulch may be accomplished in a single operation with the use of approved hydroseeding equipment. The materials shall be mixed with water in the machine and kept in an agitated state in order that the materials may be uniformly suspended in the water. The slurry shall be of such consistency that it can be sprayed from a hydroseed gun or through at least 200 feet of 1 1/2 inch diameter hose. The spraying equipment shall be so designed that when the solution is sprayed over an area, the resulting deposits of lime, fertilizer, grass seed, and mulch shall be equal to the specified quantities.
- B. Prior to the start of hydroseeding, the Contractor shall furnish to the Engineer, in writing, the weights of limestone, fertilizer, grass seed, mulch, tackifier (as required) and moisture retention agent (as required) per 100 gallons of water to be used. This statement should also specify the number of square yards of seeding that can be covered with the solution specified above. If the results of hydroseeding operations are unsatisfactory, the Contractor will be required to abandon this method and to apply the lime, fertilizer, grass seed and mulch by other means.
- C. Seed shall be incorporated with the mulching material to obtain a minimum hydroseeded sown coverage of 200 pounds of the specified seed mix per acre, as recommended by the seed suppliers, or as directed by the Engineer.
- D. Wood fiber mulch shall be uniformly spread over certain selected seeded areas at the minimum rate of 1,400 pounds per acre unless otherwise directed. Mulch shall be placed

by spraying from an approved spraying machine with pressure sufficient to cover the entire area in a single operation.

- E. The Contractor shall immediately cleanup hydroseed oversprays from plant materials, pavements, furnishings, etc., to the satisfaction of the Engineer.

3.05 MAINTENANCE:

- A. The Contractor shall maintain and protect the entire seeded area, as necessary to ensure dense healthy growth, until completion of the guarantee period and final acceptance of the project, or for 60 days, whichever is longer. If lawns are planted in late summer or during the fall, maintenance shall continue through the following spring for at least 60 days. Maintenance shall include watering as specified, liming, fertilizing, removal of stones, control of weeds, insect pests and fungal pathogens, and regular mowing. Defective work shall be corrected as soon as possible after it becomes apparent and weather and season permit.
- B. The first cutting of lawn areas shall be done when the grass is between 2 ½ - 3 inches in height. The lawn shall be cut no shorter than 2 inches in height and shall be regularly mowed as necessary to maintain the above-prescribed conditions. All cuttings shall be removed from the lawn during the maintenance period and disposed of off-site. Cutting shall be accomplished with approved equipment that is weed free, clean of all herbicides and pesticides and has freshly sharpened blades. No mowing shall occur without inspection and approval of the owner or Engineer.
- C. The Contractor shall be responsible to regularly water seeded areas with the equivalent of 1-inch minimum of rainfall per week, or as necessary to develop and sustain dense, green growth.
- D. Six weeks after turf has established, and only during the months of April, May, or September, the Contractor shall apply fertilizer as specified above, at one half the rate recommended by the initial soils laboratory tests, or as directed by the Engineer.
- E. The Contractor shall be responsible for securing all seeded areas from physical damage as necessary, including warning signs, barriers, temporary fencing, or other means of protection, through the guarantee period until final acceptance. All damaged areas shall be repaired to reestablish healthy vigorous growth of turf to the satisfaction of the Engineer, at no additional cost to the Owner. All temporary barriers shall remain the property of the Contractor and shall be removed by the Contractor upon final acceptance by the Engineer.
- F. Pavement shall be kept clean and clear of cuttings and debris at all times during the maintenance period to the satisfaction of the Engineer.

3.06 INSPECTION AND PRELIMINARY ACCEPTANCE:

- A. At the beginning of the planting season following that in which the permanent grass crop is sown, seeded areas will be inspected. Any section not showing dense, vigorous growth shall be promptly reseeded by the Contractor at no additional cost to the Owner. The

seeded areas shall be watered, weeded, cut and otherwise maintained by the Contractor, as many times as necessary, in accordance with these specifications, until they are accepted.

- B. The Contractor shall provide written notice to the Engineer not less than 10 days before the anticipated date of inspection for preliminary acceptance. The Engineer shall recommend preliminary acceptance of the work of this Section only after completion and re-inspection of all necessary repairs, renewals, or replacements.
- C. Inspection and acceptance of seeded areas may be requested and granted in part, provided the areas for which acceptance is requested are relatively substantial in size, and with clearly definable boundaries. Acceptance and use of these areas by the Owner shall not waive any other provisions of this Contract.

3.07 GUARANTEE:

- A. Seeded areas shall be guaranteed until final acceptance of the project, or, in the case of late summer or fall planting, the guarantee period shall extend through the following spring.
- B. When the work is accepted in part, the guarantee period shall extend from each partial acceptance to the terminal date of the last guarantee period. All guarantee periods terminate at one time.
- C. Guarantee shall not apply to the replacement of seeded lawns resulting from the removal, loss, or damage due to occupancy of the project in any part; vandalism or acts of neglect on the part of others; physical damage by animals, vehicles, etc.; and Acts of God, including but not limited to, catastrophic fire, hurricanes, riots, war, etc.
- D. In the instance of curtailment of water by local water authorities (when supply was to be furnished by the Owner), the Contractor shall furnish all necessary water by water tanker, the cost of which will be approved and paid for by the Owner.

3.08 FINAL INSPECTION AND FINAL ACCEPTANCE:

- A. At the end of the guarantee period, the Contractor shall provide written notice to the Engineer not less than 10 days before the anticipated date of final inspection for final acceptance.
- B. The Engineer shall recommend final acceptance of the work of this Section only after completion and re-inspection of all necessary repairs, renewals or replacements.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. Under this Section, the Contractor shall furnish all labor, materials, equipment and transportation required to complete Earthwork as indicated on the drawings, as designated by the Engineer, or as specified herein, to complete all proposed work.
- B. The Contractor or Sub-contractor must have a minimum of five (5) years of experience installing athletic fields of similar size and quality of this project.
- C. Without limiting the generality thereof, Earthwork shall include excavating, furnishing borrow materials as necessary, and backfilling for the construction of all proposed work from existing grades to finished grades. Work shall include the removal of unclassified material, such as bituminous pavements, curbs, ledge and boulders under one (1) cubic yard in size, concrete, reinforced and plain, structures, and metal or wood posts; and unsuitable materials of every nature throughout the site within twelve (12) inches below finished subgrade elevations for proposed work or as indicated or required for new construction; transportation of the excavated materials; proof-compacting exposed subgrades within excavation areas for tennis courts, track, bleacher and athletic fields, backfilling to proposed base course subgrades with approved excavated and/or furnished materials; and the legal disposal of unsuitable, and/or surplus excavated materials.
- D. Work under this Section shall include the furnishing of all borrow materials required to complete the proposed work as designed. Where "processed gravel", "gravel borrow", or "gravel" is indicated in the specifications or on the drawings, only gravel conforming to this section of the specifications may be utilized.
- E. All topsoil/loam for seeding, whether re-used or furnished from off-site, shall conform to Section 02910 of these Specifications.
- F. The Contractor shall make excavations of normal depth in earth for trenches and structures, shall backfill and compact such excavations to the extent necessary, shall furnish the necessary material and construct embankments and fills, and shall make miscellaneous earth excavations and do miscellaneous grading.

1.02 RELATED WORK:

- A. Section 00890, PERMITS
- B. Section 01110, CONTROL OF WORK
- C. Section 01570, ENVIRONMENTAL PROTECTION
- D. Section 02240, DEWATERING
- E. Section 02910, SCREENED LOAM BORROW AND TOPSOIL RE-USED

1.03 REFERENCES:

AASHTO - American Association of State Highway and Transportation Officials (tests or specifications). AASHTO or AASHO

AWWA - American Waterworks Association

American Society for Testing and Materials (ASTM)

ASTM C 131 Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

ASTM C136 Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM C330 Specification for Lightweight Aggregate for Structural Concrete.

ASTM D1556 Test Method for Density of Soil in Place by the Sand Cone Method.

ASTM D1557 Test Methods for Moisture-density Relations of Soils and Soil Aggregate Mixtures Using Ten-pound (10 Lb.) Hammer and Eighteen-inch (18") Drop.

ASTM D2922 Test Methods for Density of Soil and Soil-aggregate in Place by Nuclear Methods (Shallow Depth).

ASTM F-2396-04 Standard Guide for Construction of High Performance Sand-Based Rootzones for Sports Fields

New Hampshire Department of Transportation's 2010 Standard Specification for Road and Bridge Construction.

1.04 SUBMITTALS: IN ACCORDANCE WITH REQUIREMENTS OF GENERAL SPECIFICATIONS, SUBMIT THE FOLLOWING:

Samples of all materials proposed for the project shall be submitted to the Engineer for review. Size of the samples shall be as approved by the Engineer.

1.05 PROTECTION OF EXISTING PROPERTY:

A. The work shall be executed in such manner as to prevent any damage to facilities at the site and adjacent property and existing improvements, such as but not limited to parking areas, curbs, paving, service utility lines, structures, monuments, bench marks, observation wells, and other public or private property. Protect existing improvements from damage caused by settlement, lateral movements, undermining, washout and other hazards created by earthwork operations.

B. In case of any damage or injury caused in the performance of the work, the Contractor shall, at its own expense, make good such damage or injury to the satisfaction of, and without cost to, the Owner. Existing roads, sidewalks, and curbs damaged during the project work shall be repaired or replaced to at least the condition that existed at the start of operations. The Contractor shall replace, at his own cost, existing benchmarks, observation wells, monuments, and other reference points, which are disturbed or destroyed.

- C. Buried drainage structures and pipes, observation wells and piezometers, including those which project less than eighteen inches (18") above grade, which are subject to damage from construction equipment shall be clearly marked to indicate the hazard. Markers shall indicate limits of danger areas, by means which will be clearly visible to operators of trucks and other construction equipment, and shall be maintained at all times until completion of project.

1.06 DRAINAGE:

- A. The Contractor shall provide, at its own expense, adequate drainage facilities to complete all work items in an acceptable manner. Drainage shall be done in a manner so that runoff will not adversely affect construction procedures or cause excessive disturbance of underlying natural ground or abutting properties. All work shall be done in the dry.

1.07 FROST PROTECTION AND SNOW REMOVAL:

- A. The Contractor shall, at its own expense, keep earthwork operations clear and free of accumulations of snow as required to carry out the work.
- B. The Contractor shall protect the subgrade beneath new structures and pipes from frost penetration when freezing temperatures are expected.

1.08 SPECIAL REQUIREMENTS:

- A. The sequence of all excavation operations shall be such as to insure the most efficient re-use of suitable excavated materials and the use of a minimum amount of specified borrow.
- B. The Contractor shall inform and satisfy himself as to the character, quantity, and distribution of all material to be excavated. No payment will be made for the placement of any excavated material which is used for purposes other than those designated and as specified herein. Further, these shall be removed at no cost to the Owner if so approved by the Engineer.
- C. The Engineer shall have final determination over the excavation, moving, placing and disposition of all materials, and shall determine the suitability of materials to be placed in excavated areas.
- D. After excavating existing pavements, soil and fill materials to soil subgrade for the tennis courts, and athletic field, the Contractor shall "proof-compact" the exposed subgrades in the presence of the Engineer. Refer to Paragraph 3.03 for additional information.
- E. All backfill to subgrade, shall be compacted to not less than ninety-five percent (95%) of the maximum dry density of the material as determined by the Standard AASHTO Test Designation T-180-86, Modified Proctor Test with the exception of the lawn areas and natural turf athletic field areas which shall be compacted per Section 02910.
- F. Unsuitable and/or excess excavated materials shall be removed and properly disposed of in legal disposal areas off of the site at no additional cost to the Owner.

- G. Exploratory excavation to locate existing utilities or obstructions, shall be at the Contractor's discretion to assist him in the work of this project and no extra payment shall be made for such verification. Although extra payment is not considered, lack of such payment does not constitute a waiver of the Contractor's responsibility to verify all utilities. The contractor must ensure verification of existing services and ensure the safety of the Contractor's work forces.

PART 2 – PRODUCTS

2.01 BORROW MATERIALS:

- A. Excavated topsoil and furnished topsoil to be utilized for sodding, seeding and landscaping must conform to Section 02910 SCREENED LOAM BORROW AND TOPSOIL RE-USED in order to be used as Loam Borrow. Existing topsoil not passing tests for Loam Borrow may be considered suitable as general fill below subgrade, in landscaped areas only and may be utilized throughout the proposed sod and seeded areas, up to subgrades of proposed work.
- B. Gravel Borrow shall be as specified under paragraph 2.03 of these Specifications and shall be utilized whenever gravel is noted, including beneath pavements and structural elements unless otherwise noted.
- C. Although suitable excavated backfill materials and topsoil may be reused to fill to subgrade as specified herein, if there are insufficient quantities of materials available the Contractor shall furnish Suitable Backfill as specified in paragraph 2.02A below.
- D. If approved by the Engineer, Suitable Backfill materials excavated from beneath pavements may be utilized as backfill from four inches above the overt of pipes so long as all material over four (4) inches in size is removed from the material prior to backfilling and all trench compaction requirements may be met.
- E. Where Sand Borrow is required, materials shall conform to Sand Borrow shall satisfy the requirements listed in NHDOT Specification Section 304.2.3, Item No. 304.1. Utilize Sand Borrow as necessary for re-grading subgrade.

2.02 SUITABLE ON SITE BACKFILL

- A. All other materials to be placed where Specifications or Drawings call for "fill," "backfilling," or "filling" to subgrade, shall be natural soil, well-graded and free from all organic weak, compressible, and frozen materials, and shall contain no stone larger than four (4) inches in maximum dimension. It shall be of such nature and character that it can be dried and compacted and shall be free of all expansive materials (such as high plastic clays) and of materials subject to decay, decomposition, or dissolution, and shall conform to the following gradations:

U.S. Sieve No. Total Percent Passing by Weight

4 inch	100
#4	20-75
#40	0-25
#200	0-5

- B. If, sufficient suitable fill material is not available from excavations under this Contract, to complete filling to subgrades as specified above, additional fill, as specified under paragraph 2.02A above, shall be furnished by the Contractor from other sources at no additional cost. Excavated material from the site, and furnished material for use as Suitable Backfill, shall be deemed suitable only if they meet the requirements of paragraph 2.02A above, can be properly compacted, and are satisfactory to the Engineer.
- C. Use Suitable Backfill compacted as specified for general grading as backfill except as specified herein; fill to sub-grades of proposed work where shown.

2.03 MATERIALS:

A. GRAVEL BORROW:

Gravel Borrow shall satisfy the requirements listed in NHDOT Specification Section 304.2.4, Item No. 304.2.

B. CRUSHED STONE:

Crushed stone shall satisfy the requirements listed in NHDOT Specification Section 304.2.10, Item No. 304.4.

C. SAND BORROW:

Sand Borrow shall satisfy the requirements listed in NHDOT Specification Section 304.2.3, Item No. 304.1.

D. PEASTONE:

Peastone shall be smooth, hard, naturally occurring, rounded stone meeting the following gradation requirements:

<u>U.S. Sieve No.</u>	<u>Total Percent Passing by Weight</u>
1/2 inch	100
3/8 inch	93
1/4 inch	33
#4	12
#8	0.3

E. BACKFILL MATERIALS:

1. Class B Backfill:

Class B backfill shall be granular, well graded friable soil; free of rubbish, ice, snow, tree stumps, roots, clay and organic matter; with 30 percent or less passing the No. 200 sieve; no stone greater than two-third (2/3) loose lift thickness, or six inches, whichever is smaller.

2. Select Backfill:

Select backfill shall be granular, well graded friable soil, free of rubbish, ice, snow, tree stumps, roots, clay and organic matter, and other deleterious or organic material; graded within the following limits:

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>
3"	100
No. 10	30-95
No. 40	10-70
No. 200	0-10

F. LOAM BORROW:

Loam Borrow shall satisfy the specification section 02910 included in these specifications.

G. PROCESSED GRAVEL:

1. Processed gravel shall consist of inert material that is hard, durable stone and coarse sand, free from loam and clay, surface coatings and deleterious materials. The coarse aggregate shall have a percentage of wear, by the Los Angeles Abrasion Test, of not more than 50.

2. The gradation shall meet the following requirements:

<u>Sieve Designation</u>	<u>Percentage Passing</u>
3 in.	100
1 1/2 in.	70-100
1/4 in.	50-85
No. 4	30-60
No. 200	0-10

3. The approved source of bank-run gravel material shall be processed by mechanical means. The equipment for producing crushed gravel shall be of adequate size with sufficient adjustments to produce the desired materials. The processed material shall be stockpiled in such a manner to minimize segregation of particle sizes. All processed gravel shall come from approved stockpiles.

PART 3 - EXECUTION

3.01 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING

CONSTRUCTION:

Contractor shall take the necessary steps to avoid disturbance of subgrade during excavation and filling operations, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials, dewatering and other acceptable control measures.

3.02 EXCAVATION:

A. GENERAL:

1. The Contractor shall perform all work of any nature and description required to accomplish the work as shown on the Drawings and as specified.
2. Excavations, unless otherwise required by the Engineer, shall be carried only to the depths and limits shown on the Drawings.
3. In all excavation areas, the Contractor shall strip the surficial topsoil layer and underlying subsoil layer separate from underlying soils.
4. The Contractor shall follow a construction procedure, which permits visual identification of stable natural ground within the excavation areas by the Engineer. Where groundwater is encountered, the size of the open excavation shall be limited to that which can be handled by the Contractor's chosen method of dewatering and which will allow visual observation of the bottom and backfill in-the-dry.
5. The Contractor shall excavate unsuitable materials to stable natural ground where encountered at proposed subgrade. Unsuitable material includes topsoil, loam, peat, other organic materials, snow, ice, trash and construction debris. Unless specified elsewhere or otherwise approved by the Engineer, excavation areas where unsuitable materials have been excavated to stable ground shall be proof-compacted as described in Paragraph 3.03, and then backfilled to the subgrade level for the finished surface feature (track, field, bleachers or tennis courts) with compacted Select Backfill or crushed stone wrapped all around in non-woven filter fabric.
6. When the plans require excavation in areas in proximity to existing sidewalks, structures and utilities, it shall be the responsibility of the Contractor, at his own expense, to provide adequate and suitable drainage away from proposed work and existing features or use other satisfactory means and methods to protect and maintain the stability of such construction within or adjacent to the limits of work.
7. Protect all existing trees, shrubs or other plan referenced features to remain. Hand excavate around all items to remain including tree roots or where utilities must be verified. Exposed tree roots shall be immediately covered with Loam Borrow in accordance with these specifications.
8. No roots greater than two (2) inches in diameter shall be cut from trees to remain without approval of the Engineer. Roots greater than one (1) inch in diameter that are cut or broken shall be promptly pruned to a smooth clean cut and painted with an

approved compound.

9. Any removal of existing facilities required in order to achieve the excavation to proceed, such as fences, walls, walkways, etc., shall be accomplished by the Contractor at no additional cost to the owner. Restoration of these facilities shall be to a condition equal to that before removal, and safe and operational to the satisfaction of the Engineer.
10. Excavation shall be performed to the lines, grades, and elevations shown on the plans or as approved by the Engineer, and shall be made in such a manner that the requirements for formation of the subgrade can be followed.
11. No excavation shall be started until the Engineer has reviewed and acknowledged the area of proposed construction. All material encountered, of whatever nature within the limits indicated, shall be removed and disposed of as approved. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times.
12. The planes at the bottom of the excavation (in cut), or the top of the fill, when completed, shall be known as the subgrade, and shall be true to the lines, grades and cross section shown on the plans, to allow proposed work (base courses and finished courses of the finished surface features) to be completed.
13. All unsuitable excavated material shall be legally disposed of outside of, and away from, the project limits. All suitable excavated material deemed surplus by the Engineer shall become the property of the Contractor and shall be properly removed from the site.
14. Fills to subgrade level shall be formed of successive layers not exceeding six (6) inches in depth and each layer shall be compacted to not less than 95 percent of maximum dry density of the material as determined by the standard AASHTO Test Designation T-180-86, Modified Proctor Test.
15. No additional payment will be made for materials removed, manipulated or replaced by the Contractor in order to obtain the specified density. Any removal, manipulation, aerating, replacement and re-compaction of materials necessary to obtain the required density shall be considered as incidental to the excavation and compaction operations and shall be performed by the Contractor at no additional cost.
16. After areas to receive loam borrow have been brought to subgrade, and immediately prior to placing and spreading such material, the subgrade shall be loosened by discing to a depth of at least three inches to permit bonding of the finished material to the subgrade material. Then place and spread the loam borrow to the depths required by the Drawings to establish finish grades. Refer to Loam Borrow Specifications.
17. Protect all existing areas against damage due to the work under this Contract, and perform all repair and replacement work to any such areas which are damaged hereunder.

18. No extra work shall be initiated without notification of the Engineer in writing, and the written approval of the Engineer in response.
19. The Contractor shall be responsible for any and all pumping or bailing necessary to complete his operations, and to keep all areas sufficiently dry to guarantee compaction in accordance with paragraph 3.02.A.17 above.
20. Where insufficient suitable materials of any kind exist on site for incorporation into the proposed work within proposed work lines, the Contractor shall furnish materials from off site, as necessary and in accordance with these specifications, at no additional cost to the Owner.

B. EXCAVATION NEAR EXISTING STRUCTURES:

1. Attention is directed to the fact that there are pipes, manholes, drains, and other utilities in certain locations. An attempt has been made to locate all utilities on the drawings, but the completeness or accuracy of the given information is not guaranteed. The contractor is responsible for contacting dig safe and appropriate municipal departments prior to construction operations begin to indicate general location of all utilities.
2. As the excavation approaches pipes, conduits, or other underground structures, digging by machinery shall be discontinued and excavation shall be done by means of hand tools, as required. Such manual excavation, when incidental to normal excavation, shall be included in the work to be done under items involving normal excavation.
3. Where determination of the exact location of a pipe or other underground structure is necessary for properly performing the work, the Contractor shall excavate test pits to determine the locations.

C. TRENCH HAND EXCAVATION

1. When approaching the vicinity of significant tree roots, underground pipes, conduits, or other structures, or any suspected functioning underground features, digging by machinery shall be discontinued and the excavation shall be done by hand. Hand excavation shall also be undertaken when so approved by the Engineer. Such hand excavation shall be considered incidental to the trench excavation and no additional compensation will be allowed.
2. Protection of Existing Structures - All existing pipes, conduits, poles, wires, fences, curbing, property line markers, and other structures which, in the opinion of the Engineer, are not required to be changed in location, shall be carefully supported and protected from injury by the Contractor, and in case of damage, they shall be restored by the Contractor without additional compensation, to as good a condition as that in which they were found.

3.03 BACKFILL PLACEMENT AND COMPACTION:

A. GENERAL:

1. After initial excavation to subgrade in excavation areas for the tennis courts, track, bleachers and athletic fields, the Contractor shall proof-compact the exposed subgrades in the presence of the Engineer who will verify that the subgrades are stable. Proof-compaction shall be defined as at least four complete coverages of the excavation area with the rear wheels of a fully loaded 10-wheel dump truck. Areas of subgrade that deflect, weave or pump under the stress of proof-compaction shall be overexcavated by 18-inches and backfilled with Select Backfill as defined in Paragraph 2.03 F. 2., above. Select Backfill shall be placed in maximum nine-inch thick horizontal layers (measured prior to compaction) and compacted to at least 95 percent of maximum dry density of the material as determined by ASTM D1557, Method C.
2. After approval of subgrade by the Engineer, the Contractor shall backfill areas to required contours and elevations with specified materials.
3. The Contractor shall place and compact materials to the specified density in continuous horizontal layers. The degree of compaction shall be based on maximum dry density as determined by ASTM Test D1557, Method C. The minimum degree of compaction for fill placed shall be as follows:

<u>Location</u>	<u>Percent of Maximum Density</u>
Below pipe centerline	95
Above pipe centerline	92
Below pavement (upper 3 ft.)	95
Embankments	95
Below pipe in embankments	95
Adjacent to structures	92
Below structures	95

4. The Engineer reserves the right to test backfill for conformance to the specifications and Contractor shall assist as required to obtain the information. Compaction testing will be performed by the Engineer or by an inspection laboratory designated by the Engineer, engaged and paid for by the CONTRACTOR. If test results indicate work does not conform to specification requirements, the Contractor shall remove or correct the defective Work by recompacting where appropriate or replacing as necessary and approved by the Engineer, to bring the work into compliance, at no additional cost to the Owner. All backfilled materials under structures and buildings shall be field tested for compliance with the requirements of this specification.
5. The Contractor shall remove loam and topsoil, loose vegetation, stumps, large roots, etc., from areas upon which embankments will be built or areas where material will be placed for grading. The subgrade shall be shaped as indicated on the Drawings and shall be prepared by forking, furrowing, or plowing so that the first layer of the fill material placed on the subgrade will be well bonded to the subgrade.

3.04 DISPOSAL OF SURPLUS MATERIALS:

- A. Surplus excavated materials, which are acceptable to the Engineer, shall be used to backfill normal excavations in rock or to replace other materials unacceptable for use as backfill. Upon written approval of the Engineer, surplus excavated materials shall be neatly deposited and graded so as to make or widen fills, flatten side slopes, or fill depressions; or shall be neatly deposited for other purposes as indicated by the Owner, within its jurisdictional limits; all at no additional cost to the Owner.
- B. Surplus excavated material not needed as specified above shall be hauled away and disposed of by the Contractor at no additional cost to the Owner, at appropriate locations, and in accordance with arrangements made by him. Disposal of all rubble shall be in accordance with all applicable local, state and federal regulations.
- C. No excavated material shall be removed from the site of the work or disposed of by the Contractor unless approved by the Engineer.
- D. The Contractor shall comply with NHDES regulations that govern the removal and disposal of surplus excavated materials. Materials, including contaminated soils, having concentrations of oil or hazardous materials less than an otherwise Reportable Concentration and that are not a hazardous waste, may not be disposed of at locations where concentrations of oil and/or hazardous material at the receiving site are significantly lower than the levels of those oil and /or hazardous materials present in the soil being disposed or reused.
- E. Soil testing, if required, for all materials to be reused on-site or removed and disposed of offsite, shall be the responsibility of the contractor. The town reserves the right to obtain its own test results from the same sample as the contractor without penalties to the owner. The contractor is required to obtain a large enough sample to divide with the owner for this proposes.

END OF SECTION

**Leary Field – Portsmouth, New Hampshire
Weston & Sampson Project No. 2140758**

July 20, 2015

City of Portsmouth, New Hampshire
c/o Michael Moonan
Weston & Sampson
427 Main Street, 4th Floor
Worcester, Massachusetts 01608

**RE: Geotechnical Engineering Report
Proposed Light Poles at Leary Field – Portsmouth, New Hampshire**

INTRODUCTION

Weston & Sampson Engineers, Inc. (Weston & Sampson) is pleased to present our geotechnical engineering report for the proposed light poles at Leary Field in Portsmouth, New Hampshire. Twelve new poles are proposed at locations surrounding an existing baseball field, tennis courts, and basketball courts. Borings were completed at each proposed light pole location as shown in the attached **Soil Exploration Plan**. We understand that pole heights will range from 70 ft. to 80 ft. Light pole foundations are assumed to consist of cylindrical precast concrete bases installed in drilled shafts and backfilled with structural concrete.

SITE CONDITIONS

Surface Conditions

Leary Park is bordered to the north by Parrot Avenue and South Mill Pond (tidal), to the east by Junkin Avenue, to the south by Rockland Street, and to the west by residential properties. The park includes two natural turf baseball fields (north and south fields) at the west side of the park, six tennis courts, two basketball courts, and an off-leash dog area in the central area of the park, and a parking lot and playground area on the east side of the park. The parking lot and court areas are surfaced with asphalt concrete (AC) pavement.

Based on a topographic survey of the south baseball field and court areas completed by Doucet Survey, Inc. (dated January 21, 2015), surface elevations in these areas range from approximately El. 8 to El. 10. Survey elevations, and those shown in the attached Soil Exploration Plan reference the North American Vertical Datum of 1988 (NAVD88).

Subsurface Explorations

Subsurface conditions at proposed light pole locations were explored by advancing twelve test borings (B-1 through B-12) to depths up to 36.0 ft. below the existing ground surface (BGS) at the approximate locations shown on the attached **Soil Exploration Plan**. The borings were completed on June 29 through July 2, 2015 by New England Boring Contractors of Derry, NH using track mounted drill rigs and hollow stem auger (B-1 only) and drive-and-wash casing advance drilling methods. A smaller track rig was used for borings B-6 through B-9 due to limited space between the south baseball field and the tennis courts.

Standard penetration tests (SPT) were completed in each boring using a standard 24-in. long by 1 $\frac{3}{8}$ -in. inside diameter (2-in. outside diameter) split spoon sampler driven 24 in. by blows from a 140-lb. automatic hammer falling 30-in. per blow. The smaller rig used for B-6 through B-9 was equipped with a safety hammer. Sampling intervals generally ranged from continuous (every 2 ft.) in the fill and organic soils to every 5 ft. in the underlying native soils. SPT (sampler) refusal, where noted in the attached boring logs, is defined as more than 100 hammer blows for less than six inches of sampler penetration. Auger refusal is defined as no discernable advance of the augers over a period of approximately 5 minutes.

A Weston & Sampson representative observed drilling activities in the field. Subsurface conditions encountered in our explorations are described in the following sections and in the attached **Boring Logs**.

Subsurface Conditions

Subsurface conditions generally consisted of up to 6 inches of topsoil overlying undocumented (non-engineered) SAND FILL, ORGANIC SILT, and PEAT to depths ranging from 4.0 to 10.0 ft. The fill and organics were underlain by native deposits of CLAY and SILT to depths ranging from 17.5 ft. to 34.5 ft., except B-6 and B-10 where the clay and silt strata were not encountered. The clay and silt (and fill at B-6 and B-10) are underlain by native SAND to the depths explored, except in B-1 and B-2, which encountered refusal immediately beneath the clay layer at depths of 19.5 ft. and 20.0 ft., respectively.

The SAND FILL generally ranged in consistency from loose to medium dense and contained variable amounts of gravel (trace to gravelly), variable amounts of silt (little to silty), and occasional debris including plastic, glass, coal ash, and slag. Layers of ORGANIC SILT and PEAT were encountered beneath the fill in B-3, B-4, B-5, B-7, B-8, B-11, and B-12, and were generally soft to very soft. The native CLAY was generally silty and ranged in consistency from stiff to very stiff near the top of the strata to soft to very soft in the middle and bottom of the strata. The clay was underlain by a strata of very soft sandy SILT with trace clay in borings B-3 and B-4. The native SAND underlying the clay and silt strata was generally medium dense to very dense, silty, and contained some angular gravel. Dense GRAVEL with trace silt and sand was encountered below the native sand in B-6.

Groundwater

Groundwater levels observed in the borings ranged from 2.0 to 10.0 ft. BGS based on wet samples encountered during drilling. It should be expected that groundwater levels will fluctuate

with tides in South Mill Pond, season, variations in precipitation, construction in the area, and other factors. Perched groundwater conditions could exist close to the ground surface, especially during and after extended periods of wet weather.

GEOTECHNICAL RECOMMENDATIONS

Based on the subsurface conditions encountered in our explorations and our engineering analyses, construction of the proposed light poles is feasible following the recommendations contained herein. The primary geotechnical consideration for the light pole foundations is the presence of undocumented fill, soft organic soils, and soft to very soft clay and silt to depths ranging from 17.5 ft. to 34.5 ft. BGS. The light pole foundations should be designed in accordance with the provisions of the current edition of the Massachusetts State Building Code and the Technical Specifications provided by the light pole manufacturer.

The proposed light poles can be supported by precast concrete bases installed in drilled shafts and backfilled with concrete. The drilled shafts should extend through the fill, organics, and clay soils and at least 2 feet into the underlying native medium dense (or denser) sand. Drilled shaft excavations will require use of temporary casing and/or drilling fluid to maintain open excavations and support the surrounding ground. All loose and disturbed materials should be removed from the base of the shaft prior to placement of the precast base. Backfill around the precast base should consist of Portland cement concrete with a minimum (28 day) compressive strength of 3,000 pounds per square inch. The concrete should be placed from the bottom of the shaft using a tremie pipe during extraction of the temporary casing.

An allowable bearing pressure of 2,500 psf can be used at the base of the shaft to resist axial loads provided all loose material and slough is removed from the bored hole prior to placement of the precast light pole base and concrete backfill. Skin friction along the shaft sidewall should be ignored when calculating resistance to axial loads.

Resistance to lateral loads can be calculated using the soil parameters in the following table. Resistance in the top two feet of foundation embedment and through the full depth of organic soil layers should be ignored. Groundwater at the ground surface should be assumed.

	SAND FILL	NATIVE CLAY & SILT (Medium Stiff*)	NATIVE CLAY & SILT (Soft**)
Submerged Unit Weight, lb/ft ³	52.6	42.6	42.6
Soil Angle of Internal Friction, ϕ	30	-	-
Unconfined compressive strength, psf	-	1,500	100
Coefficient of Passive Earth Pressure, K_p (Rankine)	3	-	-

* - or stiffer ** - or softer

LIMITATIONS

We have prepared this report for use by the City of Portsmouth and the design and construction teams for the proposed light poles on this site, only. The information herein could be used for bidding

or estimating purposes but should not be construed as a warranty of subsurface conditions. We have made observations only at the aforementioned locations and only to the stated depths. These observations do not reflect soil types, strata thicknesses, water levels or seepage that may exist between observation locations. We should be consulted to observe foundation installation. We should be consulted to review final design and specifications in order to see that our recommendations are suitably followed. If any changes are made to the proposed structures, foundation types, or configurations, our recommendations may not be applicable, and we should be consulted.

The preceding recommendations should be considered preliminary, as actual soil conditions may vary. In order for our recommendations to be final, we should be retained to observe actual subsurface conditions encountered. Our observations will allow us to interpret actual conditions and adapt our recommendations if needed.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty, expressed or implied, is given.

It has been a pleasure assisting you with this project and we look forward to our continued involvement. Please call if you have any questions.

Very truly yours,

WESTON & SAMPSON, INC.



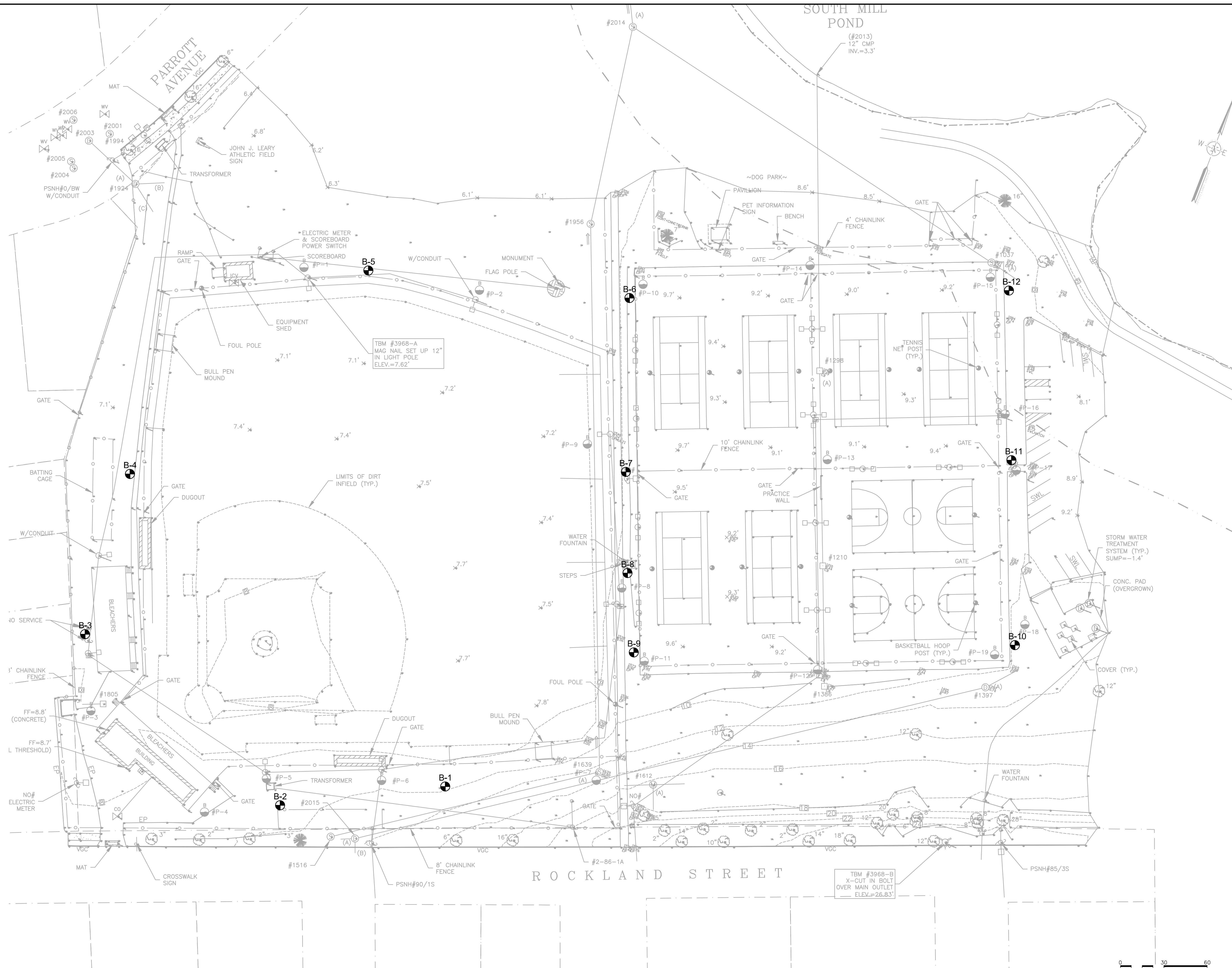
Christopher J. Palmer, PE
Team Leader



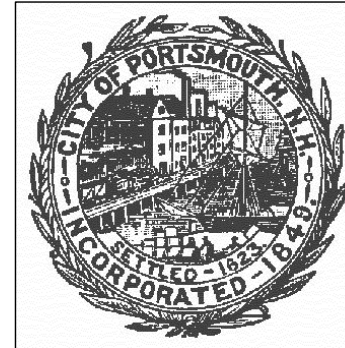
Mark P. Mitsch, PE
Senior Associate

Attachments:

Soil Exploration Plan
Boring Logs (12 pages)



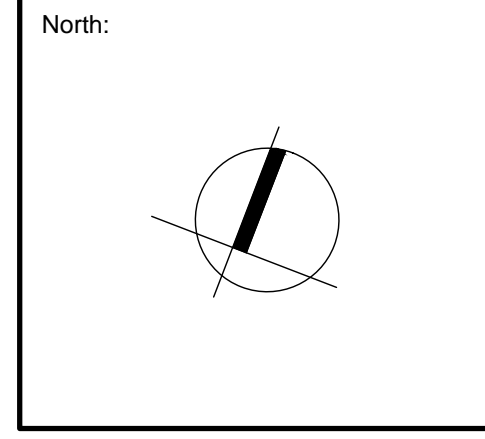
Project:
**SOUTH MILL POND
 TENNIS COURTS**



Rockland Street
 Portsmouth, NH

Weston & Sampson.
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 978-652-1900 (800) Sampson
 www.westonandsampson.com

Consultants:



Revisions:

Rev	Date	Description

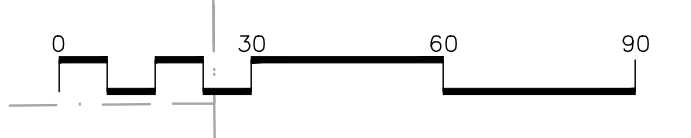
Seal:

**90% SUBMISSION
 NOT FOR CONSTRUCTION**

Date: 07.01.2015
 Scale: 1" = 30'
 Drawn By: CCC
 Reviewed By:
 Checked By:
 Approved By:

Drawing Title:
**SOIL EXPLORATION
 PLAN**

Sheet Number:
L1.00



planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-1
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 10.0 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 6/30/15 DATE END 6/30/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 3.25" ID HOLLOW STEM AUGERS.
GROUNDWATER OBSERVATIONS: Wet samples observed below 8 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	18/24	0-2	6-7-6-4		6" topsoil over medium dense, brown, fine to coarse silty SAND FILL, little gravel; moist. Medium dense, brown, fine to medium silty SAND FILL, little gravel; moist. Stiff, gray, silty CLAY; moist.		6" TOPSOIL
		S2	13/24	2-4	6-5-3-2				SAND FILL
		S3	13/24	4-6	3-4-5-4				
5		S4	22/24	6-8	6-6-7-8		Stiff, gray, silty CLAY; moist.		
		S5	13/24	8-10	7-6-7-4				
10									CLAY
15		S6	10/24	15-17	5-2-5-10		Soft, gray-brown, silty CLAY, some gravel, little fine to medium sand; wet.	1 2	
20							Auger refusal at 19.5 ft.		
25									
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Blow counts did not reflect consistency of sample. Sample was based on observation. 2. Change in auger behavior from smooth to mild grinding at approximately 18.5 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-1

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-2
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 10.0 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 6/30/15 DATE END 6/30/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD


GROUNDWATER OBSERVATIONS:
Wet samples observed below 4 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	15/24	0-2	2-5-5-7		5" topsoil over medium dense, brown, fine to coarse silty SAND FILL, some gravel; moist. Medium dense, brown, fine to coarse silty SAND FILL, little gravel; moist. Top 8": Loose, brown, fine to coarse silty SAND FILL; wet. Bot. 12": Medium stiff, gray, silty CLAY; wet.	1	5" TOPSOIL
		S2	15/24	2-4	7-4-8-5				SAND FILL
		S3	20/24	4-6	2-2-3-3				
5									
		S4	20/24	9-11	2-2-2-4		Medium stiff, gray, silty CLAY; wet.		
10									
		S5	24/24	14-16	WOH/24"		Very soft, gray, silty CLAY; wet.		
15									
		S6	1/12	19-20	8-10-100/0"		Poor recovery - angular gravels. SPT refusal at 20.0 ft.		BEDROCK OR BOULDER
20									
25									
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Change in roller bit behavior from smooth to moderate grinding at approximately 18.5 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-2

	PROJECT Leary Field Portsmouth, NH	REPORT OF BORING No. B-3 SHEET 1 OF 1 Project No. 2140758.F CHKD BY Tom Strike, P.E.
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BORING Co. <u>New England Boring Contractors, Inc.</u>	BORING LOCATION <u>See attached Soil Exploration Plan.</u>
FOREMAN <u>Manlea</u>	GROUND SURFACE ELEV. <u>8.0 ft. +/-</u> DATUM <u>NAV/D88</u>
WSE ENGINEER: <u>Timothy Blair</u>	DATE START <u>6/30/15</u> DATE END <u>6/30/15</u>

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES USING A 140 lb. AUTO HAMMER.	GROUNDWATER OBSERVATIONS:
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS WITH THE DRIVE AND WASH METHOD	Wet samples observed below 4 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	15/24	0-2	2-2-2-2		6" topsoil over loose, brown, fine to medium silty SAND FILL, little gravel; moist. Very soft, brown, fine to medium SANDY ORGANIC SILT, trace gravel, trace clay; moist. Medium stiff, gray, silty CLAY; wet.		6" TOPSOIL
		S2	14/24	2-4	1-1-1-1				SAND FILL
		S3	20/24	4-6	1-1-3-5				ORGANIC SILT
5									
10		S4	2/24	9-11	2-2-2-2		Medium stiff, gray, silty CLAY; wet.		
15		S6	24/24	14-16	WOH/24"		Very soft, gray, silty CLAY; wet.		CLAY
20		S7	8/24	19-21	WOR/24"		Very soft, gray, silty CLAY; wet.		
25		S8	18/24	24-26	WOR/24"		Very soft, gray, silty CLAY; wet.		
30		S9	24/24	29-30	WOH/24"		Very soft, gray, fine sandy SILT, trace clay; wet.		SILT
35		S10	18/24	34-36	5-12-16-22		Medium dense, gray, fine SAND, some silt; wet.		SAND
						Boring terminated at 36.0 ft.			

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:

- THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
- WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No.	B-3
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planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-4
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. **BORING LOCATION** See attached Soil Exploration Plan.
FOREMAN Manlea **GROUND SURFACE ELEV.** 7.5 ft. +/- **DATUM** NAVD88
WSE ENGINEER: Timothy Blair **DATE START** 6/30/15 **DATE END** 6/30/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 6 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	14/24	0-2	2-2-4-5		2" topsoil over loose, brown, fine to medium silty SAND FILL, trace gravel; moist.		2" TOPSOIL
		S2	12/24	2-4	3-4-5-4		Loose, silty SAND FILL with trace debris (glass, coal ash, and slag); moist.		SAND FILL
		S3	13/24	4-6	2-2-1-1		Very loose, dark brown, PEAT; moist.		PEAT
5		S4	12/24	6-8	WOH/18"-3		Top 6": Very loose, dark brown, PEAT; moist. Bot. 6": Medium stiff, gray, silty CLAY; wet.		CLAY
		S5	22/24	9-11	1-3-3-2		Medium stiff, gray, silty CLAY; wet.		
10									CLAY
		S6	24/24	14-16	WOR/24"		Very soft, gray, silty CLAY; wet.		
15									CLAY
		S7	18/24	19-21	1/12"-1/12"		Very soft, gray, silty CLAY; wet.		
20									CLAY
		S8	22/24	24-26	WOR/24"		Very soft, gray, fine SANDY SILT, trace clay; wet.		
25									SILT
		S9	8/24	29-31	3-7-8-7		Medium dense, gray, fine to medium silty SAND, some gravel; wet.		
30							Boring terminated at 31.0 ft.	1	SAND

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Change in roller bit behavior from smooth to moderate grinding at approximately 28.5 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:

- THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
- WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-4

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-5
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. **BORING LOCATION** See attached Soil Exploration Plan.
FOREMAN Manlea **GROUND SURFACE ELEV.** 6.0 ft. +/- **DATUM** NAVD88
WSE ENGINEER: Timothy Blair **DATE START** 7/1/15 **DATE END** 7/1/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 4 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	8/24	0-2	2-2-3-3		3" topsoil over loose, brown, fine to medium silty SAND FILL; moist. Very soft, dark brown, ORGANIC SILT FILL, trace debris (glass, coal ash, and slag); moist. Stiff, gray, silty CLAY; wet.	1	3" TOPSOIL
		S2	12/24	2-4	1-1-1-1				SAND FILL
		S3	20/24	4-6	3-4-7-9				ORGANIC SILT
5									
10		S4	22/24	9-11	2-2-3-2		Medium stiff, gray, silty CLAY; wet.	1	CLAY
15		S5	24/24	14-16	WOR/24"		Very soft, gray, silty CLAY; wet.	1	CLAY
20		S6	18/24	19-21	WOR/12"-1-7		Very soft, gray, silty CLAY; wet.	1	CLAY
25		S7	10/24	21-23	5-9-9-10		Medium dense, gray, fine to medium silty SAND, some gravel; wet.	1	SAND
30							Boring terminated at 23.0 ft.	1	

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Fine to medium sand and gravels observed in tip of spoon. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-5

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-6
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 9.5 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 7/1/15 DATE END 7/1/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. SAFETY HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 10 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION	
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"					
0		S1	12/24	0-2	5-7-8-6		Medium dense, brown, fine to coarse SAND FILL, some gravel, some silt; moist.	1	SAND FILL	
		S2	20/24	2-4	10-13-14-16					Medium dense, brown, fine to medium SAND FILL, some silt, little gravel; moist.
		S3	18/24	4-6	27-24-24-24					
5		S4	20/24	6-8	28-25-22-19		Dense, brown, fine to medium silty SAND, little gravel; moist.		SAND	
10		S5	12/24	10-12	29-37-38-33		Very dense, brown, gravelly fine to coarse SAND, some silt; wet.		GRAVEL	
15		S6	4/24	15-17	23-27-13-26		Dense, gray, fine to coarse GRAVEL, trace fine to medium sand, trace silt; wet. Boring terminated at 17.0 ft.			
20										
25										
30										

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Roller bit grinding and gravelly casing wash observed between approximately 13.0 and 15.0 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-6

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-7
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 9.5 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 7/1/15 DATE END 7/1/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. MANUAL OPERATED SAFETY HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 2 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	10/24	0-2	5-8-14-13		Medium dense, brown, fine to coarse SAND FILL, some silt; moist.		SAND FILL
		S2	4/24	2-4	12-6-2-2		Loose, brown, fine to coarse GRAVELLY SAND FILL, some silt; wet.		
		S3	8/24	4-6	3-3-3-4		Top 4": Medium stiff, dark brown, PEAT; wet. Bot. 7": Medium stiff, gray, silty CLAY; wet.		
5									
10		S4	18/24	10-12	8-8-10-10		Very stiff, gray, silty CLAY; wet.		CLAY
15		S5	10/24	15-17	WOH-2-2-6		Soft, gray, silty CLAY, trace fine sand; wet.		
20		S6	14/24	20-22	5-16-30-43		Dense, gray, fine to medium silty SAND, some angular gravel; wet. Boring terminated at 22.0 ft.	1	
25									
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Change in roller bit behavior from smooth to moderate grinding at approximately 19 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-7

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-8
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 9.5 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 7/2/15 DATE END 7/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. SAFETY HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 2 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	15/24	0-2	5-5-9-11		2" topsoil over medium dense, brown, fine to coarse SAND FILL, some silt, little gravel; moist.	1	2" TOPSOIL
		S2	2/24	2-4	5-3-4-3		Loose, brown, fine to coarse gravelly SAND FILL, some silt; wet.		SAND FILL
		S3	10/24	4-6	6-6-6-6		Top 3": Medium dense, brown, fine to coarse gravelly SAND FILL, some organic silt; wet. Bot. 7": Stiff, gray, silty CLAY, trace peat; wet.		CLAY
5									
10		S4	24/24	10-12	7-8-8-5		Stiff, gray, silty CLAY; wet.		
15									
		S5	24/24	15-17	1-2-1-3		Soft, gray, silty CLAY, trace fine sand; wet.		
20									
		S6	13/24	20-22	20-24-38-37		Very dense, brown, fine to coarse silty SAND, some angular gravel; wet. Boring terminated at 22.0 ft.		SAND
25									
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Change in roller bit behavior from smooth to moderate grinding at approximately 18.0 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG.
FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-8

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-9
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 9.5 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 7/2/15 DATE END 7/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. SAFETY HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 2 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	10/24	0-2	7-7-7-5		1" topsoil over medium dense, brown, fine to coarse SAND FILL, some gravel, little silt; moist.	1	1" TOPSOIL
		S2	14/24	2-4	4-7-6-4		Medium dense, brown, fine to coarse silty SAND FILL, some gravel, trace brick debris; wet.		SAND FILL
		S3	1/24	4-6	3-4-6-10		Medium dense, brown, fine to coarse silty SAND FILL, some gravel; wet		
5		S4	24/24	6-8	11-10-12-12		Very stiff, gray, silty CLAY; wet.		
10		S5	24/24	10-12	3-2-1-1		Soft, gray, silty CLAY; wet.		CLAY
15		S6	15/24	15-17	1-1-1-1		Very soft, gray, silty CLAY, trace fine sand; wet.		
20		S7	11/24	20-22	18-80-85-20		Very dense, gray, fine to medium silty SAND, some angular gravel; wet. Boring terminated at 22.0 ft.		SAND
25									
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Change in roller bit behavior from smooth to moderate grinding at approximately 17.5 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-9

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-10
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 10.5 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 6/29/15 DATE END 6/29/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 6 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	15/24	0-2	4-4-10-13		2" topsoil over medium dense, gray, fine to coarse SAND FILL, little silt, little gravel; moist.		2" TOPSOIL
		S2	14/24	2-4	24-16-10-8		Medium dense, brown, fine to medium SAND FILL, some gravel, little silt; moist.		SAND FILL
		S3	12/24	4-6	9-10-6-5		Medium dense, brown, fine to coarse silty SAND FILL, little gravel, trace debris (plastics); moist.		
5		S4	8/24	6-8	5-3-3-2		Loose, brown, fine to coarse silty SAND FILL, some gravel; wet.		SAND FILL
		S5	14/24	8-10	2-3-4-7		Loose, brown, fine to medium silty SAND FILL, some gravel, trace debris (plastics); wet.		
		S6	17/24	10-12	6-6-7-8		Medium dense, brown, fine to medium silty SAND, little gravel; wet.		
10									SAND
		S7	15/24	14-16	10-12-12-9		Medium dense, gray, fine to medium silty SAND, little gravel; wet.		
		S8	13/24	19-21	10-13-18-14		Dense, gray, fine to medium silty SAND, some gravel; wet.		
15									SAND
		S9	17/24	24-26	14-20-24-33		Dense, gray, fine to medium silty SAND, some gravel; wet.		
							Boring terminated at 26.0 ft.		
20									SAND
25									SAND
30									SAND

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-10

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-11
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. **BORING LOCATION** See attached Soil Exploration Plan.
FOREMAN Manlea **GROUND SURFACE ELEV.** 10.0 ft. +/- **DATUM** NAVD88
WSE ENGINEER: Timothy Blair **DATE START** 6/29/15 **DATE END** 6/29/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 4 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	14/24	0-2	3-12-9-9		2" topsoil over medium dense, brown, fine to coarse SAND FILL, some gravel, little silt; moist.		2" TOPSOIL
		S2	14/24	2-4	7-7-8-7				SAND FILL
		S3	12/24	4-6	5-4-3-3				DEBRIS FILL
5		S4	22/24	6-8	3-2-2-3		Loose, black, silty DEBRIS FILL (coal and slag), little peat, little fine to medium sand; wet. Top 6": Soft, dark brown, PEAT; wet. Bottom 16": Medium stiff, gray, silty CLAY; wet. Stiff, gray, silty CLAY; wet.		PEAT
		S5	18/24	8-10	3-4-6-6				CLAY
10									CLAY
15		S6	24/24	14-16	WOH/18" - 2		Very soft, gray/brown, silty CLAY, trace fine sand; wet.		SAND
20		S7	5/24	19-21	13-14-12-14		Medium dense, gray, fine to medium silty SAND, some gravel; wet.	1 2	SAND
25		S8	6/24	24-26	14-14-24-23		Dense, gray, fine to medium silty SAND, some gravel; wet. Boring terminated at 26.0 ft.		
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Large gravel in tip of spoon may have affected sample recovery. 2. Possible cobble at approximately 21.5 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-11

planning, permitting,
design, construction,
operation, maintenance



PROJECT
Leary Field
Portsmouth, NH

REPORT OF BORING No. B-12
SHEET 1 OF 1
Project No. 2140758.F
CHKD BY Tom Strike, P.E.

BORING Co. New England Boring Contractors, Inc. BORING LOCATION See attached Soil Exploration Plan.
FOREMAN Manlea GROUND SURFACE ELEV. 10.0 ft. +/- DATUM NAVD88
WSE ENGINEER: Timothy Blair DATE START 6/29/15 DATE END 6/29/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. AUTO HAMMER.
METHOD: TRACK-MOUNTED ATV DRILL RIG USING 4" ID CASING FLIGHTS
WITH THE DRIVE AND WASH METHOD

GROUNDWATER OBSERVATIONS:
Wet samples observed below 6 feet.

DEPTH (ft)	CASING (BLOWS/12")	SAMPLE				PID (ppm)	SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S1	10/24	0-2	4-5-9-10		Medium dense, brown, fine to coarse SAND FILL, some gravel, little silt; moist.	1	SAND FILL
		S2	11/24	2-4	7-5-6-5				
		S3	15/24	4-6	4-3-1-1				
5		S4	15/24	6-8	1-2-2-4		Top 4": Soft, dark brown, PEAT; wet. Bot. 11": Medium stiff, gray, silty CLAY; wet.	2	PEAT
		S5	17/24	8-10	5-5-6-8				
10							No sample recovery.	1	CLAY
		S6	0/24	14-16	3-4-3-2				
15							Very soft, gray, silty CLAY; wet.	2	SAND
		S7	24/24	19-21	WOH/24"				
20							Medium, gray, fine to medium silty SAND, some gravel; wet.	2	SAND
		S8	8/24	24-26	5-5-17-20				
25							Boring terminated at 26.0 ft.		
30									

GRANULAR SOILS		COHESIVE SOILS		NOTES:
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	1. Silty clay observed in casing wash at approximately 15.0 ft. 2. Change in roller bit behavior at approximately 22.0 ft. WOR = Weight of rods WOH = Weight of hammer
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

NOTES:
1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B-12

**Portsmouth High School Light Poles
Weston & Sampson Project No. 2140758.K**

December 22, 2015

City of Portsmouth, New Hampshire
c/o Michael Moonan
Weston & Sampson
427 Main Street, 4th Floor
Worcester, Massachusetts 01608

**RE: Geotechnical Engineering Report
Proposed Light Poles at Portsmouth High School – Portsmouth, New Hampshire**

INTRODUCTION

Weston & Sampson Engineers, Inc. (Weston & Sampson) is pleased to present our geotechnical engineering report for the proposed light poles at Portsmouth High School in Portsmouth, New Hampshire. Up to Twenty-eight new light poles are proposed at locations surrounding the existing Portsmouth High School athletic fields. Light poles and foundations currently exist at many of the proposed light pole locations. It is our understanding that new foundations will be required at twenty-three of the locations and existing foundations will be re-used at five locations. Borings were completed at nineteen of the proposed new foundation locations (including two alternative locations in the practice field area) as shown on the attached **Soil Exploration Plans**. We understand that pole heights will range between 40 ft. and 90 ft. Light pole foundations typically consist of cylindrical precast concrete bases installed in drilled shafts and backfilled with structural concrete.

SITE CONDITIONS

Surface Conditions

The Portsmouth High School Athletic Fields consist of a shared baseball and soccer field, a football field, tennis courts, and a practice field. All fields are located to the south of the school, except for the practice field, which is located to the east of the school. Wetlands border the football and shared baseball and soccer fields to the south, the baseball field to the west, south, and east, the tennis courts on all sides, and the practice field to the south, east, and north.

Based on topographic information provided on Project Plans prepared by Weston & Sampson, surface elevations in the shared baseball and soccer fields slope upward from the south towards the north between approximately El. 11 ft. and 22 ft., are relatively level surface in the baseball field between approximately El. 12 ft. and 14 ft., and are relatively level in the tennis

courts and the practice field at between approximately El. 26 ft. and 28 ft. The elevation datum was not provided on the plans.

Subsurface Explorations

Subsurface conditions at proposed light pole foundation locations were explored by advancing twenty-one borings (B1 through B20 and B14A) to depths up to 46 ft. below the existing ground surface (BGS) at the approximate locations shown on the attached **Soil Exploration Plans**. The borings were completed between November 2 and 4, 2015 and on December 11, 2015 by New England Boring Contractors of Derry, NH using an ATV-mounted drill rig and hollow stem auger and drive-and-wash casing drilling methods.

Standard penetration tests (SPT) were completed in each boring using a standard 24-in. long by 1 $\frac{3}{8}$ -in. inside diameter (2-in. outside diameter) split spoon sampler driven 24 in. by blows from a 140-lb. winch operated safety hammer falling 30-in. per blow. Sampling intervals generally ranged from continuous (every 2 ft.) in the fill and organic soils to every 5 ft. in the underlying native soils. SPT (sampler) refusal, where noted in the attached boring logs, is defined as more than 100 hammer blows for less than six inches of sampler penetration. Auger refusal is defined as no discernable advance of the augers over a period of approximately 5 minutes.

A Weston & Sampson representative observed drilling activities in the field. Subsurface conditions encountered in our explorations are described in the following sections and in the attached **Boring Logs**.

Subsurface Conditions

Subsurface conditions in the approximately upper 7.5 feet was generally consistent in the borings and consisted of up to 7-inches of topsoil overlying undocumented (non-engineered) FILL to depths ranging between 2 and 7.5 ft. BGS. A layer of BURIED TOPSOIL (organics) was encountered below the fill to depths ranging between 4 and 6.5 ft. BGS in borings B4, B6, B9, and B13. Native, inorganic soil deposits below the fill and organics varied by location as discussed below.

Baseball Field – Borings B1 through B4 were performed at light pole foundation locations around the baseball field. Dense, SILTY SAND with little gravel and little clay and medium stiff to very stiff CLAYEY SILT were encountered below the fill and organics to depths ranging between approximately 7.5 and 12.5 ft. BGS. These deposits were underlain by very soft to medium stiff, moderately plastic CLAY to depths ranging between approximately 20 and 44 ft. BGS. Dense GLACIAL TILL, containing fine to coarse sand with varying amounts of gravel and silt, was encountered below the CLAY in borings B1, B2, and B4. Refusal was encountered directly below the CLAY at an approximate depth of 32 ft. BGS in boring B3.

Shared Baseball and Soccer Fields – Borings B7 through B12 and B18, B19, and B20 were performed at light pole foundation locations around the shared baseball and soccer fields. Borings B9, B11, B19, and B20 encountered similar subsurface conditions below the fill and organics as those encountered in borings around the baseball field. Borings B9, B11, and B19 encountered layers of very stiff, medium dense SAND with little gravel and trace silt, and stiff to very stiff SANDY SILTY to approximately 7.5 ft. BGS. Very soft to stiff, moderately plastic CLAY

was encountered below these layers to depths ranging between 15 and 38 ft. BGS. Dense to very dense glacial till was encountered directly below the clay. Boring B20 was advanced to 34 ft. BGS without sampling to attempt to estimate the top of the glacial till. Gray, gravelly CLAY was encountered at 33 ft. BGS based on a change in auger resistance during drilling and was terminated at 35.5 ft. BGS due to significant heave in the augers.

Borings B7, B8, B10, B12, and B18 encountered layers of dense SAND, very stiff to stiff SANDY SILT, very stiff to hard CLAYEY SILT, and medium dense to very dense GLACIAL TILL below the fill and organics. Boring B18 was advanced through overburden soils without sampling to estimate the top of glacial till. Borings B7, B8, B10, and B12 encountered either sampler or auger refusal at depths ranging between approximately 9.5 and 21.8 ft. BGS. Boring B18 was terminated in the glacial till at 16 ft. BGS.

Tennis Courts and Practice Field – Borings B5 and B6 were performed at light pole foundation locations around the tennis courts and borings B13, B14, B14A, B15, B16, and B17 were performed at light pole foundation locations around the practice field (including alternative light pole foundation areas). Layers of hard SANDY SILT and dense to very dense GLACIAL TILL were encountered below the fill and organics in these borings. Roller bit and sampler refusals were encountered at depths of approximately 13 and 19.1 ft. BGS in borings B5 and B6, respectively. Roller bit and auger refusals were encountered in borings B14, B14A, B15, B16, and B17 at depths ranging between approximately 4.3 and 12.3 ft. BGS. Boring B14A was performed approximately 4 ft. from B14.

It could not be confirmed if the refusals encountered in the borings were on boulders, obstructions, or bedrock. Rock core sampling was not performed at refusal depths to assess the nature of the refusals.

Groundwater

Groundwater was observed in all borings, except in B14, B14A, and B15 at depths ranging between approximately 2 and 6 ft. BGS based on wet samples encountered during drilling. It should be expected that groundwater levels will fluctuate with season, variations in precipitation, construction in the area, and other factors. Perched groundwater conditions could exist close to the ground surface, especially during and after extended periods of wet weather.

GEOTECHNICAL RECOMMENDATIONS

Based on the subsurface conditions encountered in our explorations and our engineering analyses, construction of the proposed light poles is feasible following the recommendations contained herein. The primary geotechnical considerations for the light pole foundations is the presence of very soft clay to depths ranging between approximately 15 ft. and 44 ft. BGS and the possibility of bedrock above precast concrete base support depths. As previously discussed, light pole foundations typically consist of cylindrical precast concrete bases installed in drilled shafts and backfilled with structural concrete. At locations where bedrock exists above precast concrete base support depths, construction of shallow spread footings for support of the light poles will be required. The light pole foundations should be designed in accordance with the provisions of the current

edition of the Massachusetts State Building Code and the Technical Specifications provided by the light pole manufacturer.

Precast Concrete Base Support

The proposed light poles can be supported by precast concrete bases installed in drilled shafts and backfilled with concrete provided bedrock does not exist above proposed support depths. The drilled shafts should extend through the fill, buried topsoil (organics), and clay soils and at least 2 feet into the underlying native medium dense (or denser) glacial till or on bedrock. Drilled shaft excavations will require use of temporary casing and/or drilling fluid to maintain open excavations and support the surrounding ground. All loose and disturbed materials should be removed from the base of the shaft prior to placement of the precast base. Backfill around the precast base should consist of Portland cement concrete with a minimum (28 day) compressive strength of 3,000 pounds per square inch. The concrete should be placed from the bottom of the shaft using a tremie pipe during extraction of the temporary casing.

An allowable bearing pressure of 4,000 psf can be used at the base of the shaft to resist axial loads provided all loose material and slough is removed from the bored hole prior to placement of the precast light pole base and concrete backfill. Skin friction along the shaft sidewall should be ignored when calculating resistance to axial loads.

Resistance to lateral loads can be calculated using the soil parameters in the following tables. Resistance in the top two feet of foundation embedment should be ignored. Groundwater at the ground surface should be assumed.

	SAND FILL	CLAYEY SILT FILL	SILTY SAND
Submerged Unit Weight, lb/ft ³	52.6	52.6	52.6
Soil Angle of Internal Friction, ϕ	30	-	28
Unconfined compressive strength, psf	-	1,500	-
Coefficient of Passive Earth Pressure, K_p (Rankine)	3	-	2.8

	SAND	CLAYEY SILT (Including Buried Topsoil)	CLAY	GLACIAL TILL
Submerged Unit Weight, lb/ft ³	57.6	52.6	42.6	72.6
Soil Angle of Internal Friction, ϕ	30	-	-	35
Unconfined compressive strength, psf	-	1500	100	-
Coefficient of Passive Earth Pressure, K_p (Rankine)	3	-	-	3.7

Shallow Spread Footing Support

Construction of shallow spread footings for support of the light poles could be required at locations where bedrock is above precast concrete base support depths. All fill and organic soils should be

removed from the entire zone-of-stress influence beneath footings to expose the native, inorganic soils or bedrock. The zone-of-influence is defined by planes extending horizontally away from the outside edges of the footings for 2 ft. and then down and away at a 1H:1V slope. Footing bases should be compacted with a 700-pound vibratory plate compactor, or equivalent effort, until firm and stable. Standing water should be removed from excavations prior to placing concrete or fill. In no case shall fill or concrete be installed on frozen soils or in standing water. Compacted 1-1/2-inch crushed stone fill should be used to elevate subgrades up to bottom of footing elevations as necessary.

Backfill around spread footings should consist of Gravel conforming to the requirements of Item 304.2 of the New Hampshire Department of Transportation (NHDOT) Standard Specifications for Road and Bridge Construction. This material should be placed in 10-inch maximum loose lifts, with each lift compacted to a minimum of 95 percent of the materials maximum dry density as determined by ASTM Specification D1557. Material excavated from the footing excavation could be re-used as Gravel provided the material is dry, inorganic, and free of deleterious materials, contains less than 20 percent by weight passing the No. 200 Sieve, and is approved by the geotechnical engineer. Excavated clayey silt, silty clay, and buried topsoil materials are not considered suitable for re-use.

Footings bearing on the materials discussed above should be designed using an allowable bearing pressure of 4,000 psf. The allowable bearing pressure can be increased to 6,000 psf to resist temporary wind and seismic loads provided the resultant load eccentricities remain within the middle third of the footing. Resistance to lateral loads can be obtained by passive pressure against the sides of the footings equivalent to the pressure due to a fluid with a unit weight of 350 pounds per cubic foot (pcf), assuming the top of the fluid is 12 inches below finished grade. Lateral resistance can also be provided by friction along the bottoms of the footings assuming a footing base friction coefficient of 0.45. Footings should be embedded at least 4 ft. below the nearest proposed adjacent ground surface exposed to freezing.

LIMITATIONS

We have prepared this report for use by the City of Portsmouth and the design and construction teams for the proposed light poles on this site, only. The information herein could be used for bidding or estimating purposes but should not be construed as a warranty of subsurface conditions. We have made observations only at the aforementioned locations and only to the stated depths. These observations do not reflect soil types, strata thicknesses, water levels or seepage that may exist between observation locations. We should be consulted to observe foundation installation. We should be consulted to review final design and specifications in order to see that our recommendations are suitably followed. If any changes are made to the proposed structures, foundation types, or configurations, our recommendations may not be applicable, and we should be consulted.

The preceding recommendations should be considered preliminary, as actual soil conditions may vary. In order for our recommendations to be final, we should be retained to observe actual subsurface conditions encountered. Our observations will allow us to interpret actual conditions and adapt our recommendations if needed.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with the generally accepted practices in this area at the time this report was prepared. No warranty, expressed or implied, is given.

It has been a pleasure assisting you with this project and we look forward to our continued involvement. Please call if you have any questions.

Very truly yours,

WESTON & SAMPSON, INC.



Thomas J. Strike, PE
Project Engineer



Mark P. Mitsch, PE
Senior Associate

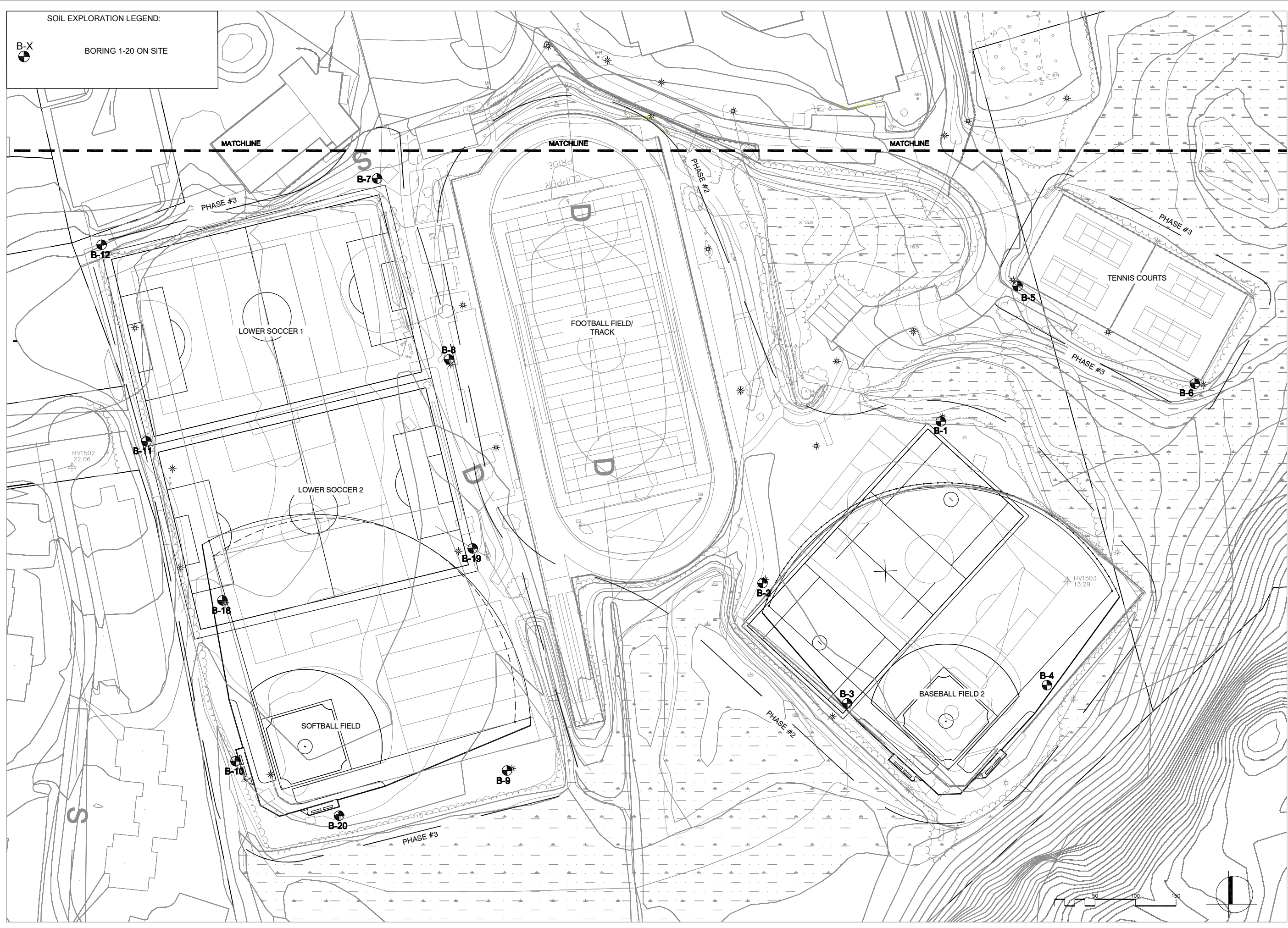
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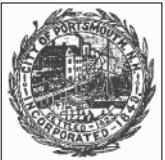
- Soil Exploration Plans (2 pages)
- Boring Logs (24 pages)

SOIL EXPLORATION LEGEND:




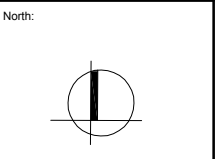
BORING 1-20 ON SITE



Project:
PORTSMOUTH HIGH SCHOOL

 50 ANDREW JACKSON DR.
 PORTSMOUTH, NH.


Weston & Sampson
 427 Main Street, Suite 400, Worcester, MA
 978-532-1900 (800) Sampson
 www.westonandsampson.com

Consultants:




Revisions:

Rev	Date	Description

Seal:


PLANS FOR CONSTRUCTION

Date: 10.22.2015
 Scale: AS SHOWN
 Drawn By: EJA
 Reviewed By: MSM
 Checked By: MSM
 Approved By:

Drawing Title:
SOIL EXPLORATION PLAN 1 OF 2

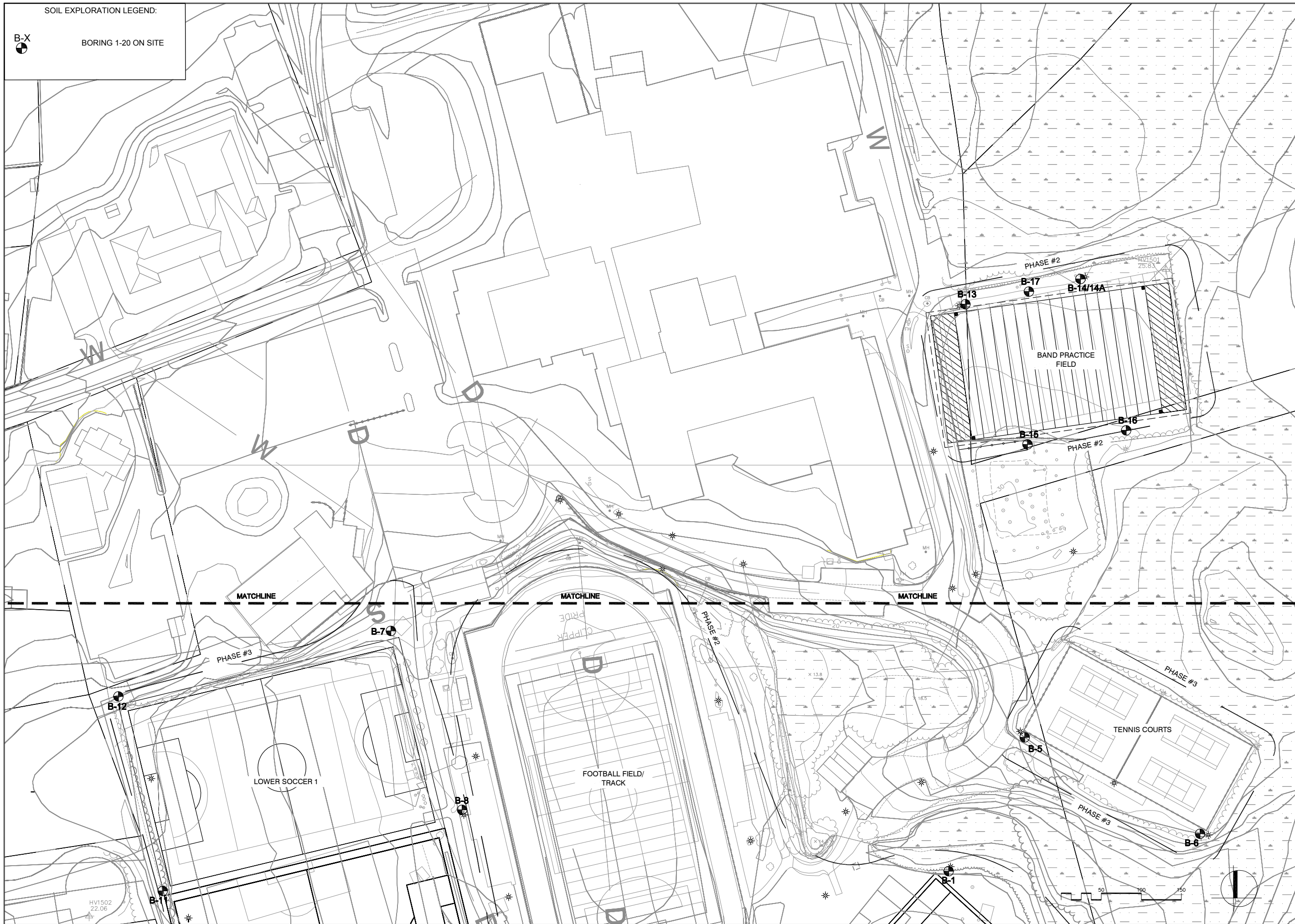
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SOIL EXPLORATION LEGEND:

B-X

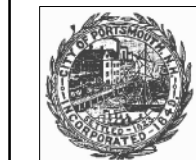


BORING 1-20 ON SITE



Project:

PORTSMOUTH HIGH SCHOOL



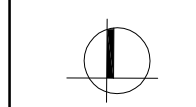
50 ANDREW JACKSON DR.
PORTSMOUTH, NH.

Weston & Sampson.

427 Main Street, Suite 400, Worcester, MA
978-532-1900 (800) Sampson
www.westonandsampson.com

Consultants:

North:



Revisions:

Rev	Date	Description

Seal:

PLANS FOR CONSTRUCTION

Date: 10.22.2015

Scale: AS SHOWN

Drawn By: EJA

Reviewed By: MSM

Checked By: MSM

Approved By:

Drawing Title:

SOIL EXPLORATION
PLAN 2 OF 2

Sheet Number:

L0.01

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B1
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 14 ft. +/- **DATUM** NA
DATE START 11/3/15 **DATE END** 11/3/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/3/15	NA	2 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	14/24	0-2	6-15-6-10	Very stiff, gray, CLAYEY SILT FILL, some fine sand, trace gravel; moist.	1	6" TOPSOIL
		S-2	12/24	2-4	9-11-12-15			CLAYEY SILT FILL
		S-3	12/24	4-6	9-12-20-23			Dense, gray-brown, fine to medium SILTY SAND, little gravel, little clay; wet.
10		S-4	15/24	10-12	5-5-2-3	Loose, gray, fine to medium SAND, trace silt; wet. Bottom 3": gray, CLAY, trace fine sand; wet.	2	CLAY
15		S-5	24/24	15-17	WOH/12"-2-1	Very soft, gray, CLAY, trace fine sand; wet.	3	GLACIAL TILL
20		S-6	24/24	20-22	4-6-15-16	Top 21": same as above with some fine sand. Medium dense, gray, fine to coarse sandy GRAVEL, little silt; wet.	4	
25					Boring terminated at 22 ft.			
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. WOH = weight of the hammer.
3. Auger grinding below 18 ft.
4. 5 ft. heave in auger at 20 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B1

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B2
SHEET 1 OF 2
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 13 ft. +/- **DATUM** NA
DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE
CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	3 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	15/24	0-2	5-6-9-11	Medium dense, brown, SILTY SAND FILL, little gravel, trace organics (roots); moist.		5" TOPSOIL
		S-2	0/24	2-4	19-19-21-26			
5		S-3	0/24	4-6	13-9-14-10	No recovery.	1	SAND FILL
		S-4	11/24	6-8	10-12-14-19	Very stiff, gray-brown mottled, CLAYEY SILT; wet.	2	
10		S-5	24/24	9-11	4-4-6-5	Stiff, gray-brown mottled, CLAYEY SILT; wet.	3	CLAYEY SILT
15		S-6	24/24	14-16	WOH/24"	Very soft, gray, CLAY, trace fine sand; wet.	4	CLAY
20		S-7	0/24	19-21	WOR/24"	No recovery.	5	CLAY
25		S-8	24/24	24-26	WOR/24"	Very soft, gray, CLAY, trace fine sand; wet.		CLAY
30		S-9	24/24	29-31	WOH/24"	Same as above.		CLAY

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level reading taken in hole after casing was removed.
2. Roller bit grinding between 3 and 5 ft.
3. Open hole drilling below 9 ft.
4. WOH = weight of the hammer.
5. WOR = weight of the rod.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG.
FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME
MEASUREMENTS ARE MADE.

BORING No. B2

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B2
SHEET 2 OF 2
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 13 ft. +/- **DATUM** NA
DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE
CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:** _____

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	3 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
35		S-10	24/24	34-36	WOH/12"-4-4	Soft, gray, CLAY, little fine sand, little silt; wet.	6	CLAY
40		S-11	10/24	39-41	WOR/18"-2	Very soft, gray, CLAY, trace fine sand; wet.		
45		S-12	8/24	44-46	16-14-19-36	Dense, gray, fine to coarse SAND, some silt, little gravel; wet.		GLACIAL TILL
50						Boring terminated at 46 ft.		
55								
60								
65								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
6. Rollerbit grinding at about 44 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B2

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B3
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 12 ft. +/- **DATUM** NA
DATE START 11/3/15 **DATE END** 11/3/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE
CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	3 ft. +/-	NA	24 hrs.

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	16/24	0-2	3-8-10-9	Medium dense, brown, fine to medium SAND FILL, some gravel, trace silt; moist.		6" TOPSOIL
		S-2	18/24	2-4	8-42-30-31	Very dense, brown, CLAYEY SILT FILL, little fine sand, trace gravel, roots; moist.		
5		S-3	0/24	4-6	80-45-23-21	No recovery.	1 2	SAND and CLAYEY SILT FILL
		S-4	4/24	6-8	34-31-14-8	Very dense, brown, sandy GRAVEL FILL, trace silt; wet.		
10		S-5	8/24	9-11	7-4-2-2	Medium stiff, gray-brown mottled, CLAYEY SILT; wet.	3	CLAYEY SILT
15		S-6	24/24	14-16	WOH/24"	Very soft, gray, CLAY, trace fine sand; wet.	4	
20		S-7	8/24	19-21	WOR/24"	Same as above.	5	
25		S-8	24/24	24-26	WOR/24"	Same as above.		
30		S-9	12/23	29-30.9	WOR/21"-100/2"	Same as above.	6	
					Roller bit refusal at 32 ft.			

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level reading taken in hole on 11/4/15.
2. Roller bit grinding between 3 and 5 ft.
3. Open hole drilling below 9 ft.
4. WOH = weight of the hammer.
5. WOR = weight of the rod.
6. Rollerbit refusal at 32 ft. (5 minutes grinding, 0" advance).

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B3

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B4
SHEET 1 OF 2
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 14 ft. +/- **DATUM** NA
DATE START 11/3/15 **DATE END** 11/3/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. OTHER: See note 4

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	2.5 ft. +/-	NA	24 hrs.

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION	
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S-1	7/24	0-2	6-14-20-9	Hard, dark brown, SILTY SAND FILL, little sand, little gravel, trace organics (roots); moist.	1	3" TOPSOIL	
		S-2	7/24	2-4	6-7-17-23			SAND FILL	
		S-3	11/24	4-6	13-9-16-14			BURIED TOPSOIL	
5						Very stiff, dark brown, CLAYEY SILT, little sand, little gravel, trace organics (roots); wet.	2	CLAYEY SILT	
10		S-4	1/24	10-12	WOH/24"	Very soft, gray, CLAY, trace fine sand; wet.	3	CLAY	
15		S-5	23/24	15-17	WOH/18"-1	Same as above.	4	CLAY	
20		S-6	24/24	20-22	WOH/18"-1	Same as above.	4	CLAY	
25		S-7	24/24	25-27	1-1-1-1	Same as above.	4	CLAY	
30		S-8	24/24	29-31	WOH/18"-8	Same as above. Bottom 12": with pockets of some fine sand, little gravel.	4	CLAY	
		S-9	24/24	31-33	10-3-5-6				Medium stiff, gray, SANDY CLAY, little silt; wet.

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level reading taken in hole on 11/4/15.
2. Auger grinding between 3-5 ft.
3. WOH = weight of the rod and hammer.
4. Switched to Drive and Wash method: Driven 4" casing using 300 lb. hammer falling 30 in. Moved location ~3 ft. north. Open hole drilling below 9 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B4

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B4
SHEET 2 OF 2
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors

BORING LOCATION See attached plan

FOREMAN Ben Cross

GROUND SURFACE ELEV. 14 ft. +/- **DATUM** NA

WSE ENGINEER: Julie A. Eaton, EIT

DATE START 11/3/15 **DATE END** 11/3/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.

CASING: HOLLOW STEM AUGER

CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. OTHER: See note 4

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	2.5 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
35		S-10	24/24	34-36	9-2-4-4	Top 12": gray, GRAVEL, some clay, little fine sand; wet. Medium stiff, gray, CLAY, little fine sand, trace gravel; wet.		CLAY
40		S-11	16/24	39-41	8-13-22-24	Dense, gray, sandy GRAVEL, some silt; wet.		GLACIAL TILL
45						Boring terminated at 41 ft.		
50								
55								
60								
65								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B4

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B5
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT
BORING LOCATION See attached plan
GROUND SURFACE ELEV. 26 ft. +/- **DATUM** NA
DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE
CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	3 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	6/24	0-2	5-19-23-10	Dense, brown, gravelly fine to coarse, SAND FILL, trace silt; moist.		2" TOPSOIL
		S-2	4/24	2-4	9-11-12-12	Medium dense, brown, gravelly, fine to coarse SAND FILL, little silt; moist.	1	SAND FILL
5		S-3	5/24	4-6	23-20-14-8	Hard, brown, SAND SILT, trace organics (roots), trace gravel; wet.	2	BURIED TOPSOIL
		S-4	13/24	6-8	18-24-22-30	Dense, brown-gray, fine to coarse SAND, some gravel, some silt, trace clay; wet.		
10		S-5	11/11	9-9.9	40-100/5"	Very dense, brown, fine to coarse SAND, some gravel, some silt, trace clay; wet.	3	GLACIAL TILL
							4	
							5	
15						Roller bit refusal at 13 ft.		
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS		NOTES: 1. Roller bit grinding between 3 and 4 ft. 2. Water level based on observation of wet sample. 3. Open hole drilling below 9 ft. 4. Roller bit grinding below 9.5 ft. 5. Roller bit refusal (5 minutes grinding, 0" advance) and loss of wash circulation at 13 ft.
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY	
0-4	V. LOOSE	0-2	V. SOFT	
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
> 50	V. DENSE	15-30	V. STIFF	
		> 30	HARD	

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B5

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B6
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 26 ft. +/- **DATUM** NA
DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE
CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:** _____

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	3 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	8/24	0-2	2-7-7-9	Medium dense, brown, fine to coarse, SAND FILL, little gravel, trace silt; moist.		3" TOPSOIL
		S-2	3/24	2-4	13-11-6-8			
5		S-3	7/24	4-6	33-6-5-4	Stiff, gray-brown, CLAYEY SILT, some fine sand, trace organics (roots); wet.	1 2	BURIED TOPSOIL
		S-4	24/24	6-8	10-17-29-35			
10		S-5	5/24	9-11	33-71-76-99	Top 8": becomes hard with little organics. Dense, gray, fine to medium SAND, some silt, little gravel; wet.	3	GLACIAL TILL
15		S-6	12/17	14-15.4	45-60-100/5"	Same as above.	4	
20		S-7	0/1	19-19.1	100/1"	No recovery. Sampler refusal at 19.1 ft.		
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Roller bit grinding between 3 and 4 ft.
2. Water level based on observation of wet sample.
3. Open hole drilling below 9 ft.
4. Roller bit grinding below 18 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B6

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B7
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN David Thompson
WSE ENGINEER: Julie A. Eaton, EIT
BORING LOCATION See attached plan
GROUND SURFACE ELEV. 16 ft. +/- **DATUM** NA
DATE START 11/2/15 **DATE END** 11/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/2/15	NA	4 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	13/24	0-2	4-3-11-9	Medium dense, brown, fine to coarse SAND FILL, some gravel, some silt; moist.	1	6" TOPSOIL
		S-2	18/24	2-4	6-6-10-20			SAND FILL
		S-3	12/24	4-6	19-15-15-20			SILTY CLAY FILL
5						Dense, brown, fine to coarse SAND, little gravel, little silt; wet.	1	SAND
10		S-4	24/24	10-12	1-5-19-15	Very stiff, gray, CLAYEY SILT, some fine sand; wet. Bottom 6": gray, fine to coarse sandy GRAVEL, little silt; wet.	2	CLAYEY SILT
15		S-5	14/24	15-17	6-4-7-3	Medium dense, gray, fine to coarse SAND, some gravel, little silt; wet.	2	GLACIAL TILL
20		S-6	17/22	20-21.8	3-11-14-100/4"	Medium dense, gray, fine to coarse SAND, some gravel, little silt; wet.	2	
25						Sampler refusal at 21.8 ft.	2	
30							2	

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. Auger grinding between 12 and 15 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B7

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B8
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN David Thompson
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 15 ft. +/- **DATUM** NA
DATE START 11/2/15 **DATE END** 11/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/2/15	NA	4 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION	
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S-1	3/24	0-2	9-9-6-11	Medium dense, brown, fine to medium SAND FILL, little gravel, little silt; moist.	1	3" TOPSOIL/MULCH SAND FILL	
		S-2	13/24	2-4	11-14-21-24				Hard, brown, CLAYEY SILT, trace fine sand; moist.
		S-3	16/24	4-6	18-22-19-19				Hard, brown-gray mottled, CLAYEY SILT, trace fine sand; wet.
5									
10					Auger refusal at 9.5 ft.	2			
15									
20									
25									
30									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. Auger grinding starting at 9 ft. Auger refusal at 9.5 ft. (5 minutes grinding, 0" advance).

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B8

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B9
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN David Thompson
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 11 ft. +/- **DATUM** NA
DATE START 11/2/15 **DATE END** 11/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/2/15	NA	2 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	8/24	0-2	3-8-6-10	Medium dense, brown, fine to medium SAND FILL, some gravel, little silt; moist.	1	3" TOPSOIL
		S-2	12/24	2-4	2-3-5-5			SAND FILL
		S-3	24/24	4-6	5-10-11-20			BURIED TOPSOIL
5						Top 4": same as above with little organics (roots). Very stiff, brown-gray mottled, CLAYEY SILT, little fine sand; wet.	2	CLAYEY SILT
10		S-4	24/24	10-12	1-1/12"-1	Very soft, gray, SILTY CLAY, trace fine sand, wet.		CLAY
15		S-5	24/24	15-17	WOH/24"	Very soft, gray, CLAY; wet.		
20		S-6	24/24	20-22	80-96-24-24	Very dense, brown, fine to coarse sandy GRAVEL, little silt; wet.		GLACIAL TILL
25						Boring terminated at 22 ft.		
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. WOH = weight of the hammer.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B9

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B10
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN David Thompson
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 12 ft. +/- **DATUM** NA
DATE START 11/2/15 **DATE END** 11/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/2/15	NA	4 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	12/24	0-2	2-6-7-7	Medium dense, brown, SILTY SAND, little gravel; moist. No recovery.	1	7" TOPSOIL
		S-2	0/24	2-4	4-6-9-11			SILTY SAND
		S-3	24/24	4-6	9-15-22-18	Hard, gray-brown mottled, CLAYEY SILT, little fine sand; wet.		CLAYEY SILT
10		S-4	15/15	10-11.3	7-1-100/3"	Top 8": hard, gray, CLAYEY SILT, some sand; wet. Very dense, gray, fine to coarse SAND, some gravel; wet.	2	GLACIAL TILL
						Auger refusal at 11.3 ft.		
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. Auger refusal at 11.3 ft. (5 minutes grinding, 0" advance).

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG.
FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME
MEASUREMENTS ARE MADE.

BORING No. B10

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B11
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN David Thompson
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 18 ft. +/- **DATUM** NA
DATE START 11/2/15 **DATE END** 11/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/2/15	NA	2 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION	
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"				
0		S-1	16/24	0-2	3-5-11-16	Medium dense, brown-gray, fine to medium SAND, little gravel, little silt; moist.	1	6" TOPSOIL	
		S-2	16/24	2-4	10-11-13-16			Medium dense, brown, fine to medium SAND, little gravel, trace silt; wet.	SAND
5		S-3	24/24	4-6	11-12-15-15			Same as above.	
10		S-4	18/24	10-12	WOH/18"-1	Very soft, gray, CLAY; wet.	2	CLAY	
15		S-5	12/24	15-17	WOR/6"-9-8-2				Medium dense, gray, fine to medium SAND, little clay; wet.
20		S-6	6/24	20-22	33-23-20-19	Dense, gray, fine to coarse SAND, some gravel, little silt; wet.	4	GLACIAL TILL	
25									Boring terminated at 22 ft.
30									

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. WOH = weight of the hammer.
3. WOR = weight of the rod.
4. Auger grinding below 19 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B11

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B12
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN David Thompson
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 22 ft. +/- **DATUM** NA
DATE START 11/2/15 **DATE END** 11/2/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/2/15	NA	6 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	11/24	0-2	3-8-9-10	Medium dense, brown, SILTY SAND FILL, trace gravel; moist.	1	3" TOPSOIL
		S-2	19/24	2-4	5-9-11-14			SAND FILL
		S-3	11/24	4-6	36-37-26-33			SILTY SAND
5						Very dense, brown, fine to coarse SAND, some gravel, little silt; moist.	2	GLACIAL TILL
10		S-4	12/18	10-11.5	15-9-65-100/0"	Very dense, brown, gravelly SAND, little silt; wet.	2	
						Auger refusal at 11.5 ft.		
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level measured in hole after casing was removed.
2. Auger refusal at 11.5 ft. (5 minutes grinding, 0" advance).

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B12

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B13
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Ben Cross
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 26 ft. +/- **DATUM** NA
DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.
CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE
CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
11/4/15	NA	4 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	13/24	0-2	3-7-7-7	Medium dense, dark brown, fine to medium SAND FILL, some silt, little gravel, trace organics; moist. Top 8": Hard, dark brown sandy SILT, roots; moist. Dense, gray, fine to medium SAND, little gravel, little silt; moist. Dense, brown-gray, SILTY SAND, some gravel; wet.	1 2 3	3" TOPSOIL
		S-2	16/24	2-4	9-9-22-24			SAND FILL
		S-3	12/24	4-6	29-29-19-34			BURIED TOPSOIL
5								GLACIAL TILL
10		S-4	6/24	9-11	67-76-28-13	Very dense, brown, fine to coarse SAND, some gravel, little silt; wet. Roller bit refusal at 12.3 ft.	4	
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Water level based on observation of wet sample.
2. Open hole drilling below 4 ft.
3. Roller bit grinding below 6 ft.
4. Roller bit refusal at 12.3 ft. (5 minutes grinding, 4" advance)

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B13

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B14
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors

FOREMAN Ben Cross

WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan

GROUND SURFACE ELEV. 26 ft. +/- **DATUM** NA

DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. WINCH OPERATED SAFETY HAMMER.

CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE

CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
Groundwater not observed.				

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	11/24	0-2	5-8-6-8	Medium dense, brown, fine to medium SAND FILL, some silt, little gravel; moist.	1, 2, 3	3" TOPSOIL
		S-2	12/24	2-4	8-100/5"			SAND FILL
		S-3	0/0	4-	100/0			GLACIAL TILL
5					No penetration.			
10					Roller bit refusal at 4.3 ft.			
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Casing refusal at 3 ft.
2. Roller bit grinding below 3 ft.
3. Roller bit refusal at 4.3 ft. (10 minutes grinding, 4" advance).

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B14

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B14A
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors

FOREMAN Ben Cross

WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan

GROUND SURFACE ELEV. 26 ft. +/- **DATUM** NA

DATE START 11/4/15 **DATE END** 11/4/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 LB. WINCH OPERATED SAFETY HAMMER.

CASING: DRIVEN 4" CASING USING A 300 LB. HAMMER FALLING 30 IN. AND
THE DRIVE AND WASH TECHNIQUE

CASING SIZE: 4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0								
5		S-1	0/1	4-4.1	100/1	No recovery. Roller bit refusal at 4.5 ft.	1 2, 3	
10								
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Casing refusal at 4 ft.
2. Roller bit refusal at 4.5 ft. (5 minutes grinding, 4" advance).
3. Boring advanced about 4 ft. west of B14.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG.
FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B14A

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B15
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Walter Hockele
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 29 ft. +/- **DATUM** NA
DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
Groundwater not observed. See note 5.				

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	14/24	0-2	3-13-28-57	Dense, brown, gravelly, fine to coarse SAND FILL, little to some silt; moist.	1	4" TOPSOIL
		S-2	7/24	2-4	34-34-28-22			SAND FILL
		S-3	10/15	4-5.3	26-68-100/3"			GLACIAL TILL
5					Very dense, brown, sandy, coarse GRAVEL, trace silt; moist.	2		
10					Auger refusal at 7.5 ft.	3,4		
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Spoon tilted north while driving from 1 ft. to 5.3 ft.
2. Auger grinding from 3.5 to 7.5 ft.
3. Slight change in grinding from 6.5 ft. to 7.5 ft.
4. Auger refusal at 7.5 ft. (5 minutes grinding, less than 2" advance)

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B15

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B16
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Walter Hockele
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 28 ft. +/- **DATUM** NA
DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
12/11/2015		5.3 ft. +/-	5.8 ft.	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	20/24	0-2	2-6-12-12	Medium dense, brown, gravelly, fine to coarse SAND FILL, little to some silt; moist.		4" TOPSOIL SAND FILL
		S-2	19/24	2-4	23-32-30-45	Very dense, brown-orange mottled, gravelly, fine to coarse SAND, some silt; moist.		GLACIAL TILL
5		S-3	13/13	4-5.1	23-32-100/1"	Very dense, brown, gravelly, fine to coarse SAND, some silt; moist.	1	
					Auger refusal at 5.8 ft.	2,3,4		
10								
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Auger grinding below 4.8 ft.
2. Auger refusal at 5.8 ft. (5 minutes grinding, less than 2" advance)
3. Groundwater observed in hole after drilling.
4. Bedrock and/or boulders observed in wooded area south of boring.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B16

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B17
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Walter Hockele
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 26 ft. +/- **DATUM** NA
DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
12/11/2015		8 ft. +/-	8.5 ft.	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	17/24	0-2	4-8-9-6	Medium dense, brown, gravelly, fine to coarse SAND FILL, little to some silt; moist.		3" TOPSOIL
								SAND FILL
		S-2	14/24	2-4	6-6-7-10			Top 6": same as above. Medium dense, brown SILTY SAND, some organics (roots), trace gravel; moist.
5		S-3	15/24	4-6	12-14-13-16	Medium dense, gray-brown mottled, fine to medium SILTY SAND, little gravel, trace clay; moist.		
10		S-4	1/1	8.5-8.6	100/1"	Very dense, brown-gray, GRAVEL, some sand, some silt; wet.		2
								3
10					Auger refusal at 8.6 ft.			
15								
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Bottom 6": becomes gray, without organics, trace clay.
2. Auger grinding below 7.5 ft. Auger leaning north west.
3. Groundwater observed in hole after drilling.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B17

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B18
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Walter Hockele
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 15 ft. +/- **DATUM** NA
DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
12/11/2015		5 ft. +/-	14 ft.	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0							1	6" TOPSOIL
5							2	SAND TO SILTY CLAY
							3	
10							4	
15		S-1	13/24	14-16	19-24-20-18	Dense, brown, gravelly, fine to coarse SAND, little to some silt; wet.		GLACIAL TILL
						Boring terminated at 16 ft.		
20								
25								
30								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:

- Advance boring through overburden soils to estimate top of glacial till.
- Groundwater reading taken after termination
- Auger change observed at ~7 ft. (Blue-gray-orange SILTY CLAY cuttings observed).
- Auger grinding below 12.5 ft.; estimated as top of glacial till.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG.
FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B18

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B19
SHEET 1 OF 2
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Walter Hockele
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 13 ft. +/- **DATUM** NA
DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
12/11/2015		2.5 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0		S-1	14/24	0-2	3-7-7-5	Very dense, brown, fine to coarse SAND FILL, some gravel, some silt; moist.	1	7" TOPSOIL
								SAND FILL
5		S-2	17/24	2-4	10-7-9-14	Stiff, dark gray, fine to medium SANDY SILT, some clay; most. Bottom 7": becomes orange-gray.		SANDY SILT
		S-3	16/24	4-6	11-14-9-14			
10		S-4	24/24	9-11	1/12"-1-1	Very soft, gray, CLAY, some silt, trace fine to medium sand; wet.		CLAY
15		S-5	24/24	14-16	WOH/6"-WOH/18"	Very soft, gray, CLAY, little to some silt, trace fine to medium sand; wet.	2,3	CLAY
20		S-6	24/24	19-21	WOH/24"	Very soft, gray, CLAY, little silt, trace fine sand; wet.		CLAY
25		S-7	24/24	24-26	WOH/12"-2-1	Very soft, gray, CLAY, some silt, little fine to medium sand; wet.		CLAY
30		S-8	24/24	29-31	WOH/12"-8-5	Stiff, gray, CLAY, some silt, little fine to medium sand; wet. Bottom 4": loose, gray, fine to medium SAND, trace clay, trace silt; wet.	4	CLAY
		S-9	24/24	34-36	WOH/12"-3-1	Soft, gray, CLAY, little to some silt, trace fine to medium sand; wet.	5	

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Groundwater observed in hole prior to advancing augers
2. WOR - weight of rods
3. WOH = weight of hammer
4. Auger change at ~30 ft.
5. Open hole below 34 ft.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B19

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B19
SHEET 2 OF 2
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors

FOREMAN Walter Hockele

WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan

GROUND SURFACE ELEV. 13 ft. +/- **DATUM** NA

DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.

CASING: HOLLOW STEM AUGER

CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS

DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
12/11/2015		2.5 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
35		S-10	24/24	36-38	WOR/12"-5-12	Medium stiff, gray, CLAY, little to some silt, trace fine sand; wet. Bottom 6": gray, gravelly, fine to medium SAND, some clay, trace silt; wet.	6	CLAY
		S-11	12/12	38-39	13-23 (see note 6)			Gray, gravelly, fine to coarse SAND, little silt; wet.
40								Boring terminated at 39 ft.
45								
50								
55								
60								
65								

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
6. Due to lack of rods, spoon only driven 12 inches.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B19

PROJECT
Portsmouth High
School Light Poles
Portsmouth, NH

REPORT OF BORING No. B20
SHEET 1 OF 1
Project No. 2140758.K
CHKD BY Thomas J. Strike, PE

BORING Co. New England Boring Contractors
FOREMAN Walter Hockele
WSE ENGINEER: Julie A. Eaton, EIT

BORING LOCATION See attached plan
GROUND SURFACE ELEV. 11 ft. +/- **DATUM** NA
DATE START 12/11/15 **DATE END** 12/11/15

SAMPLER: 2 IN. OD SPLIT SPOON SAMPLER (SPT) DRIVEN 24 INCHES
USING A 140 lb. CATHEAD OPERATED SAFETY HAMMER.
CASING: HOLLOW STEM AUGER
CASING SIZE: 2 1/4 IN. INSIDE DIAMETER. **OTHER:**

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
12/11/2015		3 ft. +/-	NA	NA

DEPTH (feet)	CASING (blows/ft)	SAMPLE				SAMPLE DESCRIPTION	NOTES	STRATUM DESCRIPTION
		No.	REC/PEN (in)	DEPTH (ft)	BLOWS/6"			
0							1	
							2	
							3	
5								
10								
15								
20								CLAY
25								
30								
							4	
		S-1	18/18	34-35.5	16-13-15	Gray, gravelly CLAY, some sand, wet.		

GRANULAR SOILS		COHESIVE SOILS	
BLOWS/FT	DENSITY	BLOWS/FT	DENSITY
0-4	V. LOOSE	0-2	V. SOFT
4-10	LOOSE	2-4	SOFT
10-30	M. DENSE	4-8	M. STIFF
30-50	DENSE	8-15	STIFF
> 50	V. DENSE	15-30	V. STIFF
		> 30	HARD

NOTES:
1. Advance boring through overburden soils to estimate top of till or load bearing soils.
2. Groundwater reading taken after termination.
3. Auger change observed at ~4 ft. (Blue-gray-orange SILTY CLAY cuttings observed)
4. Auger change at 33 ft. Approximately 10 ft. of heave in sample S1. Blow counts do not accurately represent density.

GENERAL NOTES: i) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
ii) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THIS BORING LOG. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS ARE MADE.

BORING No. B20

SECTION 02755

HOT MIX ASPHALT PAVEMENT

PART I - GENERAL

1.01 SCOPE OF WORK

- A. Under this Section, the Contractor shall furnish all necessary labor, materials, equipment, and transportation necessary to construct the following:
 - 1. The hot mix asphalt pavement for the walks shall be composed of materials as specified herein and shall be constructed on a prepared base course to the depth, grade and cross-section shown on the plans, as specified herein and as required by the Engineer.
 - 2. Unless otherwise specified in the Contract Drawings, hot mix asphalt pavement shall be composed of a one and a half (1.5) inch hot mix asphalt binder course, and a one and a half (1.5) inch bituminous concrete dense mix course.

1.02 REFERENCE STANDARDS AND SPECIFICATIONS

- A. Reference to the standards, specifications and tests of technical societies, organizations and governmental bodies are made in the Contract Documents.
 - 1. AASHTO - American Association of State Highway and Transportation Officials (tests or specifications).
 - 2. ASTM - American Society for Testing and Materials.
 - 3. New Hampshire Department of Transportation's 2010 Standard Specification for Road and Bridge Construction.

1.03 SUBMITTALS

- A. Asphalt emulsion Type SS-1 product and application specification.
- D. Submit catalog cuts and manufacturer's specifications for Airport Grade Asphalt Emulsion Mix and Aggregate.
- E. Compaction tests are required on all hot mix asphalt base surfaces on a 5' grid interval or per Owner's direction. At the Contractor's expense, an independent testing agency must perform the work and submit the results directly to the Landscape Architect.

PART II - MATERIALS

2.01 HOT MIX ASPHALT PAVEMENT

- A. Hot mix asphalt Pavement shall consist of binder mix and dense mix courses constructed to the thicknesses shown on the plans and shall conform to the relevant provisions of New Hampshire Department of Transportation’s 2010 Standard Specification for Road and Bridge Construction.
- B. Base/Binder Courses
 - 1. Base/Binder Courses shall be Hot Mix Asphalt (HMA) Pavement, Base Course.
- C. Surface Course
 - 1. Surface Course shall be Hot Mix Asphalt (HMA) Pavement, Dense Mix Course.
- D. Pavement Mixtures
 - 1. The general composition of aggregate and the hot mix asphalt mixture (the proportion of asphalt cement to mineral aggregate) shall be as provided in the table below.

Table A
Specifications for Hot Mix Asphalt
 Percent Passing by Weight Sieve Designation

Sieve Designation & Percent Binder Content	Base Course	Dense Mix Course
2 inch	100	
1 inch	57-87	
3/4 inch		
5/8 inch		
1/2 inch	40-65	100
3/8 inch		80-100
No. 4	20-45	55-80
No. 8	15-33	48-59
No. 16		36-49
No. 30	8-17	24-38
No. 50	4-12	14-27
No. 100		6-18
No. 200	0-4	4-8

Binder	4-5	7-8
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2.02 ASPHALT EMULSION

- A. Asphalt emulsion tack coat shall be Type SS-1 or SS-1H as specified by the Asphalt Institute.

2.03 TROWELABLE ASPHALT FILLER/PATCH

- A. Airport grade asphalt emulsion mix and aggregate shall be used to repair gouges or cracks which can then be brought to grade to receive an overlay or color sealcoat.

2.04 ADHESIVE FABRIC FOR CRACK PATCHING

- A. Fabric shall be the Petromat/Petrotac system, as manufactured by Phillips Fibers Corporation, or approved equal.

PART III – EXECUTION

3.01 HOT MIX ASPHALT PAVEMENT

- A. Hot mix asphalt pavements shall be constructed on a prepared foundation of gravel in accordance with the Massachusetts Standard Specifications, Section 405, except where overlayment is over existing pavement.
- B. The bituminous mixtures shall be placed on the approved base only when, in the opinion of the Engineer, the course is sufficiently dry and weather conditions are suitable.
- C. Where walls, curbing, or other suitable permanent supports are not present, the Contractor shall secure proper alignment and adequate compaction of the binder and surface courses as shown on the Contract Drawings and finish all edges with a neat tamped edge.
- D. The mixture shall be placed in two (2) courses as shown on the Contract Drawings. Each course shall be spread and finished as required in the New Hampshire Department of Transportation’s 2010 Standard Specification for Road and Bridge Construction.
- E. Prior to completion of bituminous concrete overlay, the Contractor shall have the existing patched surfaces tack coated and leveled to eliminate all “birdbaths” or extreme lows which may create ponding or drainage problems. Leveling course (surface treatment) bituminous concrete applied as necessary, shall be raked and feathered and be properly rolled and compacted. The Contractor shall apply “level” lines, screeds, or use other measures to achieve the proper leveling surface

suitable for overlay.

All adhesive fabric shall be in place and approved prior to completing this work.

- F. After completion, the bituminous concrete courses shall conform to the thickness shown on the Contract Drawings, smooth and even and of a dense and uniform structure. When tested with a sixteen (16) foot straight edge placed parallel to the centerline of the pavement, there shall be no deviation from a true surface in excess of one-quarter (1/4) inch.

3.02 ASPHALT EMULSION TACK COAT

- A. To all existing surfaces to be pave against or overlaid, apply a single very thin (0.05 to 0.15 gallons per square yard) application of diluted asphalt emulsion (Type SS-1) to cover the entire surface of existing pavement.
- B. Essential qualities of coverage are (1) it must be very thin and (2) uniformly cover entire surface of existing pavement.
- C. Place only that amount of tack coat which can be overlaid with new pavement by the end of each day, and; **IF RAIN IS ANTICIPATED DO NOT APPLY TACK COAT.**

PART IV - GUARANTEE/WARRANTY

- 4.01 The pavement and coatings shall be guaranteed against defects in workmanship or quality for a period of one (1) year after final acceptance. The Contractor shall replace, repair, recoat or otherwise make satisfactory to the Owner any unacceptable pavement and or coating at no additional cost to the Owner.

END OF SECTION

SECTION 02910

SCREENED LOAM BORROW AND TOPSOIL RE-USED

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Under this Section, the Contractor shall furnish all labor, materials, equipment (including low ground pressure equipment (LGP)) and transportation required to furnish and place ½" Screened Loam Borrow as shown on the drawings and as specified. This Section shall also apply to turf restoration from damage as a result of the lighting installation. If existing, in place, topsoil is reused it shall be in compliance with this specification.
- B. In place topsoil that is reused shall be tilled or disced and amended per this Section to reduce compaction and allow for turf establishment. Care should be taken not to comingle the subgrade material with the topsoil during tilling.
- C. Prospective bidders are advised that significant quantities of topsoil are present at the property and presumably available for reuse if compatible with the requirements of this specification. The Contractor shall be responsible for amending topsoil, as required to comply with this specification.
- C. The Contractor shall be responsible for screening and amending topsoil as required.
- D. No heavy duty equipment and vehicular traffic shall be allowed on the prepared areas. While using the blecavator, the contractor shall fine grade soil over the blecavation areas based on the proposed elevations indicated on the site plan.

1.02 SAMPLES/TESTS

- A. The Contractor shall furnish a Certified Laboratory Report showing the soils classification and nutrient analysis of representative samples of the proposed Loam to be used, including the extent of lime and fertilizer required. Samples submitted for approval must be representative of the total volume to be furnished, taken in the presence of the Engineer, and delivered to a certified laboratory by the Contractor; all costs for such shall be borne by the Contractor.
- B. At least ten (10) days prior to shipment/delivery of materials, the Contractor shall submit to the Owner a one (1) cubic foot representative sample, certifications, certified test results for materials as specified below. The Contractor shall provide a listing of the addresses (locations) identifying the origin of the soil to be delivered. If the origin is from multiple locations, all locations shall be provided at the time of submission of required information specified above. No materials shall be ordered or delivered until the required submittals have been reviewed and

approved by the Owner. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. The Owner shall reserve the right to reject, on or after delivery, any material that does not meet these Specifications.

- C. If the material does not conform to the above requirements it shall be rejected and additional sources shall be found. Sampling and testing shall be accomplished as specified herein until an approved material is found, all at the Contractor's expense.
- D. To assure that materials fulfill specified requirements regarding textural analysis, organic matter content, pH, and fertility testing may be undertaken:
 - 1. Prior to site delivery; at source;
 - 2. At time of delivery; on-site; and/or
 - 3. Immediately following spreading on site. Soil sampling shall also indicate if specified soil was supplied uniformly to the minimum specified depth.

1.03 STANDARDS

- A. ASTM - American Society for Testing and Materials.

1.04 NOTIFICATION

- A. The Contractor shall notify the Owner in writing at least ten (10) days in advance of the time he intends furnishing Screened Loam Borrow stating the location and amount of such deposit, the name and address of the supplier and also shall furnish such facilities, transportation and assistance as the Owner may require for collecting and forwarding samples.

1.05 QUALITY CONTROL

- A. Following installation of irrigation system and prior to installation of sod, contractor shall notify landscape architect or owner and provide the owner with compaction tests along the center line of the field as well as along the side lines to ensure that the root zone mix has not been heavily compacted. Compaction test shall fall within the industry standards for fields and any areas that exceed these standards shall be corrected at the contractor's expense prior to installation of sod.
- B. The Contractor or Sub-contractor must have a minimum of five (5) years of experience installing root zone mix based athletic fields of similar size and quality of this project.
- C. The Contractor shall avoid excessive compaction of the subgrade prior to installation of the loam. Refer to section 02300 EARTHWORK.

PART 2 - MATERIALS

2.01 LOAM BORROW

- A. In accordance with the specific requirements of this project, existing on-site soil may be re-used as Loam Borrow only if it meets this Specification. Existing topsoil that does not meet this Specification may be re-used only up to the subgrade elevation within the limits of areas to receive new Loam Borrow. The Contractor shall furnish all required Loam Borrow, from off site sources, as necessary, to complete the project.
- B. Screened Loam shall be “fine sandy loam” or “sandy loam” determined by mechanical analysis (ASTM D-422) and based on the “USDA” Classification System”. Screened Loam has the following mechanical analysis:

<u>Textural Class</u>	<u>Percentage of Total Weight</u>	<u>Average Percentage</u>
Sand (0.05 – 2.0mm)	45 – 75	60
Silt (0.002 – 0.05mm)	15 – 35	25
Clay (Less than 0.002mm)	5 – 20	15

- C. Screened Loam shall be a natural product consisting primarily of natural topsoil, free from subsoil, and obtained from an area that has never been stripped, as noted above, the location of the source of the loam must be submitted to the Owner. Screened Loam shall not contain less than five percent (5%) nor more than ten percent (10%) organic matter as determined by the loss on ignition of oven-dried samples, at 100°C ± 5°C. To adjust organic matter content, the soil may be amended, prior to site delivery, by the addition of composted leaf mold or peat moss. Use of organic amendments is accepted only if random soil sampling indicates a through incorporation of these materials. No mixing or amending of Loam will be permitted on site. The Loam shall not be delivered when in a wet or frozen condition.
- D. Screened Loam shall consist of fertile, friable, natural loam capable of sustaining vigorous plant growth. Loam shall be without admixture of subsoil, and refuse, resulting in a homogeneous material free of stones greater than ½” in the longest dimension, be free of lumps, plants, glass, roots, sticks, excessive stone content, debris, and extraneous matter as determined by the Owner. Screened Loam shall be within the pH range of 6.0 to 6.5 except as where noted on plans and details. It shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. The maximum soluble salt index shall be 100. Screened Loam shall not have levels of aluminum great than 200 parts per million.

- E. If limestone is required to amend the screened loam to bring it within a pH range of 6.0 to 6.5 no more than 200 pounds of limestone per 1,000 square feet of loam, incorporated into the soil, or 50 pounds of limestone per 1,000 square feet of loam, surface application, within a single season.
- F. The Owner will reject any material delivered to the site that does not meet these Specifications after post-delivery testing. If the delivered screened loam does not meet the specifications stated in this document, the delivered screened loam will be removed by the Contractor at the Contractor's expense and at the time of rejection.
- G. The topsoil shall not be handled or moved when in a wet or frozen condition.
- H. Topsoil structure shall not be destroyed through excessive and unnecessary handling or compaction. Inappropriate handling leading to the compaction or deterioration of soil structure will result in rejection of topsoil for use.
- I. At no time should equipment or material rest on the soil.
- J. Loam Borrow shall be free of plants and their roots, debris and other extraneous matter. It shall be uncontaminated by salt water, foreign matter and substances harmful to plant growth. The electrical conductivity (EC2) of a 1:2 soil-water suspension shall be equal to, or less than, 1.0 millimhos/cm. (test material passing #4 sieve).

2.02 REUSE OF EXISTING TOPSOIL

- A. The reuse of topsoil that does not meet the specifications for use as loam borrow may only be permitted for use as a general fill material to subgrade elevations at the limits of lawn and planting areas.
- B. Care shall be taken not to overwork the soil, causing it to break down, utilizing only agricultural equipment such as plows, discs, or harrows and portable quarry sieves, screens, or blenders.

PART 3 - EXECUTION

3.01 PLACEMENT

- A. The Contractor shall furnish and spread Loam Borrow to the depths shown on the contract drawings, which depth shall be the minimum required depth after settlement. No compaction shall be required beyond that extent necessary to place sod or to plant trees and shrubs to ensure against unevenness or settling below accepted growth lines.
- B. All backfill to subgrade, shall be compacted to not less than eighty-five percent (85%) and not more than ninety percent (90%) of the maximum dry density of the

material as determined by the Standard AASHTO Test Designation T-180-86, Modified Proctor Test.

- C. Low Ground Pressure (LGP) Equipment must be used for final grading of subgrade in order to minimize the compaction on the backfill and subgrade.

3.02 ADDITIVES

- A. The Contractor shall apply all necessary fertilizer and lime to the soil in accordance with the manufacturer and laboratory's recommendations and as required by the sodding, seeding and/or planting specifications referenced elsewhere.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 WORK INCLUDED:

This section of the specifications covers the furnishing and installation of forms for cast-in-place concrete.

1.02 RELATED WORK:

- A. Section 03200, CONCRETE REINFORCEMENT
- B. Section 03300, CAST-IN-PLACE CONCRETE

1.03 REFERENCES:

The following standards form a part of this specification:

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301 Standard Specifications for Structural Concrete

ACI 347 Recommended Practices for Concrete Formwork

U.S. ARMY CORPS OF ENGINEERS (CE)

CE 03300 Cast-in-Place Concrete

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Forms for exterior and interior surfaces which will be exposed to view after the work is completed, whether such surfaces are painted or unpainted, shall be new plywood stock, steel, tempered masonite, or other materials which will provide smooth concrete surfaces without subsequent surface plastering. Plastic or plastic-faced forms shall not be used, except with the prior approval of the Engineer.
- B. Form Ties
 - 1. Provide factory-fabricated, adjustable length, removable or snap off metal form ties, designed to prevent form deflection and to prevent spalling of concrete surfaces upon removal.

2. Provide ties so that the portion remaining within concrete after removal of exterior parts is at least 1-1/2 inches from the outer concrete surface. Provide form ties, which will not leave a hole larger than one inch diameter in the concrete surface.
- C. Form release agent shall be a non-staining, non-yellowing, non-toxic liquid free from kerosene and resins of the type recommended by the manufacturer of the forming system being used such as EZ strip by L&M Construction Chemicals, Omaha, NB and "Magic Kote" by Symons Corp., Des Plaines, IL or approved equal.
- D. Where steel adjacent to vertical faces of forms cannot be otherwise secured, mortar doughnuts shall be used to prevent steel from lying too close to the finish vertical faces of the concrete.

PART 3 - EXECUTION

3.01 PREPARATION:

Surfaces of forms to be in contact with concrete shall be greased with non-staining form release compound. Wetting will not be accepted as a substitute. Approval of the Engineer shall be obtained before use of coated materials or liners in lieu of form release compound, except as modified herein.

3.02 CONSTRUCTION:

- A. For concrete surfaces which will be visible after completion of the structure, painted or unpainted, the type and the precise location of form ties, nails joints between form members, and any other features which will leave a visible trace in the finished concrete, will be subject to the approval of the Engineer.
- B. Formwork shall be so constructed, braced, or tied that the formed surfaces of the concrete will be perfectly true, smooth, and to the dimensions shown on the drawings. All forms used for circular sections shall be true arcs as indicated on the drawings. Short chords will not be acceptable. Form line shall present an uninterrupted surface conforming to radii indicated on the drawings.
- C. Forms shall be sufficiently tight to prevent leakage of mortar, and when necessary shall have temporary openings as required for thorough cleaning, and as required for introduction of concrete to avoid excessive free fall. Panels damaged in stripping or otherwise shall not be reused.
- D. Unless otherwise noted on the design drawings, forms shall be filleted and chamfered at all sharp corners, and exposed edges with a 3/4-inch chamfer. Chamfer shall not be used where masonry or other material will subsequently be installed flush with one of the adjacent surfaces of the concrete. Where a wash or slope is indicated on the drawings no additional chamfer is required.

3.03 REMOVAL OF FORMS

A. REMOVING FORMS AND SUPPORTS:

1. Removal of forms shall take place in accordance with ACI 347, Section 3.6. Except as otherwise specifically authorized by the Engineer, forms shall not be removed until the concrete has aged for the following number of day-degrees or attained 50 percent strength. (Day-degrees equals the total of number of days times the average daily air temperature at the surface of concrete. For example, 5 days at a daily average temperature of 60°F. equals 300 day-degrees.)

<u>Location</u>	<u>Day-Degrees</u>
Beams and Slabs	500
Walls and Vertical Surfaces	200

- B. Where beams, girder, columns, walls and similar vertical forms are adequately supported on shores, the side forms may be removed after 24 hours of cumulative curing time provided the side forms support no loads other than the lateral pressure of the plastic concrete. Cumulative curing time represents the sum of time intervals, not necessarily consecutive, during which the temperature of the air surrounding the concrete is above 50 deg. F in accordance with American Concrete Institute standards.
- C. Shoring shall not be removed until the concrete has attained at least 70 percent of the specified strength and sufficient strength to support safely its own weight and the construction live loads upon it.
- D. Forms shall be removed in such a manner as not to impair safety and serviceability of the structure. Concrete exposed by form removal shall have sufficient strength not to be damaged by the removal operation.

END OF SECTION

SECTION 03200
CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 WORK INCLUDED:

This section of the specification covers the furnishing and installation of reinforcement for cast-in-place concrete.

1.02 RELATED WORK:

- A. Section 03100, CONCRETE FORMWORK
- B. Section 03150, WATERSTOPS
- C. Section 03300, CAST-IN-PLACE CONCRETE

1.03 SYSTEM DESCRIPTION:

Materials and construction shall conform to ACI 318 and ACI 350 unless otherwise noted on the design drawings or modified herein.

1.04 SUBMITTALS: IN ACCORDANCE WITH REQUIREMENTS OF GENERAL SPECIFICATIONS, SUBMIT THE FOLLOWING:

- A. The Contractor shall furnish the Engineer with complete checked, reinforcing steel shop drawings and bar lists. Shop drawing shall include grade of steel used as well as splice lengths.
- B. Mill test reports shall accompany drawings. Fabrication shall not commence until the drawings and mill test reports have been released by the Engineer.
- C. When fiber reinforcement is used, contractor shall submit manufacturer's data confirming that material meets the specification.

1.05 REFERENCES:

- A. The following standards form a part of these specifications:

American Concrete Institute (ACI)

ACI 318 Building Code Requirements for Structural Concrete

ACI	347	Recommended Practice for Concrete Formwork
ACI	350	Code Requirements for Environmental Engineering Concrete Structures
ACI	SP-66	ACI Detailing Manual

American Society for Testing and Materials (ASTM)

ASTM	A185	Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
ASTM	A497	Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
ASTM	A615	Deformed Billet-Steel Bars for Concrete Reinforcement
ASTM	A775	Epoxy-coated Reinforcing Steel Bars
ASTM	A884	Epoxy-coated Welded Wire Fabric

American Welding Society (AWS)

AWS	12.1	Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction
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PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Steel reinforcing bars shall conform to ASTM A615, Grade 60, and A775 if epoxy-coated bars are specified.
- B. Welded steel wire fabric shall conform to ASTM A185 or ASTM A497 and ASTM A884 if epoxy-coated fabric is specified. Gauge and spacing of wires shall be as indicated on the drawings.
- C. Reinforcing steel shall be detailed in accordance with ACI SP-66 modified as applicable to conform to ACI 350.
- D. Reinforcement shall be accurately formed to the dimensions indicated on the drawings. Bars shall be shipped to the site with bars of the same size and shape, fastened in bundles with securely wired-on metal identification tags listing both size and mark.
- E. Any bar showing cracks after bending shall be discarded.

- F. Steel failing to meet the requirements of this specification or the drawings will be rejected and shall be removed from the site immediately.

2.02 FIBER REINFORCEMENT

When called for on the drawings, concrete engineered reinforcing fibers shall be polypropylene, collated, fibrillated fibers from Fibermesh Co., 4019 Industry Drive, Chattanooga, TN; Forta Corporation, One Hundred Forta Drive, Grove City, PA; or approved equal. Only fibers designed and manufactured specifically for use in concrete from virgin polypropylene and so certified by the manufacturer shall be acceptable.

PART 3 - EXECUTION

3.01 STEEL INSTALLATION:

- A. Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill and rust scale, dirt, and other coatings (including ice), that reduce or destroy bond. When there is a delay in depositing concrete after reinforcement is in place, bars shall be reinspected and cleaned as necessary.
- B. After forms have been oiled, but before concrete is placed, all steel shall be securely wired in the exact position called for, and shall be maintained in that position until all concrete is placed and compacted. Chair bars and supports shall be provided in a number and arrangement satisfactory to the Engineer.
- C. Concrete blocks having a minimum bearing area of 2-inches by 2-inches and equal in quality to that specified for the slab, shall be used for supporting reinforcing bars for slabs on grade. Wood blocks, stones, brick chips, etc., shall not be used to support reinforcement.
- D. Metal supports shall be of types that will not penetrate the surface of formwork or slab and which will not show through or stain surfaces that are to be exposed to view, painted or unpainted.
- E. Welding of reinforcing bars will be permitted only where permission of the Engineer has been obtained in advance. Such welding shall be performed only under conditions established by the Engineer, and in accordance with AWS 12.1.
- F. Reinforcement, which is to be exposed for a considerable length of time after having been placed, shall be painted with a heavy coat of cement grout, if required by the Engineer.

3.02 FIBER INSTALLATION:

- A. Fibermesh fibers shall be used in concrete as indicated on the drawings or as specified and in strict accordance with the manufacturer's recommendations as to type and amount. The fiber manufacturer or approved distributor shall provide the services of a qualified employee for pre-job meeting and initial job start up.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 WORK INCLUDED:

This Section covers all concrete and all related items necessary to place and finish the concrete work.

1.02 RELATED WORK:

- A. Section 02300, EARTHWORK
- B. Section 03100, CONCRETE FORMWORK
- C. Section 03200, CONCRETE REINFORCEMENT

1.03 REFERENCES:

- A. The following standards form a part of these specifications:

American Concrete Institute (ACI)

- ACI 301 Structural Concrete for Buildings
- ACI 302 Recommended Practice for Concrete Floor and Slab Construction
- ACI 304 Recommended Practice for Measuring, Mixing, Transporting, and Replacing Concrete
- ACI 305 Recommended Practice for Hot Weather Concreting
- ACI 306 Recommended Practice for Cold Weather Concreting
- ACI 318 Building Code Requirements for Reinforced Concrete
- ACI 347 Recommended Practice for Concrete Formwork

American Society for Testing and Materials (ASTM)

- ASTM C33 Concrete Aggregates
- ASTM C39 Compressive Strength of Cylindrical Concrete Specimens

ASTM	C42	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM	C87	Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM	C94	Ready-Mixed Concrete
ASTM	C143	Standard Method for Slumps of Portland Cement Concrete
ASTM	C150	Portland Cement
ASTM	C171	Sheet Materials for Curing Concrete
ASTM	C231	Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM	C260	Air-Entraining Admixtures for Concrete
ASTM	C309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM	C494	Chemical Admixtures for Concrete
ASTM	D1751	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
ASTM	D1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.04 SUBMITTALS: IN ACCORDANCE WITH REQUIREMENTS OF GENERAL SPECIFICATIONS, SUBMIT THE FOLLOWING:

- A. Six sets of shop drawings of the materials specified herein shall be submitted to the Engineer for review.
- B. Six copies of the statement of materials constituting the design of mixes which satisfy the specified strength for each size aggregate as required by ASTM C94 shall be submitted to the Engineer within one week following award of the contract.
- C. Provide one copy of the "Certificate of Delivery" for each load of concrete as it arrives on the site, under the provisions of ASTM C94.

PART 2 - PRODUCTS

2.01 CONCRETE:

- A. Concrete conforming to the requirements listed below shall be used where indicated on the drawings. Unless otherwise indicated, concrete used as fill under foundations, and elsewhere approved by the Engineer, shall be the 4,000 psi mix.

TABLE

Minimum Comp. Strength at 28 days (psi)	Maximum Water/Cement ratio (gallons per bag of cement)*	Cement Factor: 94 lb. Bags per cubic yard minimum**
3000	0.59 (6.9)	5.5
4000	0.48 (5.6)	6.5
5000	0.40 (4.7)	7.4

* Based on air-entrained concrete. If non-air-entrained concrete is called for, the listed maximum water/cement ratios may be increased slightly, as approved by the Engineer. The water is the total water in the mix, including free water on the aggregate.

** These are minimum amounts; increase as necessary to meet mix requirements.

- B. Concrete shall conform to ASTM C94. One copy of the Certificate of Delivery required by ASTM C94 shall be delivered to the Engineer immediately upon arrival of each load of concrete at the site. The Contractor shall be responsible for the design of the concrete mixtures.
- C. Standard compression tests of all proposed mixes shall be made by the testing laboratory or other satisfactory evidence shall be presented that the design mixes will attain the minimum strengths listed on the design drawings or called for herein, within the limitations of the ACI Code. No concrete shall be delivered to the job site until the Engineer has approved the design mixes.
- D. All concrete (unless otherwise directed) shall contain an air-entraining agent. Air entrained concrete shall have an air content by volume of 3 to 6 percent for 1-1/2-inch aggregate and 4 to 8 percent for 3/4-inch aggregate. The air content shall be the responsibility of the testing laboratory and in accordance with ASTM C231.
- E. All concrete shall contain a mid-range water reducer to minimize cement and water content of the mix, at the specified slump, in accordance with ASTM C494.
- F. Slump for all concrete shall be from 3-inch to 4-inch, except for concrete using a superplasticizer, when the maximum slump shall be 8 inches. Any concrete having a slump greater than 4 inches (8 inches with superplasticizer) shall be promptly removed from the site.
- G. No calcium chloride or admixtures containing calcium chloride shall be added to the concrete. No admixture other than those specified shall be used in concrete without the specific written permission of the Engineer in each case.
- H. No additional water, except for the amount indicated by the design mix shall be added to the concrete without the prior permission of the Engineer.

2.02 CEMENT:

- A. The cement shall be an approved brand of American manufactured Portland Cement, Type II conforming to ASTM C150. The brand name and type of cement proposed for use shall be submitted to the Engineer for approval immediately following award of contract. Only one color of cement, all of the same manufacture, shall be used for the work.
- B. When the use of high-early-strength Portland cement (Type III) is permitted by the Engineer the same strength requirements shall apply, but the indicated strengths shall be attained in 7 days instead of 28 days.

2.03 ADMIXTURES:

- A. Air entraining agent shall be in accordance with ASTM C260.
- B. Water reducing agent shall be a mid-range water reducer meeting ASTM C494, Type A.
- C. Water reducing agent-retarder shall be in accordance with ASTM C494, Type D.
- D. Superplasticizer agent shall be in accordance with ASTM C494, Type F or Type G and contain no more than 0.1% chloride ions. Product may be plant added or field added based on the best application considering distance, temperature and time.

2.04 AGGREGATES:

- A. Except as otherwise noted, aggregate shall conform to the requirements of ASTM C33.
- B. Fine aggregate shall consist of washed inert natural sand conforming to the requirements of ASTM C33.
- C. Coarse aggregate shall consist of well-graded crushed stone or washed gravel conforming to the requirements of ASTM C33.
- D. The following designated sizes of aggregate shall be the maximum employed in concrete.
 - 2-inch for mass concrete
 - 1½-inch for reinforced sections 18-inch and over in thickness
 - ¾-inch for reinforced and un-reinforced sections less than 18-inch thickness.

2.05 WATER:

Water for concrete shall be potable, free from injurious amounts of oil, acid, alkali, organic matter and other deleterious substances.

2.06 NON-METALLIC SHRINKAGE RESISTANT GROUT

- A. Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute

working time. The minimum ultimate compressive strength of the grout shall be 5000 psi at 7 days and 7500 psi at 28 days.

2.07 CURING MATERIALS:

- A. Curing compound shall be a curing/hardener compound such as Acurion by AntiHydro, Sikaguard Cure/Hard by Sika, Super Diamond Clear by Euclid or approved equal.
- B. Curing paper shall be a fiber-reinforced laminated Kraft bituminous product conforming to the requirements of ASTM C171.

2.08 JOINT FILLER:

- 1. Prefomed joint filler strip shall conform to ASTM D1751 or D1752, having a thickness as indicated on the drawings.
- 2. Fillers shall be provided in pieces of the full thickness required. Use of multiple layers of thin pieces to make-up the full thickness will not be permitted.

2.09 JOINT SEALANT:

Joint sealant for construction and control joints shall be a two-part polysulfide base sealant conforming to Thiokol's Building Trade Performance Specification, Class A (self-leveling), Type II (hardness: 35-45 Shore A).

PART 3 - EXECUTION

3.01 GENERAL:

Under no circumstances shall concrete that has set or partially set before placing be used; and no re-tampering of concrete or grout will be permitted.

3.02 PREPARATION:

- A. Before placing concrete, forms and the space to be occupied by the concrete shall be thoroughly cleaned, and reinforcing steel and embedded metal shall be free from dirt, oil, mill scale, loose rust, paint or other material which would tend to reduce the bond.
- B. Unless otherwise indicated, a moisture barrier shall be used under all slabs placed on the ground. The moisture barrier shall be fungi-resistant and shall have a vapor permeance rating not exceeding 0.5 perm. The moisture barrier shall be asphalt-saturated waterproof reinforced Kraft paper, clear polyethylene sheeting 0.006-inch thick, polyethylene coated asphalt-saturated reinforced Kraft paper, two layers of 30-pound asphalt-saturated felt solidly mopped with hot bitumen, or other similar material meeting the requirements for fungi-resistance and vapor permeance. Sheets shall be lapped 6-inches at joints and sealed with 2-inch wide tape.

- C. When no moisture barrier is used, the earth, concrete, masonry, or other water-permeable material against which concrete is to be placed shall be thoroughly saturated with water immediately before concrete is placed. No concrete shall be placed until the consolidation of the ground and the arrangement and details of forms and reinforcing have been inspected and approved by the Engineer.
- D. When joining fresh concrete to concrete which has attained full set, the latter shall be cleaned by chipping and washing off all dirt and scum and laitance. It then shall be moistened prior to placing new concrete.
- E. Concrete surfaces that act as a seat for structural members (other than those resting on grout) shall be troweled to an extremely flat and level surface. If necessary, such surfaces shall be ground off to achieve the required flatness and level.
- F. Fill concrete on top of concrete shall be placed in the locations indicated on the drawings or designated by the Engineer. Before fill concrete is placed, the following procedures shall be used to prepare surfaces; all dirt, scum and laitance shall be removed by chipping and washing. The clean, roughened base surface shall be saturated with water, but shall have no free water on the surface. A coat of 1:2 cement-sand grout, approximately 1/8-inch thick, shall be well scrubbed into the thoroughly dampened concrete base. The concrete fill shall be placed immediately, before grout has dried or set. Fill concrete shall be brought to the lines and grades shown on the drawings or approved by the Engineer.
- G. Concrete for thrust and anchor blocks shall be placed against undisturbed earth and wooden side forms shall be used to provide satisfactory lines and dimensions. Felt roofing paper shall be placed to protect joints. No concrete shall be placed so as to cover joints, bolts or nuts, or to interfere with the removal of the joints. Minimum bearing areas and dimensions shall be as shown on the drawings.

3.03 MIXING:

- A. Concrete shall be ready-mixed, or transit-mixed, as produced by equipment acceptable to the Engineer. No hand-mixing will be permitted. Adding water in controlled amounts during the mixing cycle shall be done only with the express approval of, and under the direction of, the Engineer.
- B. Ready-mix or transit-mixed concrete shall be transported to the site in watertight agitator or mixer trucks loaded not in excess of rated capacities for the respective conditions as stated on the nameplate. Discharge at the site shall be within 1-1/2 hours after cement was first introduced into the mix. Central mixed concrete shall be plant-mixed a minimum of 1-1/2 minutes per batch and then shall be truck-mixed or agitated a minimum of 8 minutes. Agitation shall begin immediately after the pre-mixed concrete is placed in the truck and shall continue without interruption until discharge. Transit-mixed concrete shall be mixed at mixing speed for at least 10 minutes immediately after charging the truck, followed by agitation without interruption until discharged.

- C. All central plant and rolling stock equipment and methods shall conform to the latest Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers' Bureau of the National Ready-Mixed Concrete Association, as well as ACI 304 and ASTM C94.
- D. Attention is called to the importance of dispatching trucks from the batching plant so that they shall arrive at the site of the work just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.

3.04 INSTALLATION/APPLICATION/ERECTION:

A. PLACING:

1. No concrete shall be placed by pumping methods without the prior written approval of the Engineer. Should the Contractor be allowed to place concrete by pumping methods, procedures, mix design of concrete, and all other precautions shall be in accordance with ACI 304.2R and as approved by the Engineer.
2. Concrete shall be placed in alternate areas, as defined by the construction and control joints indicated on the design drawings. A minimum of 3 days shall elapse between placement of adjacent sections.
3. Segregation of the concrete shall be prevented during handling; should any segregation occur, the concrete should be remixed before it is placed. Concrete shall be placed in the forms in horizontal layers not over 1 to 2 feet thick. Concrete shall not be allowed to drop freely more than 4 feet. If the free drop to the point of placement must exceed 4 feet, the Contractor shall obtain the approval of the Engineer for the proposed method of depositing the concrete. The concrete shall not be required to flow over distances greater than 3 feet in any direction in the forms or on the ground, unless otherwise permitted by the Engineer.
4. Unless otherwise noted, the work begun on any day shall be completed in daylight of the same day.
5. "Cold Joints" are to be avoided, but if they occur, they are to be treated as bonded construction joints.
6. Chutes for conveying concrete shall be of U-shaped design and sized to insure a continuous flow of concrete. Flat (coal) chutes shall not be employed. Chutes shall be metal or metal-lined, and each section shall have approximately the same slope. The slope shall not be less than 25 nor more than 45 degrees and shall be such as to prevent segregation of the ingredients. The discharge end of the chute shall be provided with a baffle plate or spout to prevent segregation. If the discharge end of the chute is more than 5 feet above the surface of the concrete in the forms, a spout shall be used and the lower end maintained as near the surface of deposit as practicable. When the operation is intermittent, the chute shall discharge into a hopper. Chutes shall be thoroughly cleaned before and after each run, and the debris

and any water shall be discharged outside the forms. Concrete shall not be allowed to flow horizontally more than 5 feet.

7. Concrete during and immediately after depositing shall be thoroughly compacted by means of suitable tools. Internal type mechanical vibrators shall be employed to produce the required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on long enough to produce homogeneity and optimum consolidation without permitting segregation of the solid constituents or "pumping" or migration of air. All vibrators shall be supplemented by proper wooden spade puddling adjacent to forms to remove included bubbles and honeycomb. This is essential for the top lifts of walls. All vibrators shall travel at least 10,000 rpm and be of adequate capacity. At least one vibrator shall be used for every 10 cubic yards of concrete per hour. In addition, one spare vibrator in operating condition shall be on the site.
8. Concrete slabs on the ground shall be well-tamped into place and foundation material shall be wet, tamped, and rolled until thoroughly compacted prior to placing concrete.
9. Concrete shall be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams and planes of weakness within the section. If a section cannot be placed continuously, construction joints may be located at points as provided for in the drawings or approved by the Engineer.
10. Chutes, hoppers, spouts, adjacent work, etc., shall be thoroughly cleaned before and after each run, and the water and debris shall not be discharged inside the form.

B. CONCRETE PLACING DURING COLD WEATHER:

1. Concrete shall not be placed on frozen ground, and no frozen material or material containing ice shall be used. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40°F, or is expected to fall to below 40°F, within 72 hours, and the concrete after placing shall be protected by covering, heat, or both. No accelerant shall be used to prevent freezing.
2. The temperature of concrete surfaces shall not be permitted to drop below 50°F. for at least 7 days after placement of the concrete.
3. All details of Contractor's handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Engineer. All procedures shall be in accordance with provisions of ACI 306.

C. CONCRETE PLACING DURING HOT WEATHER:

1. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. The

Contractor shall make every effort to minimize delays which will result in excessive mixing of the concrete after arrival on the job.

2. During periods of excessively hot weather (90°F, or above) ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305. Any concrete with a temperature above 90°F, when ready for placement will not be acceptable, and will be rejected.
3. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, etc.) and relative humidity. The record shall include checks on temperature of concrete as delivered and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.

D. PIPES AND EMBEDDED METALS:

1. Special care shall be taken to bring the concrete into solid contact with pipes and iron work embedded in the walls and floors, particularly underneath and around all pipes where a head of water exists, making watertight joints.
2. In general, such embedded items are not shown on the structural design drawings. Design drawings of the other trades shall be consulted for their location and details.
3. Anchor bolt location, size and details shall be verified with the equipment manufacturers certified drawings before installation.
4. Anchor bolts, reglets, sleeves, edge angles and similar embedded items will be provided, delivered to the site under other Sections of the specification, for installation under this Section.
5. Where edge angles, etc., have nuts welded on to receive machine screws, the threads of the nuts shall be protected from concrete, and the concrete shall be excluded from the space to be occupied by the screw, by the use of wood plugs or other effective means.
6. Inserts required for hanging mechanical and electrical items will be provided and installed in the forms under the mechanical and electrical Sections of the specification.
7. Should the Contractor be allowed to leave openings in the concrete for pipes or ironwork, to await the arrival of items that would delay the prosecution of the work, the openings shall be subject to the approval of the Engineer. Appropriate construction joints shall be provided. In filling any such openings with concrete, a mixture of 1: 1-1/2: 3 shall be used and a watertight bond shall be secured between the old and new concrete.

8. In bolting miscellaneous items to concrete after the concrete has set, expansion bolts of an approved pattern and type shall be used. The Contractor shall submit to the Engineer, for approval, the types of expansion bolts. Expansion bolts shall not be used until they are approved.

E. CURING:

1. Concrete curing shall be performed as specified in ACI 301 and as stated herein. All curing procedures shall have prior approval of the Engineer.

2. Concrete Floors

Concrete floors which are to receive paint, concrete fill, mortar setting beds, grout fill, or any other subsequent finish shall be cured by one of the following procedures immediately after completion of placement and finishing:

- a. Ponding or continuous sprinkling.
 - b. Application of absorptive mats or fabric kept continuously wet.
 - c. Application of sand kept continuously wet.
 - d. Application of waterproof sheet materials conforming to ASTM C171.
 - e. Application of curing compounds conforming to ASTM C309, if it can be demonstrated to the Engineer's satisfaction that the compound is applicable and that it will not prevent bonding of the subsequent finish to be received. Compound shall be placed at a rate of 200 square feet per gallon, in two applications perpendicular to each other.
3. Curing procedure shall be continued for at least 7 days.
 - a. Moisture loss from surface placed against metal or wood forms shall be minimized by keeping forms wet until removal.
 - b. Curing shall be continued for at least 7 days. When forms are removed during the curing period, surfaces shall be cured by spraying or by the use of a curing compound as previously specified.
 - c. Surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently. If necessary, 1/2-inch thick plywood sheets shall be used to protect the exposed surface.

F. BRACING AND SUPPORTS:

1. All concrete members shall be adequately and safely supported and braced until the permanent supports and braces are installed.

2. Backfilling against exterior walls shall not be done until supporting slabs are in place and have attained 70 percent of design strength, otherwise walls shall be braced against earth lateral pressure, using a system approved by the Engineer.
3. Backfilling against retaining walls shall not commence until the wall concrete has reached its 28 day strength.

G. REMOVING FORMS AND SUPPORTS:

1. Removal of forms shall take place in accordance with ACI 347, Section 3.6. Except as otherwise specifically authorized by the Engineer, forms shall not be removed until the concrete has aged for the following number of day-degrees or attained 50 percent strength. (Day-degrees equals the total of number of days times the average daily air temperature at the surface of concrete. For example, 5 days at a daily average temperature of 60°F. equals 300 day-degrees.)

<u>Location</u>	<u>Day-Degrees</u>
Beams and Slabs	500
Walls and Vertical Surfaces	200

2. Shores under beams and slabs shall not be removed until the concrete has attained at least 70 percent of the specified cylinder strength and also sufficient strength to support safely its own weight and the construction loads upon it.

H. PATCHING:

1. Defective concrete and honeycombed areas as determined by the Engineer shall be chipped down reasonably square and at least one-inch deep to sound concrete by means of hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly imbedded in the parent concrete, subject to Engineer's final inspection. If honeycomb exists around reinforcement, chip to provide a clear space at least 1-inch wide all around the steel. For areas less than 1-1/2 inches deep, the patch may be made following the procedure for filling form tie holes, described in the subsection below, using adequately dry (non-trowelable) mixtures to avoid sagging. Thicker repairs will require build-up in 1-inch layers on successive days. Unless otherwise indicated, thicker repairs shall be made with Vertipatch mortar mixture blended with Acryl-Set, both by Master Builders, Inc., Cleveland, Ohio, or approved equal.
2. For concrete areas exposed to serious abrasion and/or impact forces, the Engineer may order the use of grout with a non-shrink metallic aggregate (Embeco by Master Builders, Inc.; Ironite by Fox Industries, Madison, IL; or approved equal) as an additive in the proportions listed below:

Material	Small Patches		Large Formed Patches	
	Volumes	Weights	Volumes	Weights
Cement	1.0	1.0	1.0	1.0
Metal Aggregate	0.15	0.25	0.2	0.33
Sand	1.5	1.5	1.5	1.0
Pea Gravel	--	--	1.5	1.5

I. FINISHING OF FORMED SURFACES:

1. All concrete which is to be left exposed to view shall be scraped to remove projecting imperfections left by voids in the forms.
2. In addition to scraping, exterior exposed concrete shall be covered with a cement-base plaster mix. The mix shall consist of Thoroseal Plastic Mix and Acryl 60, as manufactured by Standard Drywall Products, Miami, FL, or approved equal. It shall be mixed and applied in accordance with the manufacturer's recommendations.
3. In addition to scraping, interior concrete surfaces which will be exposed to view and concrete surfaces which are to be prepared and painted as specified in Section 09900, PAINTING, shall receive a smooth rubbed finish, in accordance with ACI 301 and as described below.
4. To permit satisfactory finishing, forms shall be removed from the vertical faces of the concrete as early as is possible without damaging the surface. Immediately after stripping forms, any fins or projections left by the forms shall be chipped off, and the surfaces rubbed smooth.
5. Form tie holes and other voids and faults shall be patched. Voids shall be cleaned out, roughened, thoroughly wetted, coated with neat cement paste, and filled with mortar of cement and sand in the same proportions, materials, and color as used in the concrete. The surface of the patch shall be flush with the surrounding surface after finishing operations are complete. Surface shall be kept continuously damp until patches are firm enough to be rubbed without damage.
6. Rubbing shall be performed while the surface is wet using a carborundum or cement sand brick, to achieve a smooth uniform, even textured finish. Patched and chipped areas shall be blended to match as closely as possible the appearance of the rest of the surface. No cement wash or plastering will be permitted, and no mortar shall be used except as required above.
7. Where finishing is performed before the end of the curing period, concrete shall under no circumstances be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.

J. CONCRETE FLOOR FINISHING REQUIREMENTS:

Unless designated otherwise, concrete floors shall have a troweled finish as specified in Section 11.7 of ACI 301. Troweled finishes shall conform to the requirements of "Class A Tolerances," Section 11.9 as specified in ACI 301.

K. TESTING:

1. The Contractor shall provide all field testing and inspection services, and shall pay for all such services. The Engineer shall approve the testing laboratory and shall inform the Contractor when samples are to be taken for testing. The Contractor shall forward all test results to the Engineer as soon as they are available.
 - a. The Testing Laboratory shall conform to the requirements of ASTM E-329 as modified in 780 CMR R1 in the State Building Code. They shall be licensed by the State Board of Building Regulations and Standards.
2. At least one slump test shall be performed from each truck load of concrete. The sample for slump shall be taken from the middle third of a truck load. Air content tests shall be made at the discretion of the Engineer. If the measured slump or air content falls outside the specified limits, a check test shall be made immediately on another portion of the same sample. In the event of a second failure, the concrete shall be considered to have failed the requirements of the specification and shall be immediately removed from the jobsite to be discarded.
3. The Contractor shall advise the Engineer of his readiness to proceed with concrete placement at least one working day prior to each placement. The Engineer will inspect the preparations for concrete, including the preparation of previously placed concrete, the reinforcing, and the alignment and tightness of formwork. No placement shall be made without the prior approval of the Engineer.
4. A minimum of four standard compression test cylinders shall be made and tested for each 100 cubic yards or fraction thereof for each type and design strength of concrete from each day's placement of concrete. One cylinder shall be tested at 7 days and two cylinders at 28 days. The fourth cylinder from each set shall be kept until the 28 day test report on the second and third cylinders in the same set has been received. The Engineer reserves the right to require test cylinders to be made for each truckload of concrete if the nature of the project or project experience indicates such additional tests are required for proper control of concrete quality; such tests will be at the Owner's expense.
5. The strength level shall be considered satisfactory so long as the averages of all sets of three consecutive strength test results equal or exceed the specified strength f'_c , and no individual strength test (average of two cylinders) result falls below the specified strength f'_c by more than 500 psi.

6. In the event the average compressive strength of the two 28 day cylinders do not achieve the required level, the Engineer may elect to test the fourth cylinder immediately or test it after 56 days.

L. FAILURE TO MEET REQUIREMENTS:

1. The Engineer shall have the right to reject concrete represented by low strength tests or to agree to further testing of the concrete. Rejected concrete shall be promptly removed and replaced with concrete conforming to the specification. The decision of the Engineer as to whether substandard concrete is to be accepted or rejected or additional tests shall be conducted shall be final. All direct and indirect costs associated with further curing and testing of the concrete shall be at the Contractor's expense. All costs associated with removing rejected concrete, placing new concrete, and conducting tests on new concrete shall be at the Contractor's expense.
2. If the Engineer agrees to consider further curing and/or testing of the concrete before making a final decision, the Contractor shall submit a detailed plan to the Engineer, including proposed criteria for acceptance of the concrete. The plan may include additional curing of the concrete, drilling and testing of cores, load testing of the structure, or a combination.
3. If additional curing is permitted before further inspection and testing, the Contractor shall provide any necessary materials and labor to further cure the suspect concrete.
4. If drilling and testing of cores is permitted, the Contractor shall be responsible for obtaining the cores, including provision of ladders, scaffolding, and such incidental equipment as may be required. If additional curing is permitted, cores shall be drilled after the curing period, and shall be in accordance with ASTM Methods C39 and C42. The Contractor shall repair all core holes to the satisfaction of the Engineer.
5. The burden of proof, including, but not limited to the work of cutting and testing the cores, inspection, evaluation, engineering, repair of the holes, or removal and replacement of the concrete in question, and all associated costs therefor, shall be at the expense of the Contractor.
6. If load testing of the concrete is permitted, and if not otherwise indicated, slabs or beams under load test shall be loaded with their own weights plus a superimposed load of 2 times the design live load. The load shall be applied uniformly over the portion being tested in the approved manner and left in position for 24 hours. The structure shall be considered satisfactory if deflection "D" in feet, at end of 24-hour period, does not exceed the following value:

$$D = 0.001 (L \times L)/t$$

in which "L" is span in feet, "t" is depth of slab, or beam in inches. If deflection exceeds "D" in the above formula, the concrete shall be considered faulty unless

within 24 hours after removal of the load, the slab, or beam under test recovers at least 75 percent of the observed deflection.

7. If the suspect concrete still fails to meet specification requirements, the Engineer shall have the right to reject the concrete, have it removed and replaced, in accordance with paragraph 5 above, or to require mechanical strengthening of the concrete to satisfy project requirements. The Contractor shall submit a removal and replacement plan for review by the Engineer.

END OF SECTION

SECTION 16010

ELECTRICAL WORK - GENERAL PROVISIONS

PART 1 - GENERAL

1.01 WORK INCLUDED:

- A. The work covered by this section of the specifications consists of furnishing all labor, equipment, appliances, materials and incidentals in connection with the installation of the complete electrical systems as herein specified and as shown on the drawings.
- B. It is not the intent that the drawings shall show every junction box, conduit, wire, fitting, device, accessory, etc., but the Contractor shall be required to furnish without additional expense all transportation, labor and materials necessary to complete the electrical systems in accordance with the best practice of the trade.
- C. Unless otherwise specified, materials of the same classifications, used for the same purpose shall be the product of the same manufacturer.
- D. The work shall include furnishing and installing the following items:
 - 1. Underground Primary and Secondary Services
 - 2. Grounding System
 - 3. Panelboards
 - 4. Raceways
 - 5. Feeder and Branch Circuit Conductors
 - 6. Hangers and Supports
 - 7. Solderless Lugs and Connectors
 - 8. Conduit and wire for equipment and controls furnished under other divisions of the specifications, when shown on the electrical plans, with the exception of the instrumentation low voltage signal wiring.
- E. Electric Service and Metering

The power company serving this project is Eversource.

- 1. Primary service at the site is 4160 volts, 3-phase, 4 wire, 60 Hz.

2. At the utility transformer the Contractor shall furnish and install a 4-inch steel conduit from the riser pole to the primary side of the transformer. A spare conduit of the same size shall be furnished and installed for each primary feeder.
3. Furnish and install the primary cable from the transformer, leaving sufficient slack to reach, without splice, the point of connection to the power company overhead lines. Terminators for pole top and transformers shall be approved by the power company. The power company will make final connections at the overhead lines and at the primary side of the transformer.
4. Secondary metering will be by the Contractor.
5. Arrangements shall be made with the power company for obtaining service. All cost for overhead line extensions and work required for these services including metering cost shall be obtained from the power company. The Contractor shall include in his bid and shall pay this money to the power company. All work involving the service and metering shall be as approved by the power company.

F. Interpretation of Drawings

1. The Drawings are diagrammatic only and are not intended to show exact locations of outlets and conduit runs.
2. All three-phase circuits shall be run in separate conduits unless otherwise shown on the Drawings.
3. The Contractor shall verify with the Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
4. Any work installed contrary to Contract Documents, or without approval by the Engineer, shall be changed or replaced as required by the Engineer and no extra compensation will be allowed the Contractor for making these changes.
5. The locations of equipment, fixtures, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. The Contractor shall obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, shall proceed as required by the Engineer and shall furnish all labor and materials necessary to complete the work in an approved manner.

6. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.
7. The number of conductors shown on the Drawings are not necessarily the correct number required. As many conductors as are required in each case shall be installed.
8. Unless otherwise specified, all conduits, wires, and cables and the support systems for the conduits and cables that are required to make the electrical connections to equipment shall be furnished and installed. All connections to equipment shall be made as shown, specified, and required and in accordance with the approved shop and setting drawings.
9. The Contractor shall verify, in the field, all measurements necessary for his work and shall assume responsibility for their accuracy.

1.02 LOCAL CONDITIONS:

- A. Before submitting proposals, the Contractor is expected to inspect the site and survey the conditions to be encountered in the performance of the work. Failure to familiarize himself with the conditions shall not relieve the Contractor's responsibility for full completion of the work in accordance with the provisions of the Contract.

1.03 PERMITS AND INSPECTION:

- A. Permits, fees and notices shall be in accordance with the General Conditions.
- B. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over electrical construction at this project.
- C. All required permit and inspection certificates shall be obtained, paid for, and given to the Owner at the completion of the work.

1.04 CODES AND STANDARDS:

- A. Unless indicated or specified otherwise, materials and workmanship shall conform with the latest editions of the following codes, standards and specifications.
 1. National Electrical Code
 2. National Bureau of Standards Handbook H-30 National Electrical Safety Code

3. State and Local Codes, and all other authorities having jurisdiction
4. Underwriter's Laboratories, Inc. (UL)
5. American National Standards Institute, Inc.
6. Institute of Electrical and Electronic Engineers (IEEE)
7. National Electrical Manufacturers Association (NEMA)
8. National Board of Fire Underwriters
9. International Municipal Signal Association (IMSA)
10. Insulated Power Cable Engineers Associated Specifications
11. American Society for Testing Materials Specifications

1.05 REVIEW OF MATERIALS:

- A. Material and Equipment Schedules. As soon as practicable and within thirty days after the date of notice to proceed and before commencement of installation of any materials or equipment, the Contractor shall submit to the Engineer six (6) complete Brochures for approval of materials, fixtures, and equipment to be incorporated in the work. The list shall include manufacturer's name, catalog numbers, cuts, diagrams, drawings, and such other descriptive data as may be required. No consideration will be given to a partial submittal from time to time. Approval of materials will be based on manufacturer's published ratings. Any materials, fixtures and equipment listed that are not in accordance with the specification requirements will be rejected.
- B. Substitutions: Substitution of material or equipment shall be in accordance with the General Conditions.
- C. Shop Drawings. Shop drawings shall be submitted to the Engineer for review in accordance with the Division 1. Shop drawings shall be submitted for, but not limited to the following:
 1. Panelboards
 2. Wire and Cable
 3. Hangers and Supports
 4. Raceways

- D. Submit the following information with all equipment shop drawings.
1. Manufacturer's certified scale drawings, cuts, or catalogs, including installation details and manufacturer's name.
 2. Manufacturer's specifications, including certified performance characteristics and capacity ratings.
 3. Electrical wiring diagrams and controls, where applicable.
 4. Certificate of compliance with Code, where applicable.
 5. Detail of all conduit stub-up with conduit size and dimensions from columns or walls.
- E. Equipment shop drawings and wiring diagrams must be prepared specifically for this installation. Standard factory wiring diagrams with a revision marked in ink for this installation will be accepted.
- F. All control and wiring diagrams shall be complete with the following description:
1. Sequence of operation
 2. Sequence of interlocking
 3. Operation of alarms
 4. Legend
 5. Wiring Numbers
- G. All equipment shop drawings shall be properly identified and indicate the Article number of the specifications or the Drawing number which applies to the submitted item.
- H. Shop drawings for the items listed above shall be submitted for approval in accordance with the preceding paragraphs. The Engineer, however, reserves the right to require submittal of shop drawings on any other material or equipment to be installed under this Section not specifically listed above.

1.06 MINOR DEVIATIONS:

- A. The work as shown on the drawings is diagrammatic and is intended to show the work included and the arrangement of the various systems.

- B. It is not intended that the accompanying plans and specifications cover every detail of the required installation. Furnish and install equipment, materials and labor as shown or specified, as are usually furnished, or as are needed to make a complete and satisfactory operating installation, whether mentioned or not, omitting only those items which are specifically excluded.
- C. Locations and mounting heights of equipment and/or devices as shown are approximately correct. The Engineer reserves the right to relocate any equipment or device prior to actual installation at no extra cost to the Owner.
- D. No deviation from layout shall be made without written approval from the Engineer.

1.07 TEMPORARY LIGHT AND POWER:

- A. The Contractor shall provide temporary light and power and pay all energy charges as described in Division 1.

1.08 ELECTRICAL REFERENCE SYMBOLS:

- A. Symbols shown on the drawings shall approximate location of fixtures, outlet boxes, and conduit runs, and other equipment, unless otherwise detailed. The exact location shall be governed by structural conditions and obstructions. This is not to be construed to permit redesigning systems. Locate and install all boxes and equipment where they will be readily accessible.

1.09 PHASE IDENTIFICATION:

- A. The entire system of wiring shall be phased by color code as follows:
 - 1. Wires No. 6 AWG and smaller shall have a continuous colored outer covering.
 - 2. Wires larger than No. 6 AWG shall be identified at all points of termination by gummed tape, plastic tape, etc., applied to the wire.
 - 3. Bus bars in motor control centers and panelboards shall be properly identified by color as herein specified.
 - 4. Code colors for 120/208 volt systems shall be:
 - a. Phase A - Black
 - b. Phase B - Red

c. Phase C - Blue

5. Neutral wires shall be white or grey.
6. Equipment ground wires shall be green.
7. The same colors shall be used for the same phases throughout the entire project.

1.10 PROTECTION AND CLEANING OF EQUIPMENT:

- A. All electrical equipment, upon receipt, shall be adequately stored and protected from damage.
- B. After installation, all electrical equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent entrance of foreign materials.
- C. The interior of boxes and cabinets shall be left clean. Exposed surfaces shall be cleaned and plate surfaces polished.

1.11 OPERATION AND MAINTENANCE MANUALS:

- A. The Contractor shall furnish the Owner with three (3) copies of complete operating and maintenance manuals. Manuals shall include all equipment, maintenance instruction, parts list, warranties, schematic diagrams of control systems, and lubrication charts.
- B. Manuals shall contain only that information which specifically applies to this project, and all unrelated material shall be deleted. During the instruction period, herein specified, this manual shall be used and explained. Each copy of manual shall be clearly indexed and include a directory of all subcontractors and maintenance contractors, indicate the area of their responsibility, and list the name and telephone numbers of the responsible member of each organization. This material shall have a clear plastic protective shield over each sheet of data.
- C. Each manual shall be bound in an expandable plastic covered hard bound binder. Binders shall be three (3) straight post type. Ring type binders will not be acceptable. The manual's front cover and side cover shall be gold-leaf stamped "Operation and Maintenance Manual -- Electrical Systems" along with the project title.

1.12 OPERATING AND MAINTENANCE INSTRUCTIONS:

- A. A competent Engineer shall be provided by the Contractor to instruct operating personnel in the operation and maintenance of equipment and systems.

1.13 SPARE PARTS DATA:

- A. The Contractor shall furnish a complete list of recommended spare parts and supplies for the equipment furnished with current unit prices and source of supply.

1.14 TESTS:

- A. The Electrical Subcontractor shall perform all tests at the completion of the work and the results furnished to the Owner and Engineer in writing. Tests shall include, but not be limited to: all systems test free of shorts or grounds, proper neutral connections, ground system resistance, secondary voltages at main distribution panel, power panels and lighting panels, all lighting fixtures with lamps in place for 10 hours.
- B. Upon completion of all work, the **Electrical Subcontractor** shall furnish, in duplicate, certificates of inspections from all inspectors and authorities having jurisdiction, notarized letters from the manufacturers stating that authorized Factory Engineers or agents have inspected and tested the installation of their respective systems and found same to be in satisfactory operating condition.
- C. Furnish all labor, material, instruments, supplies and services and bear all costs for the accomplishment of the tests.

1.15 GUARANTEE:

- A. The Contractor shall guarantee equipment and performance of the installation and equipment in accordance with the GENERAL CONDITIONS.
- B. Lamps shall be furnished and installed in each lighting fixture as soon as fixtures are properly hung. Replace all lamps that fail within ninety (90) days after final acceptance at no additional cost. If the Contractor fails to replace lamps during the guarantee period, after a second request the Owner may replace lamps and back-charge Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. The materials used in all systems shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their

respective kinds. Samples of materials or manufacturer's specification shall be submitted for approval as required by the Engineer.

- B. Materials and equipment used shall be U.L. listed wherever such approved materials and equipment is available.
- C. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. If any apparatus has been damaged, such damage shall be repaired by the Contractor at his cost and expense. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through such special tests as required by the Engineer, at the cost and expense of the Contractor, or shall be replaced by the Contractor at his own expense.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All work shall be executed in full accordance with the National Electrical Code and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, this Contractor shall bear full responsibility for such violations and assume all costs arising therefrom.
- B. Load Balance. Check the load balance on the phases of the various systems and reconnect where necessary as approved by the Engineer to provide equal division of the loads between the phases of the various systems.
- C. Before starting the work, confer with all other trades relative to the location of pipes, and apparatus or fixtures to be installed by them and select locations for the work which will avoid possible conflicts with the work of other trades involved. All differences or conflicting conditions concerning the work shall be called to the attention of the Engineer for adjustment before starting work. For such work performed or materials installed in violation of the above clause the work shall be readjusted to the complete satisfaction of the Engineer at the sole expense of the **Electrical Subcontractor**.
- D. A concrete housekeeping pad shall be furnished and installed for all floor-mounted equipment. The pad shall be 4-inches high and sized to extend 4-inches beyond the equipment. The pad shall be poured dead level and the top scored from front to back on 18-inch centers with a parting tool. All edges shall be finished with an edging tool. The Contractor should refer to Division 3, Cast-In-Place Concrete for additional requirements.
- E. Cleanup

1. This Contractor shall cooperate with other workmen and with the General Contractor in the daily removal of debris from the work site.
2. This Contractor shall leave "broom clean" all areas where he has interrupted or completed his work.
3. He shall cooperate with the General Contractor in good housekeeping procedures.
4. At the completion of his work, prior to the final inspection, this Contractor shall clean all devices, plates, fixtures, glassware, switches, cabinets, exposed conduits, fittings, etc. and shall have the premises in a thoroughly clean condition.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Electricity-metering components.
 - 6. Concrete equipment bases.
 - 7. Cutting and patching for electrical construction.
 - 8. Touchup painting.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

- A. Product Data: For electricity-metering equipment.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.

- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

1.06 COORDINATION

- A. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work.
- B. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. EMT: ANSI C80.3, zinc-coated steel, with set-screw or compression fittings.
- B. FMC: Zinc-coated steel.
- C. IMC: ANSI C80.6, zinc-coated steel, with threaded fittings.
- D. LFMC: Zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- E. RNC: NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
- F. Raceway Fittings: Specifically designed for the raceway type with which used.

2.02 CONDUCTORS

- A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.

- B. Conductors, Larger Than No. 10 AWG: Stranded copper.
- C. Insulation: Thermoplastic, rated at 75 deg C minimum.
- D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.03 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- D. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- E. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- F. Expansion Anchors: Carbon-steel wedge or sleeve type.
- G. Toggle Bolts: All-steel springhead type.
- H. Powder-Driven Threaded Studs: Heat-treated steel.

2.04 ELECTRICAL IDENTIFICATION

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.
 - 1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
 - 2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.
 - 3. Color: Black letters on orange background.
 - 4. Legend: Indicates voltage.

- C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.
- D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend that indicates type of underground line.
- E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.
- H. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch, galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch grommets in corners for mounting.
- I. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.05 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

- A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
- B. Meter Sockets: Comply with requirements of electrical power utility company.

2.06 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."
- B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.07 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.01 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.02 RACEWAY APPLICATION

- A. Use the following raceways for outdoor installations:
 - 1. Underground, Single Run: RNC.
 - 2. Underground, Grouped: RNC.
 - 3. Connection to Vibrating Equipment: LFMC.
 - 4. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.
- B. Use the following raceways for indoor installations:
 - 1. Damp or Wet Locations: IMC.
 - 2. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.03 RACEWAY AND CABLE INSTALLATION

- A. Use temporary raceway caps to prevent foreign matter from entering.
- B. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- C. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.

- D. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.
- E. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

3.04 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

- A. Feeders: Type THHN/THWN insulated conductors in raceway.
- B. Underground Feeders and Branch Circuits: Type THWN or single-wire, Type UF insulated conductors in raceway.
- C. Branch Circuits: Type THHN/THWN insulated conductors in raceway.
- D. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

3.05 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

3.06 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.07 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- H. Simultaneously install vertical conductor supports with conductors.
- I. Install metal channel racks for mounting cabinets, panelboards, control enclosures, pull and junction boxes, and other devices unless components are mounted directly to structural elements of adequate strength.

3.08 IDENTIFICATION MATERIALS AND DEVICES

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Identify raceways and cables with color banding as follows:
 - 1. Bands: Pretensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
3. Colors: As follows:
 - a. Telecommunication System: Green and yellow.
- E. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- F. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.
- G. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 1. Phase A: Black.
 2. Phase B: Red.
 3. Phase C: Blue.
- H. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

3.09 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.10 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

3.11 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Electricity-metering components.
 - 6. Concrete bases.
 - 7. Cutting and patching for electrical construction.
 - 8. Touchup painting.

- B. Test Owner's electricity-metering installation for proper operation, accuracy, and usability of output data.
 - 1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
 - 2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
 - 3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
 - 4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
 - 5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.12 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.13 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 16123
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

1.04 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 CONDUCTORS AND CABLES

- A. Manufacturers:
1. Alcan Aluminum Corporation; Alcan Cable Div.
 2. American Insulated Wire Corp.; a Leviton Company.
 3. General Cable Corporation.
 4. Senator Wire & Cable Company.
 5. Southwire Company.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper, except feeders No. 4 AWG and larger may be aluminum complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Conductor Insulation Types: Type THHN-THWN XHHW UF complying with NEMA WC 5 or 7.
- E. Multiconductor Cable: Nonmetallic-sheathed cable, Type NM and Type USE with ground wire.

2.03 CONNECTORS AND SPLICES

- A. Manufacturers:
1. AFC Cable Systems, Inc.
 2. AMP Incorporated/Tyco International.
 3. Hubbell/Anderson.
 4. O-Z/Gedney; EGS Electrical Group LLC.
 5. 3M Company; Electrical Products Division.

- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.01 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway
- C. Exposed Branch Circuit: Type THHN-THWN, single conductors in raceway.
- D. Underground Feeders and Branch Circuits: Type UF multiconductor cable.

3.02 INSTALLATION

- A. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- B. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- C. Support cables according to Division 16 Section "Basic Electrical Materials and Methods."
- D. Identify and color-code conductors and cables according to Division 16 Section Basic Electrical Materials and Methods.

3.03 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.

3.04 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
- B. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- C. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- D. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Division 16 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
 - 3. Division 16 Section "Seismic Controls for Electrical Work" for seismic restraints and bracing of raceways, boxes, enclosures, and cabinets.
 - 4. Division 16 Section "Wiring Devices" for devices installed in boxes.

1.03 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible nonmetallic conduit.
- G. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 2. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- E. Manufacturer Seismic Qualification Certification: Submit certification that enclosures, cabinets, accessories, and components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 METAL CONDUIT AND TUBING

- A. Manufacturer[s]:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Aluminum Rigid Conduit: ANSI C80.5.
- D. IMC: ANSI C80.6.
- E. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

- F. Plastic-Coated IMC and Fittings: NEMA RN 1.
- G. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type.
- H. FMC: Zinc-coated steel.
- I. LFMC: Flexible steel conduit with PVC jacket.
- J. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.03 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturer[s]:
 - 1. American International.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Arco Corp.
 - 4. Cantex Inc.
 - 5. Certainteed Corp.; Pipe & Plastics Group.
 - 6. Condux International.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; Division of Hubbell, Inc.
 - 12. Spiralduct, Inc./AFC Cable Systems, Inc.
 - 13. Thomas & Betts Corporation.
- B. ENT: NEMA TC 13.
- C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.
- E. LFNC: UL 1660.

2.04 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
 - 1. Manufacturer[s]:
 - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
 - b. Thomas & Betts Corporation.

- c. Walker Systems, Inc.; Wiremold Company (The).
 - d. Wiremold Company (The); Electrical Sales Division.
- B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC compound with matte texture and **manufacturer's standard** color.
 - 1. Manufacturer[s]:
 - a. Butler Manufacturing Co.; Walker Division.
 - b. Enduro Composite Systems.
 - c. Hubbell, Inc.; Wiring Device Division.
 - d. Lamson & Sessions; Carlon Electrical Products.
 - e. Panduit Corp.
 - f. Walker Systems, Inc.; Wiremold Company (The).
 - g. Wiremold Company (The); Electrical Sales Division.
- C. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.05 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturer[s]:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet-PLM Division.
 - 10. Spring City Electrical Manufacturing Co.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

- H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.06 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

- B. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors:
 - 1. Exposed: Rigid steel or IMC.
 - 2. Concealed: Rigid steel or IMC.
 - 3. Underground, Single Run: RNC.
 - 4. Underground, Grouped: RNC.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 4.

- B. Minimum Raceway Size: 1/2-inch trade size.

- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
- D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- E. Do not install aluminum conduits embedded in or in contact with concrete.

3.02 INSTALLATION

- A. Complete raceway installation before starting conductor installation.
- B. Support raceways as specified in Division 16 Section "Basic Electrical Materials and Methods."
- C. Install temporary closures to prevent foreign matter from entering raceways.
- D. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- E. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- F. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 1. Run parallel or banked raceways together on common supports.
 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- G. Join raceways with fittings designed and approved for that purpose and make joints tight.
 1. Use insulating bushings to protect conductors.
- H. Tighten set screws of threadless fittings with suitable tools.
- I. Terminations:
 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase

nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

- J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- K. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where otherwise required by NFPA 70.
- L. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- M. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- N. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- O. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.03 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.04 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 16442

PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.
- F. TVSS: Transient voltage surge suppressor.

1.04 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, TVSS device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.

- b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 16 Section "Seismic Controls for Electrical Work." Include the following:
 1. Basis of Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. The term "withstand" means "the unit will remain in place without separation of internal and external parts during a seismic event."
 3. The term "withstand" means "the unit will remain in place without separation of internal and external parts during a seismic event and the unit will be fully operational after the event."
 4. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 5. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.
- E. Field Test Reports: Submit written test reports and include the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- F. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- G. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

1.06 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.07 EXTRA MATERIALS

- A. Keys: Six spares of each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Div.

- c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
2. TVSS Panelboards:
- a. Current Technology, Inc.
 - b. Liebert Corporation.

2.02 FABRICATION AND FEATURES

- A. Enclosures: Surface mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
 - 1. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
- B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- F. Bus: Hard-drawn copper, 98 percent conductivity.
- G. Main and Neutral Lugs: Compression type suitable for use with conductor material.
- H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- I. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- K. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- L. Gutter Barrier: Arrange to isolate individual panel sections.
- M. Feed-through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.03 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.05 OVERCURRENT PROTECTIVE DEVICES

- C. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical or Compression style, suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.

2.06 ACCESSORY COMPONENTS ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: To test functions of solid-state trip devices without removal from panelboard.
- C. Fungus Proofing: Permanent fungicidal treatment for panelboard interior, including overcurrent protective devices and other components.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Division 16 Section "Seismic Controls for Electrical Work."
- C. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- F. Install filler plates in unused spaces.
- G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.02 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section Basic Electrical Materials and Methods.
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.03 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.04 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Testing Agency: Owner will engage a qualified independent testing agency to perform specified testing.
- C. Testing Agency: Engage a qualified independent testing agency to perform specified testing.
- D. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- E. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:
1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
- F. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.
1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 3. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 - 4.

3.05 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.06 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 16668

EXTERIOR ATHLETIC LIGHTING – LEARY BALL FIELD

PART 1 – GENERAL

1.01 SUMMARY

- A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.
- B. The purpose of these specifications is to define the performance and design standards for Portsmouth High School. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.
- A. The sports lighting will be for the following venues:
 - 1. Baseball Field 1
 - 2. Baseball Field 2
 - 3. Tennis Courts 1 – 2
 - 4. Tennis Courts 3 – 4
 - 5. Football Field
 - 6. Soccer Field 1
 - 7. Soccer Field 2
 - 8. Lacrosse Field
 - 9. Practice Field
 - 10. Leary Baseball
- C. The primary goals of this sports lighting project are:
 - 1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore light levels are guaranteed to not drop below specified target values for a period of 25 years.
 - 2. Life-cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated.
 - 3. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Fields should be proactively monitored to detect luminaire outages over a 25-year life cycle. All communication and monitoring costs for 25-year period shall be included in the bid.
 - 4. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players and spectators.
- D. All lighting designs shall comply with all Portsmouth, New Hampshire lighting standards

1.02 LIGHTING PERFORMANCE

- A. Performance Requirements: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points

specified below. Average illumination level shall be measured in accordance with the IESNA LM-5-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not to drop below desired target values in accordance to IES RP-6-01, Page 5, Maintained Average Illuminance and shall be guaranteed for the full warranty period. Hours of usage shall comply with the following:

Area of Lighting	Annual Usage Hours	25 Year Usage Hours
Baseball 1	300	10,000
Baseball 2	300	10,000
Tennis 1-2	500	12,500
Tennis 3 - 4	500	12,500
Football	200	5,000
Soccer 1	400	10,000
Soccer 2	400	10,000
Lacrosse	200	5,000
Practice Field	200	5,000
Leary Baseball	300	10,000

- B. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be (see table below). Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

# of Poles	Pole Designation	Pole Height
7	T1, T2, T5, T6, P1, P2, P3	40'
2	T3, T4	50'
8	A1, A2, A3, A4, C1, C2, F1, F2	70'
17	A1, A2, B2, B3, B4, C2, C3, C4, F3, F4, S1, S2, S3, S6, S7	80'

- C. Lighting Methodology: There are two methods that will be considered for calculation of the lighting designs for this project. The approved Lighting Method #1, automated timed power adjustments, as described in C.1 utilizes methodology that adjusts light levels through a series of programmed adjustments. The alternate Lighting Method #2, continuous depreciating light, as described in C.2 uses continuous lamp lumen depreciation which is recovered by relamping and cleaning lenses of the luminaires. Computer models shall reflect initial design lumens, end of life design lumens, recoverable light loss factor (RLLF), and the Coefficient Utilization (CU) for the design. Both methods must be at or above target illumination levels throughout the 25 years of the contract/warranty provided by the manufacturer. A +/- 10% design/testing allowance is **not** permitted in the design logic.

1. Lighting Method #1: Automated Timed Power Adjustments:

- a. The lighting system shall use automated timed power adjustments to achieve a lumen maintenance control strategy as described in the IESNA Lighting Handbook 10th Edition, Lighting Controls Section page 16-8: "Lumen maintenance involves adjusting lamp output over time to maintain constant light output as lamps age and

- dirt accumulation reduces luminaire output. With lumen maintenance control, either lamps are dimmed when new, or the lamp's current is increased as the system ages."
- b. Manufacturers bidding an automated timed power adjustment system must provide an independent test report certifying the system meets the lumen maintenance control strategy above and verifying the field performance of the system for the duration of the useful life of the lamp based on lamp replacement hours. Report shall be signed by a licensed professional engineer with outdoor lighting experience. If report is not provided at least 10 days prior to bid opening, the manufacturer shall provide the initial and maintained designs called for in this specification under Lighting Method #2: Alternate Manufacturers, section 1.2.C.2.
 - c. Project References: Manufacturers bidding any form of Automated Timed Power Adjustment light system must provide a minimum of five (5) project references within the state of New Hampshire that have been completed within the last 12 months utilizing this exact technology. Manufacturer will include project name, project city, and if requested, contact name and contact phone number for each reference.

Area of Lighting	Average Target Illumination Levels	Max to Min Uniformity Ratio	Grid Points	Grid Spacing
Baseball 1 Infield	50 footcandles	2.0	25	30' x 30'
Baseball 1 Outfield	30 Footcandles	2.5	98	
Baseball 2 Infield	50 footcandles	2.0	25	30' x 30'
Baseball 2 Outfield	30 Footcandles	2.5	86	
Tennis Courts 1 - 2	30 footcandles	3.0	30	20' x 20'
Tennis Courts 3 - 4	30 footcandles	3.0	30	20' x 20'
Football Field	50 footcandles	2.0	72	30' x 30'
Soccer Field 1	30 footcandles	3.0	96	30' x 30'
Soccer Field 2	30 footcandles	3.0	96	30' x 30'
Lacrosse Field	30 footcandles	3.0	55	30' x 30'
Practice Field	12 footcandles	NA	416	10' x 10'
Leary Baseball	50 footcandles	2.0	25	30' x 30'
	30 Footcandles	2.5	78	

2. Lighting Method #2 – Continuous Depreciating Light

- a. The lighting system shall use continuous lamp lumen depreciation which is recovered by relamping and cleaning lenses of the luminaires. Manufacturer shall provide computer models for initial illumination level and target illumination levels on the field over 25 years. The specified maximum Recoverable Light Loss Factor (RLLF) of .69 and maintenance/group relamping schedule shall be provided in accordance with recommendations in the Leukos Abstract Volume 6, Number 3, January 2010, page 183-201: "Light Loss Factors for Sports Lighting", and presented at the 2009 IESNA Annual Conference.

1500w Luminaire RLLF Requirements

Lamp Replacement Interval (hours)	Recoverable Light Loss Factor (RLLF)
2,100	.69

- b. Independent Test Report: If lamp replacement interval is greater than 3,000 hours for 1500 watt lamps, manufacturer shall supply an independent test report with lumen depreciation over proposed lamp life, initial lumens, and end of life lumens.
- c. Based on anticipated hours of usage (see table below), Method #2 systems would require a minimum of group lamp replacements (see table below) over the 25 years.

Area of Lighting	25 Year Usage Hours	25 Year Group Relamps Required
Baseball 1 Infield Baseball 1 Outfield	300	3
Baseball 2 Infield Baseball 2 Outfield	300	3
Tennis Courts 1 - 2	500	5
Tennis Courts 3 - 4	500	5
Football Field	200	2
Soccer Field 1	400	4
Soccer Field 2	400	4
Lacrosse Field	200	2
Practice Field	200	2
Leary Baseball	300	3

Area of Lighting	Average Initial Illumination Levels	Average Target Illumination Levels	Max to Min Uniformity Ratio	Grid Points	Grid Spacing
Baseball 1 Infield Baseball 1 Outfield	72.4 footcandles 43.4 footcandles	50 footcandles 30 Footcandles	2.0 2.5	25 98	30' x 30'
Baseball 2 Infield Baseball 2 Outfield	72.4 footcandles 43.4 footcandles	50 footcandles 30 Footcandles	2.0 2.5	25 86	30' x 30'
Tennis Courts 1 - 2	43.4 footcandles	30 footcandles	3.0	30	20' x 20'
Tennis Courts 3 - 4	43.4 footcandles	30 footcandles	3.0	30	20' x 20'
Football Field	72.4 footcandles	50 footcandles	2.0	72	30' x 30'
Soccer Field 1	43.4 footcandles	30 footcandles	3.0	96	30' x 30'
Soccer Field 2	43.4 footcandles	30 footcandles	3.0	96	30' x 30'

Lacrosse Field	43.4 footcandles	30 footcandles	3.0	55	30' x 30'
Practice Field	17.3 footcandles	12 footcandles	NA	416	10' x 10'
Leary Baseball	72.4 footcandles	50 footcandles	2.0	25	30' x 30'
	43.4 footcandles	30 Footcandles	2.5	78	

- d. Revised Electrical Distribution: Manufacturer shall provide revised electrical distribution plans to include changes to service entrance, panel, and wire sizing if increased power is required which exceeds specified design loads.

1.03 ENVIRONMENTAL LIGHT CONTROL

- A. Spill Light Control: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields.

1.04 LIFE CYCLE COSTS

- A. Manufacturer shall submit 25-year life cycle cost calculation as outlined in the required submittal information.

Lamp replacement schedule per charts below:

Lighting Method 1 Lamp Replacement	Lighting Method 2 Lamp Replacement
5,000 hour intervals	2,100 hour intervals

PART 2 – PRODUCT

2.01 SPORTS LIGHTING SYSTEM CONSTRUCTION

- A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, ballast and other enclosures shall be factory assembled, aimed, wired and tested.
- B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the crossarms, pole, or electrical components enclosure.
- C. System Description: Lighting system shall consist of the following:
1. Galvanized steel poles and cross-arm assemblies.
 2. Non-approved pole technology:

- a. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long term performance concerns.
 3. Pre-stressed concrete base embedded in concrete backfill allowed to cure for 12-24 hours before pole stress is applied. Alternate may be an anchor bolt foundation designed such that the steel pole and any exposed steel portion of the foundation is located a minimum of 18 inches above final grade. The concrete for anchor bolt foundations shall be allowed to cure for a minimum of 28 days before the pole stress is applied unless shorter cure time approved by structural engineer of record.
 4. All luminaires shall be constructed with a die-cast aluminum housing or external hail shroud to protect the luminaire reflector system.
 5. Manufacturer will remote all ballasts and supporting electrical equipment in aluminum enclosures mounted approximately 10 feet above grade. The enclosures shall be touch-safe and include ballast, capacitor and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure. Integral ballast fixtures will not be accepted.
 6. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
 7. All luminaires, visors, and crossarm assemblies shall withstand 150 mph winds and maintain luminaire aiming alignment
 8. Control cabinet to provide remote on-off control and monitoring of the lighting system. Cabinet shall be constructed of aluminum and be rated NEMA Type 4. Communication method shall be provided by manufacturer. Cabinet shall contain custom configured contactor modules for 30, 60, and 100 amps, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
 9. Lightning Protection: Manufacturer shall provide integrated lightning grounding via concrete encased electrode grounding system as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.
 10. Enhanced corrosion protection package: Due to the potentially corrosive environment for this project, manufacturers must provide documentation that their products meet the following enhanced requirements in addition to the standard durability protection specified above:
 - a) Exposed carbon steel horizontal surfaces on the crossarm assembly shall be galvanized to no less than a five (5) mil average thickness.
 - b) Exposed die cast aluminum components shall be Type II anodized per MIL-STD-8625 and coated with high performance polyester.
 - c) Exposed extruded aluminum components shall be Type II anodized per MIL-STD-8625 and coated with high performance polyester.
- D. Safety: All system components shall be UL listed for the appropriate application.

2.02 ELECTRICAL

A. Electric Power Requirements for the Sports Lighting Equipment:

1. Electric power: 480 Volt, 3 Phase
 2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.
- B. Energy Consumption: The average kW consumption for the field lighting system shall not exceed the following: 87.58 kW for Baseball Field 1, 70.38 kW for Baseball Field 2, 8.96 for Tennis Courts 1-2, 8.96 for Tennis Courts 3-4, 75.07 for Football Field, 56.3 for Soccer Field 1, 68.82 for Soccer Field 2, 70.38 for Lacrosse Field, 9.38 kW for Practice Field and 62.56 kW for Leary Baseball.
- C. Revised Electrical Distribution: Manufacturer shall provide, at their cost, revised electrical distribution plans to include changes to service entrance, panel, and wire sizing if using Lighting Method 2.

2.03 STRUCTURAL PARAMETERS

- A. Wind Loads: Wind loads shall be based on the 2009 International Building Code. Wind loads to be calculated using ASCE 7-05, a design wind speed of 100 mph, exposure category C, and wind importance factor of 1.0.
- B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2009 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-5).
- C. Foundation Design: The foundation design shall be based on soil parameters as outlined in the geotechnical report.
- D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

2.04 CONTROL SYSTEM

- A. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute "early off" commands by phone. Scheduling tool shall be capable of setting curfew limits.

Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

- B. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).
- C. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of lamp outages, control operation and service scheduling including relamping operations completed and scheduled. Mobile application will be provided suitable for IOS, Android and Blackberry devices.
 Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.
 - 1. Cumulative hours: shall be tracked to show the total hours used by the facility
 - 2. Current lamp hours: shall be tracked separately to reflect the amount of hours on the current set of lamps being used, so relamping can be scheduled accurately.
 - 3. Report hours saved by using early off and push buttons by users.
- D. Communication Costs: Manufacturer shall include communication costs for operating the controls and monitoring system for a period of 25 years.

PART 3 – EXECUTION

3.01 SOIL QUALITY CONTROL

- A. It shall be the Contractor's responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner's approval / payment for additional costs associated with:
 - 1. Providing engineered foundation embedment design by a registered engineer in the State of New Hampshire for soils other than specified soil conditions;
 - 2. Additional materials required to achieve alternate foundation;
 - 3. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

3.02 DELIVERY TIMING

- A. Delivery Timing Equipment On-Site: The equipment must be on-site 4 to 6 weeks from receipt of approved submittals and receipt of complete order information.

3.03 FIELD QUALITY CONTROL

- A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04. For Lighting Method 1, Timed Power Adjustment systems, light levels must be measured and exceed the specified target levels. For Lighting Method 2, light levels must be measured and meet the specified initial light levels.
- B. Field Light Level Accountability

1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25 Years.
 2. The contractor/manufacturer shall be responsible for an additional inspection one year from the date of commissioning of the lighting system and will utilize the owner's light meter in the presence of the owner.
 3. The contractor/manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities.
Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.
- C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including illumination levels, uniformity ratios, and maximum energy consumption do not conform to the requirements of the performance specifications and submitted information, the manufacturer shall be liable to any or all of the following:
1. Manufacturer shall at his expense provide and install any necessary additional luminaires to meet the minimum lighting standards. The Manufacturer shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.
 2. Manufacturer shall minimize the Owner's additional long term luminaire maintenance and energy consumption costs created by the additional luminaires by reimbursing the Owner the amount of \$1,000.00 (one thousand dollars) for each additional luminaire required.
 3. Manufacturer shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications

3.04 25-YEAR WARRANTY

- A. Each manufacturer shall supply a signed warranty covering the entire system for 25 years OR for the maximum hours of coverage based on the estimated annual usage, whichever occurs first. Warranty shall guarantee light levels will not fall below target maintained levels. A +/- 10% design/testing allowance will not be allowed. Warranty shall also cover: lamp replacements, system energy consumption, monitoring, maintenance and control services, spill light control, and structural integrity. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations.
- B. Group lamp replacements for Method 1 systems (Time Powered Adjustment) must occur at end of useful life of lamp as stated by manufacturer. Group lamp replacements for Method 2 systems (Continuous Depreciating Light) must relamp every 2,100 hours.
- C. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and lamp outage for 25 years from the date of equipment shipment. Individual lamp outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

PART 4 – DESIGN APPROVAL

4.01 PRE-BID SUBMITTAL REQUIREMENTS

- A. Design Approval: The owner / engineer will review pre-bid submittals per section 4.0.B from all the manufacturers to ensure compliance to the specification 10 days prior to bid. If the design meets the design requirements of the specifications, a letter and/or addendum will be issued to the manufacturer indicating approval for the specific design submitted.
- B. Listed Manufacturers:
 - 1. Method 1: Time Powered Adjustment Technology - Musco's Green Generation Lighting® sports lighting system is the listed "Lighting Method 1" product.
- C. All listed manufacturers shall submit the information at the end of this section at least 10 days prior to bid. An addendum will be issued prior to bid; listing approved lighting manufacturers and the design method to be used.
- D. Bidders are required to bid only products that have been approved by this specification or addendum by the owner or owner's representative. Bids received that do not utilize an approved system/design, will be rejected.

REQUIRED SUBMITTAL INFORMATION FOR ALL MANUFACTURERS 10 DAYS PRIOR TO BID

All items listed below are mandatory, shall comply with the specification and be submitted according to pre-bid submittal requirements. Complete the Yes/No column to indicate compliance (Y) or noncompliance (N) for each item.

Submit checklist below with submittal.

Submitting as:

Lighting Method 1

Lighting Method 2

Yes / No	Tab	Item	Description
	A	Letter/ Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	Equipment Layout	Drawing(s) showing field layouts with pole locations
	C	On Field Lighting Design	Lighting design drawing(s) showing: <ol style="list-style-type: none"> Field Name, date, file number, prepared by Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), Illuminance levels at grid spacing specified Pole height, number of fixtures per pole, as well as luminaire information including wattage, lumens and optics Height of light test meter above field surface. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance (CV), coefficient of utilization (CU) uniformity gradient; number of luminaires, total kilowatts, average tilt factor; light loss factor. Manufacturer's using Lighting Method 2 shall provide both initial and maintained light scans using a maximum recoverable right loss factor (RLLF) as specified in section 1.2.C.2 and shall be shown on lighting design.
	E	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed to not fall below target levels for warranty period.
	F	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of New Hampshire, if required by owner.
	G	Control & Monitoring System	Manufacturer of the control and monitoring system shall provide written definition and schematics for automated control system to include monitoring. They will also provide ten (10) references currently using proposed system in the state of New Hampshire.
	H	Electrical Distribution Plans	Manufacturer using Lighting Method 2 must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of New Hampshire.
	I	Warranty	Provide written warranty information including all terms and conditions. Provide ten (10) references of customers currently under specified warranty in the state of

			New Hampshire.
	J	Independent Testing Report	<p>a. Lighting Method 1 is to provide an independent test report certifying the system meets the lumen maintenance control strategy defined in Section 1.2.C.1.a, verifying the field performance of the system for the duration of the useful life of the lamp based on lamp replacement hours. Report shall be signed by a licensed professional engineer with outdoor lighting experience.</p> <p>b. If Manufacturer using Lighting Method 2 desires to provide a recoverable light loss factor other than specified in section 1.2.C.2, Independent field test report from licensed professional engineer will be required to substantiate the ability to maintain light levels in accordance with section 1.7-A of the specification. Both initial and maintained light scans must still be provided. Independent Engineer conducting the report must have no affiliation with the manufacturer and report must be based on actual testing data. Testing must be done on the system as a whole, not on individual components.</p>
	K	Project References	Manufacturer to provide a list of five (5) projects where the technology and specific fixture proposed for this project has been installed in the state of New Hampshire. Reference list will include project name, project city, installation date, and if requested, contact name and contact phone number. Manufacturer bidding Lighting Method 2 must supply independent test report if lamp life relamping projection is greater than 3000 hours.
	L	Product Information	Complete bill of material and current brochures/cut sheets for all product being provided.
	M	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications. If in full compliance, tab may be omitted.
	N	Life-cycle Cost Calculation	Document life-cycle cost calculations as defined in the specification. Identify energy costs for operating the luminaires. Maintenance cost for the system including spot lamp replacement and group relamping costs must be included in the warranty. All costs should be based on 25 Years. (complete table below)

			Lighting Method 1	Lighting Method 2
a.	Luminaire energy consumption: Football, Lacrosse, and Practice Field _____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 200 annual usage hours x 25 years			
b.	Luminaire energy consumption: Baseball Field 1 and 2 and Leary Baseball _____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 300 annual usage hours x 25 years			
c.	Luminaire energy consumption: Soccer Field 1 and 2 _____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 400 annual usage hours x 25 years			
d.	Luminaire energy consumption: Tennis Courts 1 thru 4 _____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 500 annual usage hours x 25 years			

	TOTAL 25 -Year Life-cycle Operating Cost	=		
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The information supplied herein shall be used for the purpose of complying with the specifications for Portsmouth High School. By signing below I agree that all requirements of the specifications have been met and that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in the Non-Compliance section.

Manufacturer: _____ **Signature:** _____

Contact Name: _____ **Date:** ____/____/____

Contractor: _____ **Signature:** _____

SECTION 16669

EXTERIOR ATHLETIC LIGHTING- PORTSMOUTH HIGH SCHOOL

PART 1 – GENERAL

1.01 SUMMARY

- A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.
- B. The purpose of these specifications is to define the performance and design standards for Portsmouth High School. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.
- C. The sports lighting will be for the following venues:
 - 1. Baseball Field 1
 - 2. Baseball Field 2
 - 3. Tennis Courts 1 – 2
 - 4. Tennis Courts 3 – 4
 - 5. Football Field
 - 6. Soccer Field 1
 - 7. Soccer Field 2
 - 8. Lacrosse Field
 - 9. Practice Field
- D. The primary goals of this sports lighting project are:
 - 1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore light levels are guaranteed to not drop below specified target values for a period of 25 years.
 - 2. Life-cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated.
 - 3. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Fields should be proactively monitored to detect luminaire outages over a 25-year life cycle. All communication and monitoring costs for 25-year period shall be included in the bid.
 - 4. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players and spectators.
- E. All lighting designs shall comply with all Portsmouth, New Hampshire lighting standards

1.02 LIGHTING PERFORMANCE

A. Performance Requirements: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Average illumination level shall be measured in accordance with the IESNA LM-5-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not to drop below desired target values in accordance to IES RP-6-01, Page 5, Maintained Average Illuminance and shall be guaranteed for the full warranty period. Hours of usage shall comply with the following:

Area of Lighting	Annual Usage Hours	25 Year Usage Hours
Baseball 1	300	10,000
Baseball 2	300	10,000
Tennis 1-2	500	12,500
Tennis 3 - 4	500	12,500
Football	200	5,000
Soccer 1	400	10,000
Soccer 2	400	10,000
Lacrosse	200	5,000
Practice Field	200	5,000

B. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be (see table below). Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

# of Poles	Pole Designation	Pole Height
7	T1, T2, T5, T6, P1, P2, P3	40'
2	T3, T4	50'
6	A1, A2, A3, A4, F1, F2	70'
13	B2, B3, B4, C2, C3, C4, F3, F4, S1, S2, S3, S6, S7	80'

C. Lighting Methodology: There are two methods that will be considered for calculation of the lighting designs for this project. The approved Lighting Method #1, automated timed power adjustments, as described in C.1 utilizes methodology that adjusts light levels through a series of programmed adjustments. The alternate Lighting Method #2, continuous depreciating light, as described in C.2 uses continuous lamp lumen depreciation which is recovered by relamping and cleaning lenses of the luminaires. Computer models shall reflect initial design lumens, end of life design lumens, recoverable light loss factor (RLLF), and the Coefficient Utilization (CU) for the design. Both methods must be at or above target illumination levels throughout the 25 years of

the contract/warranty provided by the manufacturer. A +/- 10% design/testing allowance is **not** permitted in the design logic.

1. Lighting Method #1: Automated Timed Power Adjustments:

- a. The lighting system shall use automated timed power adjustments to achieve a lumen maintenance control strategy as described in the IESNA Lighting Handbook 10th Edition, Lighting Controls Section page 16-8: "Lumen maintenance involves adjusting lamp output over time to maintain constant light output as lamps age and dirt accumulation reduces luminaire output. With lumen maintenance control, either lamps are dimmed when new, or the lamp's current is increased as the system ages."
- b. Manufacturers bidding an automated timed power adjustment system must provide an independent test report certifying the system meets the lumen maintenance control strategy above and verifying the field performance of the system for the duration of the useful life of the lamp based on lamp replacement hours. Report shall be signed by a licensed professional engineer with outdoor lighting experience. If report is not provided at least 10 days prior to bid opening, the manufacturer shall provide the initial and maintained designs called for in this specification under Lighting Method #2: Alternate Manufacturers, section 1.2.C.2.
- c. Project References: Manufacturers bidding any form of Automated Timed Power Adjustment light system must provide a minimum of five (5) project references within the state of New Hampshire that have been completed within the last 12 months utilizing this exact technology. Manufacturer will include project name, project city, and if requested, contact name and contact phone number for each reference.

Area of Lighting	Average Target Illumination Levels	Max to Min Uniformity Ratio	Grid Points	Grid Spacing
Baseball Infield	50 footcandles	2.0	25	30' x 30'
Baseball Outfield	30 Footcandles	2.5	98	
Baseball Infield	50 footcandles	2.0	25	30' x 30'
Baseball Outfield	30 Footcandles	2.5	86	
Tennis Courts 1 - 2	30 footcandles	3.0	30	20' x 20'
Tennis Courts 3 - 4	30 footcandles	3.0	30	20' x 20'
Football Field	50 footcandles	2.0	72	30' x 30'

Soccer Field 1	30 footcandles	3.0	96	30' x 30'
Soccer Field 2	30 footcandles	3.0	96	30' x 30'
Lacrosse Field	30 footcandles	3.0	55	30' x 30'
Practice Field	12 footcandles	NA	416	10' x 10'

2. Lighting Method #2 – Continuous Depreciating Light

- a. The lighting system shall use continuous lamp lumen depreciation which is recovered by relamping and cleaning lenses of the luminaires. Manufacturer shall provide computer models for initial illumination level and target illumination levels on the field over 25 years. The specified maximum Recoverable Light Loss Factor (RLLF) of .69 and maintenance/group relamping schedule shall be provided in accordance with recommendations in the Leukos Abstract Volume 6, Number 3, January 2010, page 183-201: “Light Loss Factors for Sports Lighting”, and presented at the 2009 IESNA Annual Conference.

1500w Luminaire RLLF Requirements

Lamp Replacement Interval (hours)	Recoverable Light Loss Factor (RLLF)
2,100	.69

- b. Independent Test Report: If lamp replacement interval is greater than 3,000 hours for 1500 watt lamps, manufacturer shall supply an independent test report with lumen depreciation over proposed lamp life, initial lumens, and end of life lumens.
- c. Based on anticipated hours of usage (see table below), Method #2 systems would require a minimum of group lamp replacements (see table below) over the 25 years.

Area of Lighting	25 Year Usage Hours	25 Year Group Relamps Required
Baseball 1 Infield	300	3
Baseball 1 Outfield		
Baseball 2 Infield	300	3
Baseball 2 Outfield		
Tennis Courts 1 - 2	500	5
Tennis Courts 3 - 4	500	5
Football Field	200	2
Soccer Field 1	400	4
Soccer Field 2	400	4
Lacrosse Field	200	2
Practice Field	200	2

Area of Lighting	Average Initial Illumination Levels	Average Target Illumination Levels	Max to Min Uniformity Ratio	Grid Points	Grid Spacing
Baseball 1 Infield Baseball 1 Outfield	72.4 footcandles 43.4 footcandles	50 footcandles 30 Footcandles	2.0 2.5	25 98	30' x 30'
Baseball 2 Infield Baseball 2 Outfield	72.4 footcandles 43.4 footcandles	50 footcandles 30 Footcandles	2.0 2.5	25 86	30' x 30'
Tennis Courts 1 - 2	43.4 footcandles	30 footcandles	3.0	30	20' x 20'
Tennis Courts 3 - 4	43.4 footcandles	30 footcandles	3.0	30	20' x 20'
Football Field	72.4 footcandles	50 footcandles	2.0	72	30' x 30'
Soccer Field 1	43.4 footcandles	30 footcandles	3.0	96	30' x 30'
Soccer Field 2	43.4 footcandles	30 footcandles	3.0	96	30' x 30'
Lacrosse Field	43.4 footcandles	30 footcandles	3.0	55	30' x 30'
Practice Field	17.3 footcandles	12 footcandles	NA	416	10' x 10'

- d. Revised Electrical Distribution: Manufacturer shall provide revised electrical distribution plans to include changes to service entrance, panel, and wire sizing if increased power is required which exceeds specified design loads.

1.03 ENVIRONMENTAL LIGHT CONTROL

- A. Spill Light Control: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields.

1.04 LIFE CYCLE COSTS

- A. Manufacturer shall submit 25-year life cycle cost calculation as outlined in the required submittal information.

Lamp replacement schedule per charts below:

Lighting Method 1 Lamp Replacement	Lighting Method 2 Lamp Replacement
5,000 hour intervals	2,100 hour intervals

PART 2 – PRODUCT

2.01 SPORTS LIGHTING SYSTEM CONSTRUCTION

- A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, ballast and other enclosures shall be factory assembled, aimed, wired and tested.
- B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the crossarms, pole, or electrical components enclosure.
- C. System Description: Lighting system shall consist of the following:
 - 1. Galvanized steel poles and cross-arm assemblies.
 - 2. Non-approved pole technology:
 - a. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long term performance concerns.
 - 3. Pre-stressed concrete base embedded in concrete backfill allowed to cure for 12-24 hours before pole stress is applied. Alternate may be an anchor bolt foundation designed such that the steel pole and any exposed steel portion of the foundation is located a minimum of 18 inches above final grade. The concrete for anchor bolt foundations shall be allowed to cure for a minimum of 28 days before the pole stress is applied unless shorter cure time approved by structural engineer of record.
 - 4. All luminaires shall be constructed with a die-cast aluminum housing or external hail shroud to protect the luminaire reflector system.
 - 5. Manufacturer will remote all ballasts and supporting electrical equipment in aluminum enclosures mounted approximately 10 feet above grade. The enclosures shall be touch-safe and include ballast, capacitor and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure. Integral ballast fixtures will not be accepted.
 - 6. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.

7. All luminaires, visors, and crossarm assemblies shall withstand 150 mph winds and maintain luminaire aiming alignment
 8. Control cabinet to provide remote on-off control and monitoring of the lighting system. Cabinet shall be constructed of aluminum and be rated NEMA Type 4. Communication method shall be provided by manufacturer. Cabinet shall contain custom configured contactor modules for 30, 60, and 100 amps, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
 9. Lightning Protection: Manufacturer shall provide integrated lightning grounding via concrete encased electrode grounding system as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.
 10. Enhanced corrosion protection package: Due to the potentially corrosive environment for this project, manufacturers must provide documentation that their products meet the following enhanced requirements in addition to the standard durability protection specified above:
 - a. Exposed carbon steel horizontal surfaces on the crossarm assembly shall be galvanized to no less than a five (5) mil average thickness.
 - b. Exposed die cast aluminum components shall be Type II anodized per MIL-STD-8625 and coated with high performance polyester.
 - c. Exposed extruded aluminum components shall be Type II anodized per MIL-STD-8625 and coated with high performance polyester.
- D. Safety: All system components shall be UL listed for the appropriate application.

2.02 ELECTRICAL

- A. Electric Power Requirements for the Sports Lighting Equipment:
1. Electric power: 480 Volt, 3 Phase
 2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.
- B. Energy Consumption: The average kW consumption for the field lighting system shall not exceed the following: 87.58 kW for Baseball Field 1, 70.38 kW for Baseball Field 2, 8.96 for Tennis Courts 1-2, 8.96 for Tennis Courts 3-4, 75.07 for Football Field, 56.3 for Soccer Field 1, 68.82 for Soccer Field 2, 70.38 for Lacrosse Field, and 9.38 kW for Practice Field.

- C. Revised Electrical Distribution: Manufacturer shall provide, at their cost, revised electrical distribution plans to include changes to service entrance, panel, and wire sizing if using Lighting Method 2.

2.03 STRUCTURAL PARAMETERS

- A. Wind Loads: Wind loads shall be based on the 2009 International Building Code. Wind loads to be calculated using ASCE 7-05, a design wind speed of 100 mph, exposure category C, and wind importance factor of 1.0.
- B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2009 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-5).
- C. Foundation Design: The foundation design shall be based on soil parameters as outlined in the geotechnical report.
- D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

2.04 CONTROL SYSTEM

- A. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.
- B. The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute “early off” commands by phone. Scheduling tool shall be capable of setting curfew limits.
- C. Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.
- D. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).
- E. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of lamp outages, control operation and service scheduling including relamping operations completed and scheduled. Mobile application will be provided suitable for IOS, Android and Blackberry devices.

Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.

1. Cumulative hours: shall be tracked to show the total hours used by the facility
 2. Current lamp hours: shall be tracked separately to reflect the amount of hours on the current set of lamps being used, so relamping can be scheduled accurately.
 3. Report hours saved by using early off and push buttons by users.
- F. Communication Costs: Manufacturer shall include communication costs for operating the controls and monitoring system for a period of 25 years.

PART 3 – EXECUTION

3.01 SOIL QUALITY CONTROL

- A. It shall be the Contractor's responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner's approval / payment for additional costs associated with:
1. Providing engineered foundation embedment design by a registered engineer in the State of New Hampshire for soils other than specified soil conditions;
 2. Additional materials required to achieve alternate foundation;
 3. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

3.02 DELIVERY TIMING

- A. Delivery Timing Equipment On-Site: The equipment must be on-site 4 to 6 weeks from receipt of approved submittals and receipt of complete order information.

3.03 FIELD QUALITY CONTROL

- A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04. For Lighting Method 1, Timed Power Adjustment systems, light levels must be measured and exceed the specified target levels. For Lighting Method 2, light levels must be measured and meet the specified initial light levels.
- B. Field Light Level Accountability
1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25 Years.
 2. The contractor/manufacturer shall be responsible for an additional inspection one year from the date of commissioning of the lighting system and will utilize the owner's light meter in the presence of the owner.

3. The contractor/manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.
- C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including illumination levels, uniformity ratios, and maximum energy consumption do not conform to the requirements of the performance specifications and submitted information, the manufacturer shall be liable to any or all of the following:
1. Manufacturer shall at his expense provide and install any necessary additional luminaires to meet the minimum lighting standards. The Manufacturer shall also either replace the existing poles to meet the new wind load (EPA) requirements or verify by certification by a licensed structural engineer that the existing poles will withstand the additional wind load.
 2. Manufacturer shall minimize the Owner's additional long term luminaire maintenance and energy consumption costs created by the additional luminaires by reimbursing the Owner the amount of \$1,000.00 (one thousand dollars) for each additional luminaire required.
 3. Manufacturer shall remove the entire unacceptable lighting system and install a new lighting system to meet the specifications

3.04 25-YEAR WARRANTY

- A. Each manufacturer shall supply a signed warranty covering the entire system for 25 years OR for the maximum hours of coverage based on the estimated annual usage, whichever occurs first. Warranty shall guarantee light levels will not fall below target maintained levels. A +/- 10% design/testing allowance will not be allowed. Warranty shall also cover: lamp replacements, system energy consumption, monitoring, maintenance and control services, spill light control, and structural integrity. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty may exclude fuses, storm damage, vandalism, abuse and unauthorized repairs or alterations.
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	C	On Field Lighting Design	Lighting design drawing(s) showing: <ol style="list-style-type: none"> Field Name, date, file number, prepared by Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), Illuminance levels at grid spacing specified Pole height, number of fixtures per pole, as well as luminaire information including wattage, lumens and optics Height of light test meter above field surface. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance (CV), coefficient of utilization (CU) uniformity gradient; number of luminaries, total kilowatts, average tilt factor; light loss factor. Manufacturer's using Lighting Method 2 shall provide both initial and maintained light scans using a maximum recoverable right loss factor (RLLF) as specified in section 1.2.C.2 and shall be shown on lighting design.
	E	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed to not fall below target levels for warranty period.
	F	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of New Hampshire, if required by owner.
	G	Control & Monitoring System	Manufacturer of the control and monitoring system shall provide written definition and schematics for automated control system to include monitoring. They will also provide ten (10) references currently using proposed system in the state of New Hampshire.
	H	Electrical	Manufacturer using Lighting Method 2 must include a revised electrical distribution

		Distribution Plans	plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of NewHampshire.			
	I	Warranty	Provide written warranty information including all terms and conditions. Provide ten (10) references of customers currently under specified warranty in the state of New Hampshire.			
	J	Independent Testing Report	<p>a. Lighting Method 1 is to provide an independent test report certifying the system meets the lumen maintenance control strategy defined in Section 1.2.C.1.a, verifying the field performance of the system for the duration of the useful life of the lamp based on lamp replacement hours. Report shall be signed by a licensed professional engineer with outdoor lighting experience.</p> <p>b. If Manufacturer using Lighting Method 2 desires to provide a recoverable light loss factor other than specified in section 1.2.C.2, Independent field test report from licensed professional engineer will be required to substantiate the ability to maintain light levels in accordance with section 1.7-A of the specification. Both initial and maintained light scans must still be provided. Independent Engineer conducting the report must have no affiliation with the manufacturer and report must be based on actual testing data. Testing must be done on the system as a whole, not on individual components.</p>			
	K	Project References	Manufacturer to provide a list of five (5) projects where the technology and specific fixture proposed for this project has been installed in the state of New Hampshire. Reference list will include project name, project city, installation date, and if requested, contact name and contact phone number. Manufacturer bidding Lighting Method 2 must supply independent test report if lamp life relamping projection is greater than 3000 hours.			
	L	Product Information	Complete bill of material and current brochures/cut sheets for all product being provided.			
	M	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications. If in full compliance, tab may be omitted.			
	N	Life-cycle Cost Calculation	Document life-cycle cost calculations as defined in the specification. Identify energy costs for operating the luminaires. Maintenance cost for the system including spot lamp replacement and group relamping costs must be included in the warranty. All costs should be based on 25 Years. (complete table below)			
				Lighting Method 1	Lighting Method 2	
	a.	Luminaire energy consumption: Football, Lacrosse, and Practice Field				
		_____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 200 annual usage hours x 25 years				
	b.	Luminaire energy consumption: Baseball Field 1 and 2				
		_____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 300 annual usage hours x 25 years				

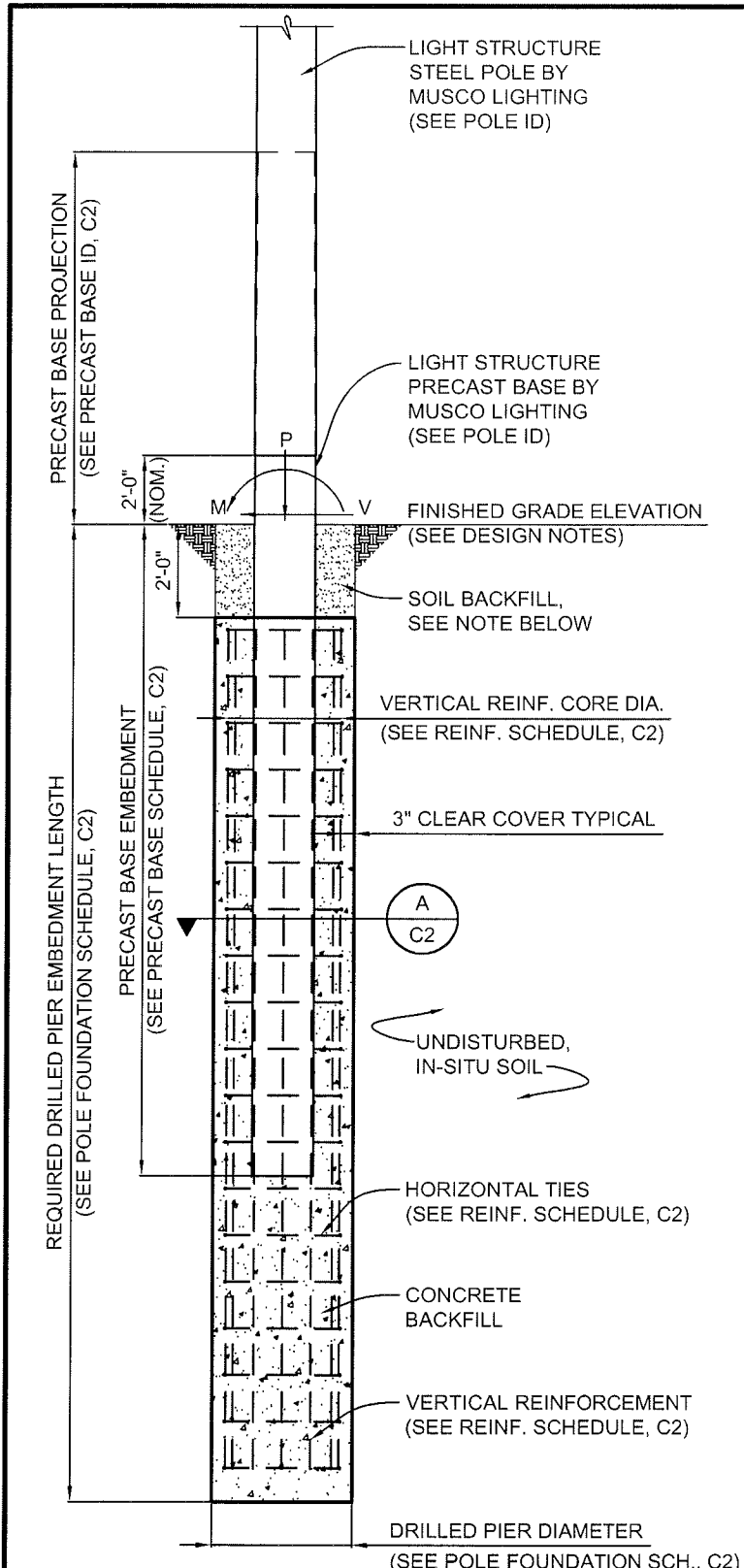
c.	Luminaire energy consumption: Soccer Field 1 and 2 _____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 400 annual usage hours x 25 years		
d.	Luminaire energy consumption: Tennis Courts 1 thru 4 _____ # of luminaires x _____ kW demand per luminaire x \$.16 kWh rate x 500 annual usage hours x 25 years		
	TOTAL 25 -Year Life-cycle Operating Cost	=	

The information supplied herein shall be used for the purpose of complying with the specifications for Portsmouth High School. By signing below I agree that all requirements of the specifications have been met and that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in the Non-Compliance section.

Manufacturer: _____ **Signature:** _____

Contact Name: _____ **Date:** ____/____/____

Contractor: _____ **Signature:**



TYP. POLE FOUNDATION ELEVATION

SCALE: NOT TO SCALE

SOIL BACKFILL NOTE:
 THE TOP TWO FEET OF ANNULUS SHALL BE BACKFILLED WITH SOIL, WITH A CLASSIFICATION OF CLASS 5 (TABLE 1806.2) OR BETTER. COMPACTION, 95% FOR COHESIVE SOIL AND 98% FOR A COHESIONLESS SOIL BASED UPON STANDARD PROCTOR TESTING (ASTM D698).

POLE IDENTIFICATION

POLE DESIGNATION	POLE TYPE	PRECAST BASE TYPE	FIXTURE CONFIGURATION (FIX. PER XARM)	FIXTURE AND ACCESSORIES EPA (FT ²)
A1	LSS80B	5B	8 (6)	18.2
A2	LSS80B	5B	8 (6)	17.6
B1, B2	LSS80B	5B	10 (4+4)	23.0
C1	LSS70C	4B	6 (6)	14.4
C2	LSS70C	4B	6 (6)	13.8
T1, T8	LSS60A	2B	5 (3)	7.7
T2, T7	LSS60A	2B	5 (3)	7.4
T3	LSS70C	4B	11 (6)	18.4
T4	LSS70C	4B	8 (6)	14.0

- POLES A1, A2, B1, & B2 EACH HAVE (2) MUSCO 24LED FIXTURES AT 50'-0" AGL INCL. ABOVE.
- POLES T1-T4, T7, & T8 EACH HAVE (2) MUSCO 24LED FIXTURES AT 40'-0" AGL INCL. ABOVE.
- POLE T3 ALSO HAS (3) MUSCO 64LED FIXTURES AT 50'-0" AGL INCLUDED ABOVE.

CONCRETE/REINFORCEMENT NOTES

CONCRETE SHALL COMPLY WITH THE FOLLOWING ASTM STANDARDS: MIXTURE WITH ASTM C-94, PORTLAND CEMENT WITH ASTM C-150 TYPE 1-A, AGGREGATES WITH ASTM C-33 AND BE IN CONFORMANCE WITH ACI 318.

CONCRETE SHALL BE AIR-ENTRAINED (COMPLY WITH ASTM C-260), HAVE A MAXIMUM WATER-CEMENT RATIO, w/cm = 0.43 AND HAVE A MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS OF 4,000 PSI.

DESIGN SLUMP LIMITS ARE 4" MINIMUM AND 6" MAXIMUM. THE JOB SITE SLUMP MAY BE INCREASED BY THE USE OF A WATER REDUCING AGENT MEETING ASTM C494-92.

CONCRETE REINFORCEMENT SHALL COMPLY WITH ASTM A615 GRADE 60, EXCEPT TIES CAN BE OF GRADE 40 AND BE IN CONFORMANCE WITH ACI 315 & 318.

CONCRETE DRILLED PIERS MUST ATTAIN 3,000 PSI STRENGTH PRIOR TO POLE INSTALLATION AND FIXTURE MOUNTING.

THE DEPTH EQUAL TO THE PRECAST BASE EMBEDMENT SHALL BE THOROUGHLY CONSOLIDATED BY MECHANICAL VIBRATION DURING PLACEMENT.

INSTALLATION NOTE (DOES NOT APPLY TO T1 & T7):
 CONCRETE TO BE PLACED IN A CONTINUOUS POUR OR A COLD JOINT WILL BE ACCEPTABLE AT THE BOTTOM OF THE PRECAST BASE. TWO POUR: WITH THE REINFORCEMENT IN PLACE, THE CONCRETE BELOW THE BOTTOM OF THE PRECAST BASE MAY BE POURED AND ALLOWED TO SET UP FOR APPROXIMATELY FOUR HOURS (CURE LONG ENOUGH TO SUPPORT WEIGHT OF PRECAST BASE). THEN THE PRECAST BASE MAY BE SET IN PLACE AND THE REST OF THE CONCRETE CONCRETE BACKFILL POURED.

DESIGN NOTES

DESIGN PARAMETERS:
 WIND: 100 MPH (EXP. C, I = 1.0) PER IBC CODE, 2009 EDITION (ASCE 7-05). DESIGN WIND PARAMETERS ARE NOTED. ACTUAL WIND SPEED AND EXPOSURE MUST BE VERIFIED FOR THE SITE BY THE PROPER GOVERNING OFFICIAL.

GEOTECHNICAL PARAMETERS:
 ALLOWABLE END BEARING SOIL PRESSURE: 2,500 PSF
 ALLOWABLE LATERAL SOIL BEARING PRESSURE: 0 PSF/FT (GRADE TO -2'-0"); VARIABLE (BELOW -2'-0")
 IN ACCORDANCE WITH THE 2009 EDITION OF THE INTERNATIONAL BUILDING CODE, CHAPTER 18.

DESIGN SOIL PARAMETERS ARE AS NOTED. ACTUAL ALLOWABLE SOIL PARAMETERS MUST BE VERIFIED ON SITE. REFERENCE GEOTECHNICAL ENGINEERING REPORT, PROJECT NO. 2140758, PREPARED BY WESTON & SAMPSON; PEABODY, MA.

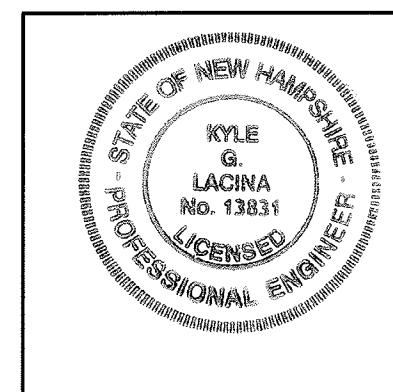
A GEOTECHNICAL ENGINEER OR REPRESENTATIVE OF IS RECOMMENDED (NOT REQUIRED) TO BE AVAILABLE AT THE TIME OF THE FOUNDATION INSTALLATION TO VERIFY THE SOIL DESIGN PARAMETERS AND TO PROVIDE ASSISTANCE IF ANY PROBLEMS ARISE IN FOUNDATION INSTALLATION.

ENCOUNTERING SOIL FORMATIONS THAT WILL REQUIRE SPECIAL DESIGN CONSIDERATIONS OR EXCAVATION PROCEDURES MAY OCCUR. POLE FOUNDATIONS WILL NEED TO BE ANALYZED ACCORDING TO THE SOIL CONDITIONS THAT EXIST. IF ANY DISCREPANCIES OR INCONSISTENCIES ARISE, NOTIFY THE ENGINEER OF SUCH DISCREPANCIES. FOUNDATIONS WILL THEN BE REVISED ACCORDINGLY. REVISIONS WILL BE ANALYZED PER RECOMMENDATIONS DIRECTED BY A LICENSED ENGINEER.

ALL EXCAVATIONS MUST BE FREE OF LOOSE SOIL AND DEBRIS PRIOR TO FOUNDATION INSTALLATION AND CONCRETE BACKFILL PLACEMENT. TEMPORARY CASINGS OR DRILLERS SLURRY MAY BE USED TO STABILIZE THE EXCAVATION DURING INSTALLATION. CASINGS MUST BE REMOVED DURING CONCRETE BACKFILL PLACEMENT. CONCRETE BACKFILL MUST BE PLACED WITH A TREMIE WHEN SLURRY OR WATER IS PRESENT WITHIN THE EXCAVATION OR WHEN THE FREE DROP EXCEEDS 6'-0".

CONTRACTOR MUST BE FAMILIAR WITH THE COMPLETE SOIL INVESTIGATION REPORT AND BORINGS, AND CONTACT THE GEOTECHNICAL FIRM (IF NECESSARY) TO UNDERSTAND THE SOIL CONDITIONS AND THE POSSIBILITY OF GROUND WATER PUMPING AND EXCAVATION STABILIZATION OR BRACING DURING PRECAST BASE INSTALLATION AND PLACEMENT OF CONCRETE BACKFILL.

GENERAL NOTES:
 FIXTURES MUST BE LOCATED TO MAINTAIN 10'-0" MINIMUM HORIZONTAL CLEARANCE FROM ANY OBSTRUCTION. ENGINEER MUST BE NOTIFIED IF FOUNDATIONS ARE NEAR ANY RETAINING WALLS OR WITHIN / NEAR ANY SLOPES STEEPER THAN 3H : 1V. POLES, FIXTURES, PRECAST BASES, ELECTRICAL ITEMS AND INSTALLATION PER MUSCO LIGHTING.



I HEREBY CERTIFY THAT THIS ENGINEERING DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT PERSONAL SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF NEW HAMPSHIRE.

Kyle G. Lacina 7-31-2015
 KYLE G. LACINA - NO. 13831 DATE:
 SEPC OF IOWA - 1427

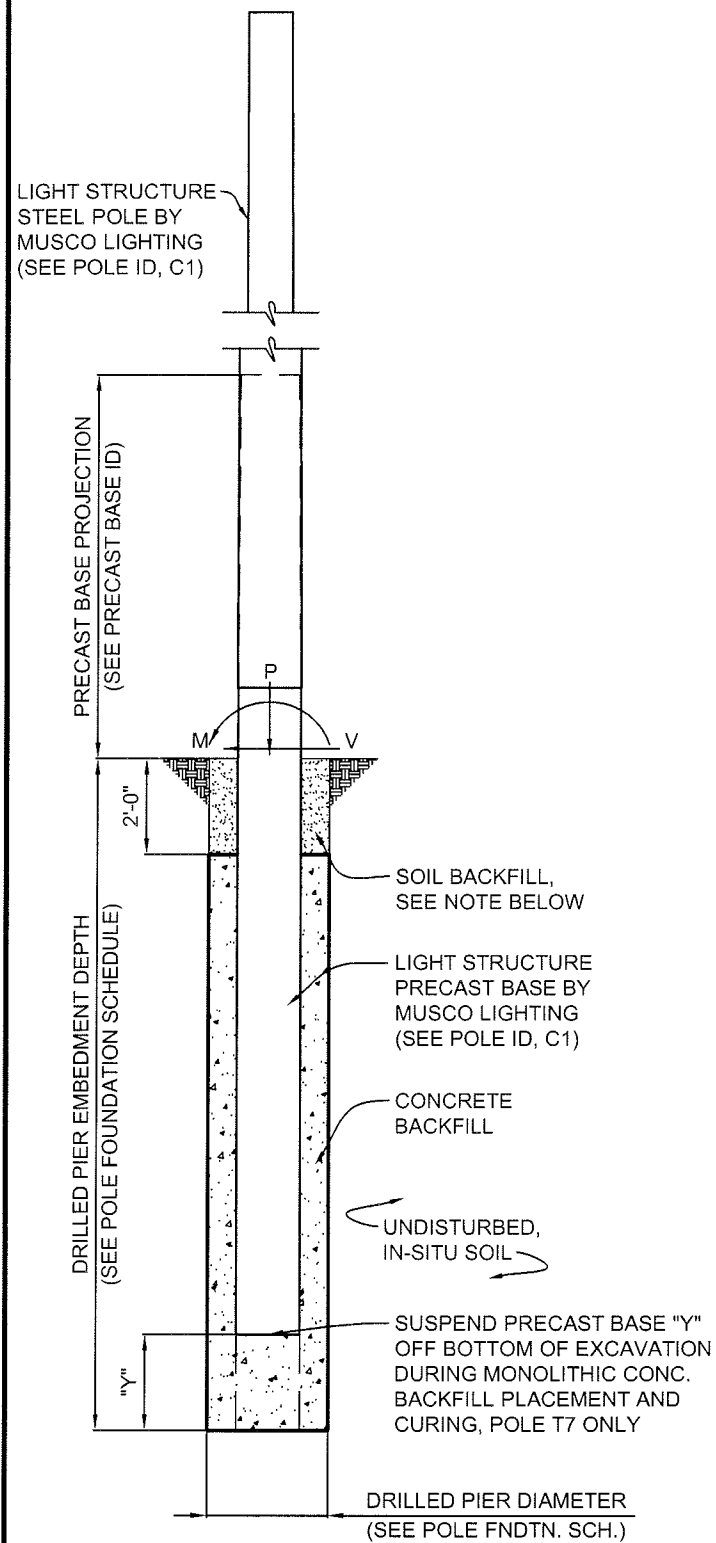
LICENSE RENEWAL DATE: NOVEMBER 30, 2015
 DRAWING NO. COVERED BY THIS SEAL: C1, C2

LEARY
 FIELD
 LIGHTING
 PORTSMOUTH, NH



SEPC OF IOWA
 114 NICHOLAS DRIVE
 MARSHALLTOWN, IOWA 50158
 PHONE NUMBER: 641-752-6334
 EMAIL: MSL.INFO@SEPC.BIZ

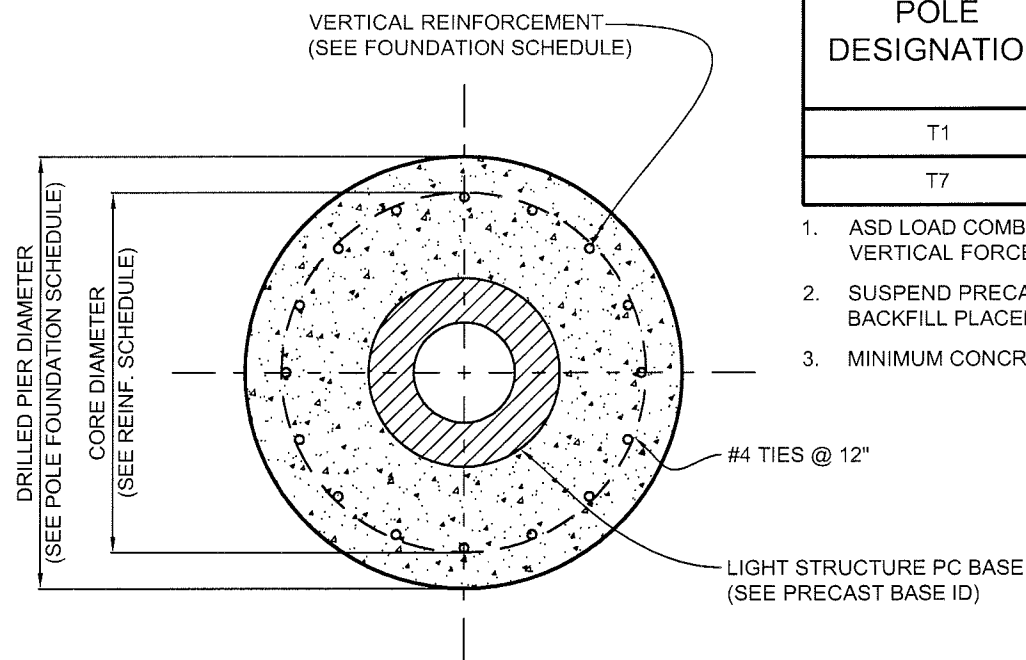
DRAWING TITLE: POLE AND FOUNDATION	PROJECT NUMBER 160813
SCALE: SEE PLAN	DATE 31 JULY 2015
NOTES: SCAN #160813C	DRAWING NUMBER C1
OF TWO	



**POLES T1 & T7
FOUNDATION ELEVATION**

SCALE: NOT TO SCALE

SOIL BACKFILL NOTE:
THE TOP TWO FEET OF ANNULUS SHALL BE BACKFILLED WITH SOIL, WITH A CLASSIFICATION OF CLASS 5 (TABLE 1806.2) OR BETTER. COMPACTION, 95% FOR COHESIVE SOIL AND 98% FOR A COHESIONLESS SOIL BASED UPON STANDARD PROCTOR TESTING (ASTM D698).



A PIER DETAIL
SCALE: NOT TO SCALE

TYP. POLE FOUNDATION SCHEDULE									
POLE DESIGNATION	FORCES (1.)			DRILLED PIER			REINFORCING		
	MOMENT (M) FT-LBS	SHEAR (V) LBS	VERTICAL (P) LBS	DIAMETER INCHES	EMBEDMENT DEPTH (4.)	CONCRETE BACKFILL YD ³ (2.)	CORE DIAMETER INCH (3.)	VERTICAL REINFORCING	HORIZONTAL TIES
A1	109,993	2,215	3,192	42	36'-0"	11.2	35	16 - #6	#4 @ 12"
A2	108,495	2,197	3,192	42	21'-0"	5.9	35	16 - #6	#4 @ 12"
B1	122,605	2,384	3,372	42	31'-0"	9.4	35	16 - #6	#4 @ 12"
B2	122,605	2,384	3,372	42	21'-0"	5.9	35	16 - #6	#4 @ 12"
C1	74,843	1,675	2,097	36	23'-0"	4.9	29	12 - #6	#4 @ 12"
C2	73,529	1,657	2,097	36	20'-0"	4.2	29	12 - #6	#4 @ 12"
T2	38,620	1,036	1,249	36	24'-0"	5.6	29	12 - #6	#4 @ 12"
T3	79,222	1,782	2,422	36	24'-0"	5.2	29	12 - #6	#4 @ 12"
T4	72,526	1,659	2,257	36	21'-0"	4.4	29	12 - #6	#4 @ 12"
T8	39,159	1,045	1,249	36	20'-0"	4.5	29	12 - #6	#4 @ 12"

- ASD LOAD COMBINATION D+W. VERTICAL FORCE IS WEIGHT OF DRESSED POLE (DOES NOT INCLUDE PRECAST BASE WEIGHT).
- MINIMUM CONCRETE BACKFILL VOLUME, SITE CONDITIONS MAY REQUIRE ADDITIONAL BACKFILL.
- CORE DIAMETER EQUAL TO INSIDE DIAMETER OF TIES.
- PIER MUST PENETRATE AT LEAST 2' BEYOND SOFT CLAY INTO MEDIUM DENSE SAND (OR BETTER) - SEE SOIL REPORT. IN NO CASE SHALL EMBEDMENT BE LESS THAN GIVEN. AUGERING INTO ROCK MAY BE REQUIRED.

POLES T1 & T7 FOUNDATION SCHEDULE							
POLE DESIGNATION	FORCES (1.)			DRILLED PIER			
	MOMENT (M) FT-LBS	SHEAR (V) LBS	VERTICAL (P) LBS	DIAMETER INCHES	EMBEDMENT DEPTH	SUSPENSION "Y" (2.)	CONCRETE BACKFILL YD ³ (3.)
T1	39,159	1,045	1,249	42	10'-0"	NA	2.7
T7	38,620	1,036	1,249	42	12'-0"	2'-0"	3.4

- ASD LOAD COMBINATION D+W. VERTICAL FORCE IS WEIGHT OF DRESSED POLE (DOES NOT INCLUDE PRECAST BASE WEIGHT).
- SUSPEND PRECAST BASE "Y" OFF THE BOTTOM OF THE EXCAVATION DURING MONOLITHIC CONCRETE BACKFILL PLACEMENT AND CURING. NA = NOT APPLICABLE, SUSPENSION NOT REQUIRED.
- MINIMUM CONCRETE BACKFILL VOLUME, SITE CONDITIONS MAY REQUIRE ADDITIONAL BACKFILL.

PRECAST BASE IDENTIFICATION					
PRECAST BASE TYPE	PRECAST BASE WEIGHT	PRECAST BASE LENGTH	PROJECTION ABOVE GRADE	STANDARD EMBEDMENT	OUTSIDE DIAMETER
2B	1,690 LBS	17'-3"	7'-3"	10'-0"	12.00"
4B	3,490 LBS	22'-0"	8'-0"	14'-0"	15.75"
5B	4,580 LBS	23'-11"	7'-11"	16'-0"	18.25"

REFERENCE POLE ID TABLE ON SHEET C1 FOR POLE TO PRECAST BASE TYPES

LEARY
FIELD
LIGHTING
PORTSMOUTH, NH

MUSCO
Lighting
CORPORATE: 100 1ST AVE WEST
OSKALOOSA, IA 52577
(800) 825-6020

SEPC OF IOWA
114 NICHOLAS DRIVE
MARSHALLTOWN, IOWA 50158
PHONE NUMBER: 641-752-6334
EMAIL: MSL.INFO@SEPC.BIZ

DRAWING TITLE:
POLE AND FOUNDATION
SCALE: SEE PLAN
NOTES:
SCAN #160813C

PROJECT NUMBER
160813

DATE
31 JULY 2015

DRAWING NUMBER
C2

OF TWO