

THE SCHOOL DISTRICT OF PHILADELPHIA  
BOARD OF EDUCATION  
Office of Capital Programs  
440 North Broad Street, 3<sup>rd</sup> Floor – Suite 371  
Philadelphia, PA 19130

TELEPHONE: (215) 400-4730

**Addendum No. 001**

**Subject: Rhawnhurst Elementary School- Additions and Renovations  
SDP Contracts No. B-070, B-071, B-072 and B-073 of 2019/20**

**Location: Rhanwhurst Elementary School  
7809 Castor Avenue  
Philadelphia, Pennsylvania 19152**

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**This Addendum, dated March 15, 2021, shall modify and become part of the Contract Documents for the work of this project. Any items not mentioned herein, or affected by, shall be performed strictly in accordance with the original documents.**

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**GENERAL INFORMATION**

**Per the Invitation to Bid and Instructions to Bidders, the following procedure is in effect for Bidder Questions or RFI's:**

**NOTE: All inquiries (RFIs) regarding the Drawings and Specifications must be submitted in writing to capitalbids@philasd.org no later than Ten (10) Calendar Days prior to the scheduled Bid Opening Date.**

**Oral requests are not acceptable and will not be answered.**

**All bidder inquiries will be answered by addendum.**

**All bidder inquiries must be submitted NO LESS THAN TEN (10) DAYS PRIOR TO THE SCHEDULED BID OPENING DATE.**

**DIVISION 0-1 SPECIFICATIONS**

**SECTION 001735 UNDERGROUND STORAGE TANK REMOVAL**

- 1. ADD Section 001735 – Underground Storage Tank removal in its entirety that is attached to Addendum #1. General Contractor is responsible for removal of 12,000 gallon Underground Storage Tank (UST) in its entirety including miscellaneous piping and associated components to the building, removal of an estimated 400 tons of contaminated soil/fill on a unit price basis and replacement with engineered fill as specified to the building. At the building where piping enters the building the mechanical & plumbing contractors shall be responsible to cap lines and continue demolition within the building as indicated on their drawings.**

**SECTION 011000 SUMMARY OF WORK**

2. **ADD** Paragraph 1.4.C.1.a.24 to the Scope of Work for the General Contractor as follows:
  - a. "24) General Contractor is responsible for removal of 12,000 gallon Underground Storage Tank (UST) in its entirety including miscellaneous piping and associated components to the building, removal of an estimated 400 tons of contaminated soil/fill on a unit price basis and replacement with engineered fill as specified to the building. At the building where piping enters the building the mechanical & plumbing contractors shall be responsible to cap lines and continue demolition within the building as indicated on their drawings.

## **CIVIL SPECIFICATIONS**

### **SECTION 310000 - EARTHWORK**

1. **REPLACE** SPECIFICATION SECTION 310000 in its entirety as part of Addendum #1.

### **SECTION 315000 - EXCAVATION**

1. **REPLACE** SPECIFICATION SECTION 315000 in its entirety as part of Addendum #1.

### **SECTION 321613 – SITE CAST-IN-PLACE CONCRETE**

1. **REPLACE** SPECIFICATION SECTION 321613 in its entirety as part of Addendum #1.

### **SECTION 334001 – SOIL PROPOERTIES INVESTIGATION**

1. **REPLACE** SPECIFICATION SECTION 334001 in its entirety as part of Addendum #1.

### **SECTION 334004 – SURFACE STROMWATER MANAGEMENT BASINS**

1. **REPLACE** SPECIFICATION SECTION 334004 in its entirety as part of Addendum #1.

### **SECTION 334007 – STORMWATER CONTROL STRUCTURES**

1. **REPLACE** SPECIFICATION SECTION 334007 in its entirety as part of Addendum #1.

### **SECTION 334726 – SUBSURFACE STORMWATER STORAGE**

1. **REPLACE** SPECIFICATION SECTION 334726 in its entirety as part of Addendum #1.

## **ARCHITECTURAL SPECIFICATIONS**

### **SECTION 070800 – COMMISSIONING OF BUILDING ENCLOSURE**

1. **REPLACE** SPECIFICATION SECTION 070800 in its entirety as part of Addendum #1.

## **PLUMBING SPECIFICATIONS**

### **SECTION 220800 – COMMISSIONING OF PLUMBING**

1. **REPLACE** SPECIFICATION SECTION 220800 in its entirety as part of Addendum #1.

## **MECHANICAL SPECIFICATIONS**

### **SECTION 230800 – COMMISSIONING OF HVAC**

1. **REPLACE** SPECIFICATION SECTION 230800 in its entirety as part of Addendum #1.

### **SECTION 230990 – TESTING, ADJUSTING AND BALANCING**

1. **REPLACE** SPECIFICATION SECTION 230990 in its entirety as part of Addendum #1.

## **ELECTRICAL SPECIFICATIONS**

### **SECTION 260800 – COMMISSIONING OF ELECTRICAL**

1. **REPLACE** SPECIFICATION SECTION 260800 in its entirety as part of Addendum #1.

## **SECTION 265200 – LUMINAIRE SCHEDULE**

1. **DELETE** General Note G3.

## **CIVIL DRAWINGS**

### **DRAWING C200 DEMOLITION PLAN**

1. CLARIFICATION UNDERGROUND STORAGE TANK (UST) to be removed can be found at the Southwest end of the building, directly across the access drive from the end of the classroom building
2. **ADD** The following sentences to the note reading “EX. OIL TANK (TO BE REMOVED)” as follows “General Contractor is responsible for removal of 12,000 gallon Underground Storage Tank (UST) in its entirety including miscellaneous piping and associated components to the building, removal of an estimated 400 tons of contaminated soil/fill on a unit price basis and replacement with engineered fill as specified to the building. At the building where piping enters the building the mechanical & plumbing contractors shall be responsible to cap lines and continue demolition within the building as indicated on their drawings.”

## **LANDSCAPE DRAWINGS**

### **DRAWING L1.2 – OVERALL LANDSCAPE PLAN/ NO SMOKING SIGNAGE**

1. **REPLACE** L1.2 In its entirety. Changes have been made to provide tags to the dumpster enclosure that is further detailed on L1.3

### **DRAWING L1.3 – LANDSCAPE PLANTING PLAN**

1. **REPLACE** L1.3 In its entirety. Changes have been made to detail the dumpster enclosure.

## **ARCHITECTURAL DRAWINGS**

### **DRAWING EX.M2 – EXISTING UNDERGROUND STORAGE TANK (UST)**

1. **ADD** EX. M2 UNDERGROUND STORAGE TANK DRAWING for information purposes only. M2 shows details of 12,000 gallon Underground Storage Tank (UST) and associated components installed in 1987/1988 that is to be removed to the existing building by the general contractor as part of this project.

### **DRAWING PH.2 BUILDING PHASING PLAN**

1. **ADD** The following note to PH.2 BUILDING PHASING PLAN as follows: “Asbestos abatement of Asbestos Containing Tile (ACT) floors and removal of ceilings shall occur summer 2021 from Notice to Proceed (NTP), anticipated to be June 15, 2021 and be complete August 6, 2021 to allow staff time to prepare for start of school year.

## **MECHANICAL DRAWINGS**

### **DRAWING M1.0 – BASEMENT UNITS “A” & “B” HVAC DEMOLITION**

1. **REPLACE.** Replace Drawing M1.0 in its entirety as part of Addendum #1.

## **BIDDER QUESTIONS SUBMITTED TO DATE & RESPONSES ARE AS FOLLOWS:**

1. There is a dumpster enclosure called out on the site drawing and it says see the Architectural drawings? But no detail on what material is being used.

**Answer:** L1.2 and L1.3 have been reissued to show the plan of the dumpster enclosure on the site and detailing including ground face masonry with a precast cap and chain link fencing and gates.

## **ATTACHMENTS**

*This Addendum includes the following attachments:*

### **Project Specifications**

SECTION 001735 – UNDERGROUND STORAGE TANK REMOVAL

### **Civil Specifications**

SECTION 330000 – EARTHWORK

SECTION 315000 – EXCAVATION

SECTION 321613 – SITE CAST-IN-PLACE CONCRETE

SECTION 334001 – SOIL PROPERTIES INVESTIGATION

SECTION 334004 – SURFACE STORMWATER MANAGEMENT BASINS

SECTION 334007 – STORMWATER CONTROL STRUCTURES

SECTION 334726 – SUBSURFACE STORMWATER STORAGE

### **Architectural Specifications**

SECTION 070800 – COMMISSIONING OF BUILDING ENVELOPE

### **PLUMBING Specifications**

SECTION 220800 – COMMISSIONING OF PLUMBING

### **Mechanical Specifications**

SECTION 230800 – COMMISSIONING OF HVAC

SECTION 230990 – TESTING, ADJUSTING AND BALANCING

### **Electrical Specifications**

SECTION 260800 – COMMISSIONING OF ELECTRICAL

### **Landscape Drawings:**

DRAWING L1.2 OVERALL LANDSCAPE PLAN/ NO SMOKING SIGNAGE

DRAWING L1.3 LANDSCAPE PLANTING PLAN

### **Existing Drawings:**

DRAWING EX.M2 EXISTING UNDERGROUND STORAGE TANK (FOR INFORMATION PURPOSES ONLY)

### **Mechanical Drawings**

DRAWING M1.0 BASEMENT UNITS “A” & “B” HVAC DEMOLITION

**END OF ADDENDUM #001**

## **SECTION 001735 – UNDERGROUND STORAGE TANK REMOVAL**

### **INTRODUCTION**

**OWNER:** The School District of Philadelphia  
440 North Broad Street, 3<sup>rd</sup> Floor, Room 3053  
Philadelphia, Pennsylvania 19103

**PROJECT LOCATION:** Rhawnhurst Elementary School  
7809 Castor Avenue  
Philadelphia, PA 19152

Specifications presented herein are for the removal of one 12,000-gallon fuel oil underground storage tank (UST) and associated piping (Area of Work (AOW)). This specification is intended to augment requirements and specifications to remove the UST and related piping, pump, and control systems presented in the overall bid package for this project. The site is occupied by the Rhawnhurst Elementary School.

### **BACKGROUND:**

The project is the Rhawnhurst Elementary School and is located at 7809 Castor Avenue in the Rhawnhurst neighborhood of the City of Philadelphia. The building is developed with one two-story main school building and one single-story annex building on an approximate 330,921 square foot parcel of land. The 12,000-gallon heating oil UST is located in the driveway of the school approximately 15 feet to the south-west of the main school building.

The site is bordered by Castor Avenue and commercial properties; to the east and west by bounding residential properties; to the south by Large Street and more residential properties.

The surface elevation at the site is approximately 110 feet above National Geodetic Vertical Datum (NGVD). Surface drainage at the site is predominantly to the southeast

### **SUMMARY SCOPE OF WORK AND ENVIRONMENTAL CONSULTANT SERVICES:**

#### **Area of Work (12,000-Gallon Heating Oil UST)**

The existing 12,000-gallon heating oil UST will be removed, disposed of in accordance with the Pennsylvania Department of Environmental Protection (PADEP) guidelines. The Contractor shall furnish all labor, materials, equipment, and incidentals required to remove the heating oil UST, associated supply and return lines and pumps, remove and dispose of up to 400 tons of non-hazardous regulated soil/fill material at an off-site disposal facility (if necessary).

The Contractor shall comply with all requirements of disposal facility and shall include the all costs associated with disposal. The Contractor may be required by the disposal facility to collect samples of the excavated soil/fill material for chemical analyses.

An Environmental Consultant, designated by the Owner, shall perform the oversight of the tank decommissioning and removal, soil disposal and site restoration. The related services of the Environmental Consultant shall include, but not be limited to, collecting soil samples, submitting

soil samples for laboratory analyses, interpreting the results, and making recommendations regarding the extent of excavation. The Environmental Consultant will also ensure that all necessary notifications are made and permits (City and State) are obtained by the Contractor and that all required reporting and documentation is completed for the tank removal.

A shoring system shall be used during the UST removal. The Contractor shall retain services of a Pennsylvania-licensed Professional Engineer (PE) to design the shoring system.

The Contractor shall dewater the excavation, as needed. If potentially impacted surface and/or groundwater are encountered, the Contractor shall test the potentially impacted water to determine if the discharge to the combined sewer system is appropriate. City of Philadelphia Water Department requires a permit for such a discharge. If levels of contaminants preclude the water from being discharged to the combined sewer, the Contractor will be required to dispose of the water at a regulated facility.

**SPECIAL REQUIREMENT – SITE MEETING/WALK-THROUGH PRIOR TO CLOSE OUT:**

Prior to the issuance of authorization for payment, a site meeting/walk-through will be required for closeout. This post-construction walk-through will be attended by the officials of School District of Philadelphia, the School District Environmental Consultant, the Contractor and its superintendent, major subcontractors, manufacturers, suppliers and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the Work. The meeting will be conducted by the School District of Philadelphia or a designated representative.

During the walk-through, the following issues will be addressed:

- a. Project completion.
- b. Any issues encountered during construction activities.
- c. An itemized review of the specifications.
- d. Review of any field decisions or change orders.
- e. Final project inspection and generation of punch list.
- f. Review of School District UST Check List.
- g. Procedures for processing applications for payment.
- h. Product warranties.
- i. Operation of tank monitoring system.

**END OF INTRODUCTION**

## **UNDERGROUND STORAGE TANK (UST) REMOVAL**

### **PART I UST REMOVAL - GENERAL**

#### **1.1.01 SCOPE OF SERVICES**

A. The Contractor shall furnish all labor, materials, equipment, appurtenances and incidentals required for the following:

1. CALL BEFORE YOU DIG! At least 3 days prior to the planned start of excavation, the Contractor shall call Pennsylvania One Call at 800-242-1776 and provide the confirmation number to the School District of Philadelphia and the Environmental Consultant.
2. Prior to any excavation activities, install all erosion and control measures required for UST removal activities.
3. Remove and dispose of product, concrete, rinsate, and sludges from the existing heating oil UST.
4. Remove and dispose of concrete pad/paving.
5. Dispose off-site of up to 400 tons of excess soil and/or fill material (if necessary). The excess soil and/or fill material shall be disposed of in accordance with the PADEP Management of Fill Policy.
6. The Contractor shall be responsible for sampling to characterize all waste generated during the UST cleaning and removal activities. The sampling will assist the Contractor in determining proper disposal methods. Contractor shall meet all the sampling requirements of the disposal facility. Waste characterization sampling will be at the Contractors expense.
7. Remove and dispose of one 12,000-gallon heating oil UST and associated piping, pumps, valves and ancillary equipment.
8. Remove and dispose of concrete UST tie-down pads if encountered.

#### **1.1.02 RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

#### **1.1.03 RELATED SECTIONS**

A. All material and removal sections relating to site preparation, site restoration, and other related Work not specified herein are covered in the appropriate Sections.

#### **1.1.04 DEFINITIONS**

The following words, terms, and abbreviations when used in this document shall have the following meanings unless the context clearly indicates otherwise.

**BACKFILL MATERIAL:** Consists of select-load bearing certified clean fill material. PADEP requires proof that the backfill is clean; analytical documentation; and the bill of lading documenting the source of the backfill material.

**CITY:** City of Philadelphia.

**CLEAN FILL:** Defined in the Municipal and Residual Waste Regulations Guidance Documents as “uncontaminated, non-water soluble, inert solid, non-decomposable material used to level an area or bring the area to grade.” PADEP has developed clean fill levels for uncontaminated soils, rock, stone, gravel, unused brick and block, concrete, and used asphalt by establishing the maximum allowable chemical concentrations for both organic and inorganic chemicals. Use of fill material that does not meet PADEP’s criteria is restricted and requires PADEP’s approval for reuse.

**CONSTRUCTION DOCUMENTS:** Consist of the general and supplemental conditions, Specifications, drawings, and any addenda issued prior to bidding.

**CONTRACTING OFFICER:** An authorized representative of the School District of Philadelphia.

**CONTRACTOR:** The person, firm or corporation awarded a prime contract by the School District of Philadelphia to perform all the work defined in the Contract, or the qualified and licensed UST Removal Contractor Subcontractor engaged by the Prime Contractor to perform the work required by this section. The Contractor shall be licensed in the City of Philadelphia. The Contractor shall submit documents confirming such license with the bid document.

**DEBRIS:** Combustible and non-combustible wastes such as ashes, leaves, wood, and waste material resulting from construction or maintenance and repair work.

**DEWATERING:** The process of removing water from an excavation.

**DISCHARGE:** Any intentional or unintentional action or omission resulting in the releasing, spilling, leaking, pumping, pouring, emitting, emptying, or dumping of hazardous substance or petroleum products onto the surface or groundwater or onto lands from which it might flow or drain into said waters or into the air.

**DRAWINGS:** The Contract Drawings.

**ENGINEERED FILL:** Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

**ENGINEERING CONTROLS:** Any physical mechanism to contain or stabilize contamination or ensure the effectiveness of a remedial action. Engineering controls may include, without limitations, cap, covers, dikes, trenches, leachate collection systems, signs, fences, and physical access controls.

**ENVIRONMENTAL CONSULTANT:** Owner’s representative under the direction of the School District Office of Environmental Management and Services. See Project Environmental Consultant.

**EXCAVATION:** The removal of encountered material as required by this Specification.

**FILL MATERIAL:** Any material that has been placed in an area by earthwork activities.



**FURNISH:** The Contractor shall supply the item specified at the job site, unloaded, and secured against damage, vandalism or theft.

**GARBAGE:** Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

**HAZARDOUS CONTAMINATED MATERIAL:** Excavated materials are considered hazardous when the following criteria are met: 1) The material tests positive for the characteristics of a hazardous waste defined in Title 40 Code of Federal Regulations (CRF) Part 261 Subpart C (261.21-262.24); 2) The material is a listed waste as per 40 CFR Part 261 Subpart D (261.31-261.33); and 3) The material is a mixture of solid waste (non-hazardous) and one or more hazardous wastes listed in 40 CFR Part 261 Subpart D (261.31-261.33).

**INTERSTITIAL:** Refers to the space between primary and secondary containment of tank, as well as the containment of the sump and piping.

**LOAD-BEARING FILL:** Consists of inorganic and readily compactable borrow soils, inert rubble or rock fragments with a maximum 8-inch particle size with less than 20 percent passing a 200 sieve. The fill moisture content should be controlled to within five percent of optimum by wetting, aeration, or blending.

**LOADING:** The act of loading materials from the site to a truck.

**NON-HAZARDOUS IMPACTED MATERIAL:** Also referred to as Impacted Material and Impacted Soil Contains metals and/or petroleum hydrocarbon levels above PADEP's Statewide Health Standards. The material includes, but is not limited to, inert rubble, concrete, debris, fill material, rock fragments, and soil. The material does not contain chemical components or chemical compounds, based on analytical laboratory analyses, which would qualify the material as hazardous waste under Title 40 Code of Federal Regulations (CRF) Part 261 Subpart C (261.21-262.24) and Subpart D (261.31-261.33).

**OWNER:** The School District of Philadelphia.

**OILY WASTE:** Petroleum products and bituminous material.

**PADEP:** Pennsylvania Department of Environmental Protection.

**PENNDOT:** Pennsylvania Department of Transportation.

**PERSONNEL DECONTAMINATION AREA:** A wash area for workers, typically consisting of a three-stage cube van: a dirty room, a shower station, and a clean room used to remove contaminated materials from the person upon exiting the Work area.

**PLANS:** The Contract Drawings.

**PLASTIC SHEETING:** Polyethylene sheet material of the thickness indicated.

**PRECISION TESTING:** Refers to testing the integrity of the tank in accordance with the test device manufacturer's instructions and U.S. EPA Technical Standards.

**PRODUCT:** No. 2 heating oil.

**PROJECT ENVIRONMENTAL CONSULTANT:** The Owner's environmental representative. The Project Environmental Consultant will perform oversight and confirm for the owner that the UST Removal has achieved a documented tank closure according to city and PADEP requirements.

**PROVIDE:** The Contractor shall furnish and install the equipment specified and perform the work necessary to provide a complete and functional system.

**UST REMOVAL CONTRACTOR:** The qualified and licensed UST Removal Contractor engaged to perform underground storage tank removal required by these specifications. The UST Removal Contractor shall be licensed in the State of Pennsylvania and shall submit documents confirming such license with the bid document.

**REGULATED MATERIAL:** Soil, rock, stone, dredged material, used asphalt, historic fill, and brick, block, or concrete from construction and demolition activities that is separated from other waste and recognizable as such that has been effected by a spill or release of a regulated substance and the concentrations of regulated substances exceed the values in tables of the PADEP Management of Fill Policy, # 258-2182-773, 1/1/2020.

**RELEASE:** Spilling, leaking, pumping, pouring, emitting, escaping, or leaching of the regulated substance into the environment in a manner not authorized by the PADEP.

**RUBBISH:** Combustible and noncombustible waste such as, but not limited to, paper, boxes, glass, crockery, metal, brick, cans, bottles, leaves, branches, trees, and bones.

**SHORING:** Measures that the Contractor shall be required to take to support the walls of the excavation.

**SOIL:** A natural body of mineral and organic matter, which changes or has changed in response to climate and organism.

**SOIL REMOVAL:** The act of transporting materials from the site to a suitable disposal facility.

**SORBENTS:** Carbon, clays, zeolites, and silicates.

**SPECIFICATIONS:** The Technical Provisions, the Special Provisions, and/or the General Provisions.

**STABILIZING MATERIAL:** Cement, fine-grained siliceous, or pozzolanic materials, lime, and thermoplastic binders.

**STOCKPILING:** The act of placing soil and/or fill material into pile.

**STRUCTURES:** Building, footings, foundations, slabs, curbs, or other man-made stationary features constructed above or below the ground surface.

**SUBGRADE:** The uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

**SUBSTANTIAL COMPLETION:** The stage in the progress of the Work when the Work or designated portion thereof is sufficiently completed in accordance with the Contract Documents so the Owner can utilize the Work for its intended use.

**SUITABLE FILL MATERIAL:** On-site material consisting of inorganic and readily compacted uncontaminated site soil, inert rubble or rock fragments.

**TEMPORARY FENCING:** A minimum 8-foot high temporary chain-link fence.

**TREATMENT:** Excavated material is mixed with binding/stabilizing material, sorbents and water in appropriate ratio.

**UNAUTHORIZED EXCAVATION:** Removal of materials beyond what is indicated in the Specification without direction by the School District of Philadelphia or the Environmental Consultant. Unauthorized excavation, as well as other remedial work not directed by the School District of Philadelphia or the Environmental Consultant, shall be at the UST Removal Contractor's expense.

**UTILITIES:** On-site underground and aboveground pipes, conduits, ducts, cables, as well as other underground and aboveground services.

**UNDERGROUND STORAGE TANK (UST):** One or more combination of tanks, as set forth in 25 PA Code Ch. 245.1, including appurtenant piping, lines, fixtures, and other related equipment, used to contain an accumulation of hazardous substance or petroleum products, the volume of which, including the volume of appurtenant piping, lines, fixtures, and other related equipment is 10 percent or more below the ground.

**WORK:** All materials, equipment, labor, services, and other facilities necessary for the Contractor to complete the Contract.

**WORK AREA:** Area(s) of project that undergo removal of the existing storage tank and associated appurtenances, installation of a new UST system, remediation or are known to be contaminated.

**WORKING DAY:** Monday through Friday and may include holidays that fall on any of those days.

1.1.05 GENERAL REQUIREMENTS

- A. The Contractor shall ensure that all materials comply with the Specifications.
- B. The Contractor shall be solely responsible for construction means, methods, techniques, sequences, and procedures and for safety precautions and programs.
- C. All electrical work shall conform to the National Fire Protection Association (NFPA) National Electric Code 70, 1993.

- D. At all times during which the Work is being performed under or affecting the Contract, the Contractor shall keep a competent superintendent approved by the Environmental Consultant constantly on the site from the commencement of the Work under this Contract until the completion thereof. The superintendent shall see that the instructions and directions of the Environmental Consultant are carried out at all times.
- E. The Contractor shall provide all labor, equipment, and material required to complete the required site UST Removal and/or activities by erecting 8-foot steel temporary fencing. The Contractor shall provide additional temporary fencing, if necessary, as a temporary staging area for potentially impacted soil excavated from the area around the existing UST.
- F. The Contractor shall coordinate his Work with any other Work being performed at the construction site and minimize interference with the Owner's normal activities that may continue during construction.
- G. The Contractor shall obtain necessary permits, arrange for inspections, and obtain approval of the appropriate agency having jurisdiction over the Work described. The costs for permits shall be included in the Base Fee. All approvals and permits shall be identified in Contractors Work Plan for review by the Owner/ Environmental Consultant.
- H. The Contractor shall secure the Work Area during excavation, tank removal, and tank replacement activities by erecting 8-foot steel temporary fencing.

1.1.06        STANDARDS

- A. The Contractor shall perform the Work in accordance with applicable Federal, State, and local fire protection, environmental and safety codes and regulations, and the latest version of the following industry standards:
  - 1. Municipal Waste; Chapters 271-285 of Title 25 of the Pennsylvania Code.
  - 2. Hazardous Waste; Chapters 260-270 of Title 25 of the Pennsylvania Code.
  - 3. PADEP's Management of Fill Policy (Document Number 258-2182-773), January 1, 2020.
  - 4. Hazardous Waste Operations and Emergency Response and Excavating, Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 & 29 CFR 1926 Subpart P., Occupational Safety and Health Administration, U.S. Department of Labor, Region V, 230 S. Dearborn Street, Room 3244, Chicago, IL 60604.
  - 5. US EPA National Emission Standards for Hazardous Air Pollutants.
  - 6. Pennsylvania Department of Environmental Protection Codes, Regulations and Guidance documents.
  - 7. All State and Local Construction Codes.
  - 8. Rules and Regulations of all other Jurisdictional Authorities.
  - 9. Flammable and Combustible Liquid Code, NFPA/30, Automotive and Marine Service Station Code, NFPA/30A, National Electrical Code, NFPA/70, and Underground Leakage of Flammable and Combustible Liquids, NFPA/329, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9904.

10. Article 79-Flammable and Combustible Liquids, Uniform Fire Code, 1994 Edition, International Fire Code Institute, 5360 Workman Mill Rd, Whittier, CA 90601, (310) 699-0124.
  11. Hazardous Waste Operations and Emergency Response and Excavating, Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 & 29 CFR 1926 Subpart P., Occupational Safety and Health Administration, U.S. Department of Labor, Region V, 230 S. Dearborn Street, Room 3244, Chicago, IL 60604.
  12. Occupational Safety and Health Standards, Flammable and Combustible Liquids, 29CFR 1910.106, Personal Protective Equipment 29CFR 1910 Subpart I, Excavations 29CFR 1926.650 Subpart P, U. S. Department of Labor, Occupational Safety and Health Administration (OSHA), Washington, D.C.
  13. Control of External Corrosion of Metallic Buried, Partially Buried, and Submerged Liquid Storage Systems, NACE Recommended Practice RP0285-95; Control of External Corrosion on Submerged Metallic Piping Systems, NACE Recommended Practice RP0169-92; National Association of Corrosion Engineers, P.O. Box 218340, Houston, TX 77213.
  14. UL Standard 58, "Steel Underground Tanks for Flammable and Combustible Liquids", 1996, "Control Equipment for Use With Flammable Liquid Dispensing Devices, UL1238, "Pipe Connectors for Flammable and Combustible Liquids and LP-Gas", UL567, "Pipe Unions for Flammable and Combustible Liquids and LP-Gas", UL567, "Power-operated Dispensing Devices for Petroleum Products", UL87, "Valves for Flammable Fluids", UL842, "Corrosion Protection for Underground Storage Tanks" UL1746, "UL Listed Non-Metal Pipe", UL971, Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, Illinois 60062. (847) 272-8800.
  15. Underground Storage Tanks; Technical Requirements and State Program Approval; Final Rules, 40 CFR Parts 280 and 281, Part II, Federal Register, Friday, September 23, 1988, Musts for USTs: A Summary of the New Regulations for Underground Storage Tank Systems, and Hazardous Waste Management Standards, Federal Register July 14, 1986. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, 401 M. Street, S.W., Washington, D.C. 20460.
  16. Installation of Underground Petroleum Storage Systems, API/1615, Cathodic Protection of Underground Petroleum Storage Tank and Piping Systems, API 1632, American Petroleum Institute, 1220 L Street, Washington, D.C. 20005.
  17. Installation Instructions, ACT-100-U, R821; Steel Tank Institute Recommended Practices for Corrosion Protection of Underground Piping NetWorks Associated with Liquid Storage and Dispensing Systems, R892; Steel Tank Institute Standard for Dual Wall Underground Steel Storage Tanks, F841; Steel Tank Institute, 570 Oakwood Road, Lake Zurich IL 60047 (847) 438-8265.
  18. OSHA Standards.
  19. US EPA National Emission Standards for Hazardous Air Pollutants.
  20. US EPA Regulation 40 CFR Part 61 (NESHAP Final Rule).
- B. Where differences exist between standards, the Contractor shall use the most conservative. If in doubt, describe differences in writing to the Owner for Owner's approval before performing the Work.
- C. The codes and standards listed above are believed to be the latest as of this publication. Codes and standards are continuously updated. The Contractor shall confirm the construction standard edition enforced by the authority having jurisdiction.

1.1.07 SUBMITTALS

- A. The Contractor shall provide the following to the School District Environmental Consultant and Owner for approval before commencing Work:
1. Employee training records.
  2. Insurance certificates.
  3. Proof that all necessary notifications have been submitted to State and local agencies.
  4. Site-Specific Health and Safety Plan (HASP).
  5. Proof that all workers identified by the Contractor for completion of the Work (supervisors and laborers) have been given medical examinations within the past year, and obtained medical clearance, as required by appropriate OSHA regulations.
  6. The Contractor shall design shoring consistent with appropriate OSHA requirements. The shoring shall be designed by a structural engineer licensed in the State of Pennsylvania and employed by the Contractor. The submitted plan shall bear a professional engineer's seal and signature. The excavation/shoring plans shall be submitted for review and approved by the School District's Geotechnical Contractor prior to the beginning of site work.
  7. Copies of all notifications required in this Specification.
  8. Source(s) of backfill material and documentation that the material proposed by the Contractor as a backfill meets the PADEP Clean Fill Criteria and consists of load-bearing fill material, including physical and analytical test results.
  9. Gradation tests on proposed backfill material.
  10. One optimum moisture-density curve (American Society for Testing and Materials, ASTM D-1557) for each type of material proposed for use as backfill.
  11. Construction Schedule for completion of the Work. The Schedule shall be manpower-loaded so that the number of man-hours per activity, number of man-hours per day, and the number of man-hours per week are explicitly shown.
  12. Waste Management and Disposal Plan specifying names of recycling or disposal facilities the Contractor will use for disposal of regulated material, address, and EPA and PADEP identification numbers (as appropriate), and the disposal facilities' required analyses to the Owner's Environmental Consultant prior to mobilization. If a change in either of these items occurs during the course of this project, the Contractor shall notify the School District and the Environmental Consultant.
  13. UST and Piping Removal and Disposal Plan, describing the following:
    - a. Means, methods, sequence of operations, and schedule to be employed in the pumping, cleaning, de-vaporizing, inspecting, excavating, removing, and disposing of the underground storage tank, appurtenances, and overburden.
    - b. Waste identification methods (e.g., labeling, marking containers, etc.).
  14. Guarantees/warranties with respect to the Work and product produced under this Contract. All warranties shall be as specified by the Manufacturer of the equipment.
  15. The Contractor shall provide data sheets and descriptive material for shoring.
  16. The Contractor shall submit necessary permits and certifications for tank removal to the Owner and Environmental Consultant within 10 days of Notice to Proceed.
  17. The Environmental Consultant shall review the submittals specified herein and return them to the Contractor approved, or with appropriate comments within 10 days of receipt from the Owner.

18. Emergency Spill Response Plan (ESRP) for hazardous materials management. The ESRP must include evacuation procedures, source of medical assistance, and procedures to be used for access by medical personnel (examples: first aid squad and physician).
- B. The Contractor shall provide the following to the Environmental Consultant and Owner upon completion of the Work:
1. Excavated material disposal documentation including weight tickets with a signature of a receiving facility certifying receipt.
  2. Product and sludge disposal documentation with a signature of a receiving facility certifying receipt.
  3. Washwater disposal documentation with a signature of a receiving facility certifying receipt.
  4. Bills-of-lading certifying disposal or recycling of the tank, pumps, and piping with a signature of a receiving facility certifying receipt.
  5. Documentation of in-place geotechnical testing of backfill, including date and time of tests, name of person performing the test, names of any inspector's present, test procedure(s) followed, quality assurance procedures, and test results.
  6. Documentation of source of off-site fill material, including analytical data from the supplier and bills-of-lading.
  7. Cumulative quantities of soil/fill material excavated during the tank and associated piping removal, beginning with start date.
  8. Daily logs.
  9. Visitations; authorized and unauthorized.
  10. Special or unusual events (e.g., emergency release or spill, contamination discovered during the tank removal activities, damage to utilities or nearby structures, etc.).
- C. The submittals shall be forwarded to the School District of Philadelphia Project Manager with concurrent copies of the submittals sent to the attention of the School District's Environmental Consultant.
- D. A formal letter of transmittal must accompany all submittals.

1.1.08            QUALITY ASSURANCE

- A. CODES AND STANDARDS: The Contractor shall perform all Work in accordance with applicable standards, including, but not limited to:
1. American Petroleum Institute (API).
  2. American Wire Gauge (AWG).
  3. Insulated Cable Engineers Association (ICEA).
  4. National Electrical Contractors' Association (NECA).
  5. National Electrical Manufacturers' Association (NEMA).
  6. National Fire Protection Association (NFPA).
  7. OSHA Standards.
  8. US EPA National Emission Standards for Hazardous Air Pollutants.
  9. PADEP.
  10. United States Environmental Protection Agency (US EPA) Regulation 40 CFR Part 61 (NESHAP Final Rule).

11. US EPA Regulation 40 CFR Part 761, Toxic Substances Control Act.
12. Underwriters' Laboratories, Inc. (UL).
13. All State and Local Construction Codes.
14. Rules and Regulations of all other jurisdictional authorities.

In case of difference between codes, specifications, state laws, local ordinances, industry standards, utility company regulations, and the Contract Documents, the most stringent shall govern.

- B. SURVEYOR: The Contractor shall engage a Professional Land Surveyor registered in the State of Pennsylvania to perform land surveying services required.
- C. The on-site Contractor and the on-site Contractor's employee(s) in charge shall have experience in the removal of tanks of similar size, type, and capacity and shall be certified by the appropriate regulatory authorities and the tank manufacturer to perform the Work. The Contractor shall submit a copy of the certifications to the Project Environmental Consultant prior to the start of Work.

1.1.09 PROJECT CONDITIONS

- A. EXISTING UTILITIES: The Contractor shall locate existing underground utilities in areas of the planned excavation work. The Contractor shall exercise every precaution to avoid damage to existing utilities including retaining services of a private utility locating company and/or employing soft digging in addition to One-Call. **If utilities are indicated to remain in place, the Contractor shall provide adequate means of support and protection during the course of work.** Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, the Contractor shall consult Utility Owner immediately for direction. The Contractor shall cooperate with Owner and Utility Company in keeping respective services and facilities in operation. The Contractor shall repair damaged utilities to satisfaction of Utility Owner. Should utilities need to be replaced or relocated, the Contractor shall prepare and submit a utility relocation/replacement plan to the Design Professional for review and approval.
- B. ELECTRICAL CABLES, CONDUIT, COMMERCIALY USED FIBER OPTIC CABLE, JUNCTION BOXES, ETC.: In conformance with Section 1.1.09A, EXISTING UTILITIES, the Contractor shall locate and exercise every precaution to avoid damage to existing facilities (electrical cables, conduits and junction boxes, including commercially used fiber optic communication cables). Should any facilities become damaged or inoperable during construction operations and it is not to be removed as part of this Contract, the UST Removal Contractor shall immediately notify the School District of Philadelphia and the Environmental Consultant regarding the specifics of the damage. The Contractor shall be responsible for all costs incurred for the repairs of damaged utilities deemed necessary by the School District of Philadelphia and the Environmental Consultant. If a third party utility or a municipal facility is involved, the Contractor shall be responsible for all costs incurred for the repairs deemed necessary after consultation with said agency.
- C. PROTECTION OF PERSONS AND PROPERTY
  1. Provide proper signs, signals, and barricades for open excavations occurring as part of this Work in accordance with applicable regulations.



2. Protect the walls of the excavation from collapse.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and silting, and other hazards created by Work covered in this Section.
4. Protect sidewalks, pavements, and other facilities from silting caused by earthwork.
5. If necessary, the Contractor shall be responsible for repairs to structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by Work covered in this Section.
6. Comply with API Recommended Practice 1604 for worker safety with respect to toxicity considerations.

1.1.10        SAFETY

**Safety requirements set forth in this section relate to the removal of the Underground Storage Tank. Safety requirements augment safety requirements presented in the General Conditions section of this bid package.**

- A. The Contractor shall prepare and submit a written, detailed Site-Specific HASP to the Environmental Consultant, which addresses all health and safety concerns and hazards related to the removal of hazardous and non-hazardous petroleum-impacted material. The HASP shall be consistent with all applicable OSHA and other regulatory requirements. The HASP shall describe the physical and chemical hazards anticipated with the Work. The HASP must be implemented by the Contractor's Site Safety Officer.
- B. The Contractor shall be responsible for the safety of Contractor's employees on the site. The Contractor shall comply with the safety and health standards specified in OSHA 29 CFR 1926.1910, Federal, State and local laws and regulations. These laws and regulations are a condition of this Work and shall be made a condition of the Contract. Hazard Communication (OSHA 29 CFR 1926.1910) shall be a requirement of the Contract.
- C. The Contractor's superintendent shall monitor the Work to ensure safety, make frequent inspections of the Work Area and equipment, and take whatever corrective action is necessary to provide a safe workplace.
- D. If safety violations are not corrected immediately, the Contractor may be required by the Owner to shut down that portion of the project where the violations are occurring, until such time as the violations are corrected. Emergency telephone numbers shall be posted in a conspicuous place and carried in the Contractor superintendent's vehicle.
- E. The Contractor shall obtain all necessary construction and safety permits from the appropriate regulatory agencies for construction operations prior to the start of Work.
- F. Removal of the tank and associated fill and soil material shall be conducted in such a way to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

The Contractor **shall not**:

1. Close or obstruct streets, sidewalks, or other occupied or used facilities without permission from authorities having jurisdiction.

The Contractor **shall** provide:

1. Alternate routes around closed or obstructed traffic ways if required by governing regulations; and,
2. Traffic control if Contractor closes or obstructs streets, sidewalks, or other occupied or used facilities.

#### 1.1.11 SEQUENCE OF OPERATIONS

Schedule requirements are specified in section 1.1.07 – Submittals. The Contractor shall submit progress schedules to the Environmental Consultant during the bi-weekly construction progress meetings conducted by the District. The Contractor shall schedule his operations such that Work in any one location shall be carried out progressively and uninterrupted and that each phase of the Work will follow in a logical sequence. The progress schedules shall detail the sequence of operations for each phase of the Work.

#### 1.1.12 COOPERATION WITH OTHER CONTRACTORS

The right is reserved by the School District of Philadelphia to do work with its own employees or by other Contractors within the limits of this project during the duration of this Contract. **COMPLETE COOPERATION WITH SUCH OTHER CONTRACTORS IS MANDATORY.** The Contractor shall coordinate his schedule of operations with others.

#### 1.1.13 DIRECTIVE TO THE CONTRACTOR

During the course of the Work to be accomplished under this Contract, certain directives or instructions may be issued to the Contractor by the Environmental Consultant and/or the School District of Philadelphia. These directives or instructions may be delivered and/or verified by written orders. The Contractor shall not assume or accept any directive or instruction not issued by the Environmental Consultant and/or the School District of Philadelphia as stated herein.

## **PART 2 – UST REMOVAL - EXECUTION**

### **2.1.01        GENERAL**

- A. The Contractor shall remove and properly dispose of the existing top concrete pad, if applicable.
- B. The Contractor shall remove overburden material, bedding, and sufficient backfill around the UST to safely remove the UST.
- C. The Contractor shall be responsible for the removal and proper off-site disposal of up to 400 tons of excess regulated soil/fill material that may be generated during the excavation activities (if necessary). The excess material includes material which may exceed PADEP's Clean Fill Criteria and any petroleum impacted soil/fill material if encountered. The contractor shall also be responsible for engineered fill or stone to replace the 400 tons and removed tank. This can be accomplished from soils on site if they are able to be properly compacted, however if fill or stone must be brought from offsite, it is the responsibility of the contractor.
- D. The Contractor shall be responsible for collecting samples of the excess soil/fill material for laboratory analysis, if necessary, to establish proper disposal procedures.
- E. The Contractor shall remove the heating oil UST and associated pumps, piping, and all ancillary equipment.
- F. The Contractor shall be familiar with the locations of all public utility facilities and structures that may be present in the vicinity of the UST and take proper precautions to avoid damage. Should any damage occur due to the Contractor's operations, repairs shall be made at the Contractor's expense in a manner acceptable to the utility affected and the Owner.
- G. The Contractor shall provide notifications to local utilities prior to commencement of on-site Work so that known utilities can be identified and clearly marked before the Work commences.
- H. The Contractor shall be responsible for meeting all requirements established by the regulatory agencies and utility companies during implementing all stages of the Work.
- I. The Contractor and the company retained for removal of the UST must be certified by PADEP for tank closures and must be licensed in Philadelphia to remove USTs.
- J. The Contractor shall install a minimum of 8-foot high temporary chain-link fence to protect the UST area of work from vandalism.

2.1.02 NOTIFICATIONS AND PERMITS

- A. Notifications: The Contractor shall notify the City of Philadelphia Fire Marshal and the City of Philadelphia Department of Licensing and Inspection (L&I) at least 10 days prior to the tank removal. Provide a copy of this notification to the Project Environmental Consultant prior to initiating Work.
- B. Permits:
  - 1. City of Philadelphia Permits: The Contractor shall obtain any necessary City of Philadelphia permits prior to the start of Work. The costs for permits shall be included in the Base Fee.
  - 2. Permits shall be displayed on-site for the duration of the project.

2.1.03 REMOVAL OF COVER/EXPOSURE OF UST TOP

- A. The Contractor shall break and remove all existing materials including concrete, asphalt pavement, or other materials required to expose the UST and associated piping sufficiently for safe removal.
- B. Use of pavement materials as backfill is prohibited.
- C. The overburden removed to expose the tank's upper surface and piping will be field screened by the Environmental Consultant using a photoionization detector (PID) or other comparable field screening equipment.

2.1.04 REMOVAL OF PRODUCT

- A. The Contractor will remove and transfer all viable product from the existing tank prior to the commencement of site activity.

2.1.05 TANK VAPOR PURGING

- A. The tank vapor purging operations shall be conducted in accordance with the API Recommended Practice 1604, "Removal and Disposal of Used Underground Storage Tanks" (API 1604) and API Publication 2015, "Safe Entry and Cleaning of Petroleum Storage Tanks" (API 2015).
- B. A combined combustible gas/oxygen gas indicator (LEL/O<sub>2</sub> meter) shall be used and provided by the Contractor to determine the presence of vapors inside the UST.
- C. If explosive or combustible vapors are detected, the Contractor shall purge each tank of explosive or combustible vapors through the introduction of inert gas such as carbon dioxide, nitrogen or argon. The gas should be introduced at low pressure through the fill opening with the supply line placed at or near the bottom of the tank. This opening should be at the opposite end of the UST from the existing tank vent pipe.
- D. All vapors shall be vented at a minimum height of 12 feet above grade.
- E. The Contractor shall use a LEL/O<sub>2</sub> meter indicator to determine when tank has been purged of explosive vapors. The UST will remain below grade during vapor purging operations. Interior

atmosphere monitoring will continue throughout the cleaning and removal process to ensure the safety of personnel working in or near the area.

- F. As concentrations of vapors in the tank, the excavation, or the Work Area may reach the flammable (explosive) range, refer to API Publication 2015 for proper procedures for purging of vapors and for control of sources of ignition. Take precautions to cover the following.
  - 1. Eliminate potential sources of ignition.
  - 2. Prevent static electricity discharges.
  - 3. Prevent accumulation of vapors at ground level.

#### 2.1.06 TANK AND PIPE CLEANING

- A. The UST shall be certified as “vapor free” prior to proceeding with further work.
- B. The cleaning and tank atmosphere testing of the UST shall be in accordance with API 1604 and API 2015.
- C. The Contractor shall drain and flush all pipe lines entering the tank. All washwater generated as a result of piping cleaning shall be drained back into the tank. If fill and distribution lines will not drain back into the tank, proper containers must be used to prevent spillage onto the ground surface.
- D. The Contractor shall access the interior of the UST through an opening made with minimum dimensions of three- by three-feet. This opening shall be cold cut into the tank upper surface to allow safe access to the tank interiors by the Contractor. All personnel entering the tank shall be in **Level "B"** personnel protection and shall follow all procedures associated with confined space entry.
- E. All interior surfaces of the tank shall be cleaned by the contractor prior to removal. All interior surfaces will be wiped down by the Contractor.
- F. The Contractor shall be responsible for proper disposal of tank bottom, sludge, solids, and wastewater, generated during tank cleaning.
- G. The Contractor shall dispose of residuals including all sludge, solids, and wastewater in accordance with the results of waste characterization and all Federal, State, and local rules and regulations. The disposal facility must be approved by the Environmental Consultant 10 days prior to the tank cleaning activities.
- H. The Contractor shall provide disposal documentation and weight ticket of the residuals, sludge and wastewater.
- I. Upon determination by the Contractor that the concentrations of toxic, combustible, or explosive vapors are within acceptable limits and the tank purging is complete, the piping associated with the storage tank (fills, product, and vent lines) and pumps shall be disconnected. The Contractor will then remove the pumps and piping.

#### 2.1.07 TANK REMOVAL

- A. The Contractor shall excavate a sufficient amount of soil/fill material from the area surrounding the tank to facilitate the removal of the UST from the ground.
- B. The Environmental Consultant shall field-screen the excavated material using a PID or comparable field screening equipment.
- D. Excavated material that exhibits elevated PID readings and/or staining shall be excavated and direct hauled to a proper off-site disposal facility.
- E. The Contractor shall remove the tank from the excavations and place them on a level surface in a secure area on the site, as directed by the Environmental Consultant.
- F. The sides of the tank shall be chocked in accordance with the manufacturer's requirements to prevent rolling.
- G. The outside of the tank shall be cleaned of all loose material to ensure future safe transport.
- H. The Contractor shall label the tank in accordance with API 1604 before removal from the site.
- I. The Contractor shall render the clean tank unsuitable for future use in accordance with the requirements of API 1604.
- J. The Contractor shall provide the Environmental Consultant with receipts to verify that the tank, pumps, and associated piping were properly disposed of as scrap for recycling.

2.1.08            EXCAVATION/REMOVAL OF REGULATED SOIL/FILL MATERIALS

- A. The Environmental Consultant shall document the presence of possible subsurface regulated soil/fill material during excavating activities. The Environmental Consultant will be responsible for the collection of post-excavation soil samples. Post-excavation soil samples shall be collected from the excavations by the Environmental Consultant in accordance with the PADEP's Technical Document (*Closure Requirements for Underground Storage Tank Systems*). The Contractor shall assist the Environmental Consultant in soil screening and collection of soil samples as necessary.
- B. The Contractor will collect and submit samples representative of the excavated material for disposal to an analytical laboratory. The Contractor will receive results back from the laboratory within 5 full working days.
- C. Excavation shall proceed to the limits defined by the Environmental Consultant, and removal of regulated material, if encountered, will be confirmed by analytical results of post-excavation soil samples.
- D. The Contractor shall be responsible for the removal and disposal of up to 400 tons of non-hazardous regulated excess soil/fill material that may be generated during progress of the Work in accordance with all Federal, State, and local laws and regulations. The disposal facilities used must meet the Owner's approval.
- E. Once the tank is removed, the Environmental Consultant will collect post-excavation samples.

- F. The excavation activities will be monitored by the Environmental Consultant on a continuous basis to establish when the limits of petroleum impacted soil/fill material, if encountered, have been reached. When the limits of petroleum impacted soil/fill material have been reached or further excavation would disturb the shoring and threaten the structural integrity of any buildings, post-excavation soil samples will be collected.
- G. Excavated regulated excess soil/fill material will be sampled by the Environmental Consultant with samples submitted for laboratory analysis to establish the required disposal procedure and obtain disposal approval at a landfill or recycling facility.
- H. The Contractor shall transport and dispose of the regulated excess soil/fill material. The excess soil/fill material is to be disposed off-site in a manner consistent with all applicable local, State, and Federal regulations. The estimated tonnage of material to be disposed of is 400 tons (if necessary). The disposal facility shall be approved by the Owner 10 days prior to transport and disposal activities. Disposal of material impacted due to a release caused by the Contractor will be at the Contractor's expense.
- I. The Contractor must follow the recommendations concerning handling of excavated material on-site as presented in PADEP's Technical Document (*Closure Requirements for Underground Storage Tank Systems*).
- J. The Contractor shall remove and dispose of excavation water, if present, in a manner consistent with all applicable local, State, and Federal regulations.

2.1.09            RELEASE OF PRODUCT

- A. Should a release of product from the UST be observed, the Contractor shall immediately notify the Environmental Consultant. The Environmental Consultant will advise the Owner and the appropriate regulatory agencies.
- B. Should a release of product occur due to negligence of the Contractor, the Contractor shall be responsible for all costs associated with containment and remediation of the release.

2.1.10            SPECIAL CONDITIONS FOR UST REMOVAL AND SITE CLEARANCE

The following Special Conditions apply to all Work to be conducted in order to complete this project:

- A. The Contractor shall control the amount of dust resulting from the material removal and tank closure activities to avoid creation of a nuisance in the surrounding areas.
- B. The Contractor shall make all required notifications and take all necessary precautions to ensure against damage to access roads, utilities and structures. Any damage to such items shall be repaired or the damaged structures shall be replaced by the Contractor at no additional cost to the Owner.
- C. The use of burning at the site for the disposal of refuse and debris is strictly prohibited.

- D. The Contractor shall furnish and install all fencing, barricades, warning signs, signals, lights, etc., wherever necessary to warn and protect the public during the Work. Fencing, barricades, and other protection devices will remain in place until all tasks associated with the tank and material removal activities are completed.
- E. Procedures used to accomplish the Work shall be as specified herein unless submitted to the Environmental Consultant for approval prior to project implementation.
- F. The procedures used by the Contractor shall provide for safe conduct of Work, careful removal and disposition of materials specified, and protection of the property. The procedures shall include a detailed description of the methods and equipment to be used for each operation, method(s) of containing impacted water (from the tank and from the subsurface), and the sequence of operations.
- G. All disposal including, but not limited to, tank contents, residuals, rinsate, any regulated soil/fill material, and/or groundwater shall be by the Contractor in accordance with local, State, and Federal regulations. Regulated material disposal shall be to an Owner-approved recycling method, an approved recycling facility, or an approved non-hazardous landfill.
- H. Prior to any Work being performed, the Contractor shall purge the tank to remove flammable/combustible vapors. Accordingly, the Contractor shall use appropriate methods to assess the vapor concentration in the tank and the surrounding work area before initiating Work in the area.
- I. The Contractor shall install appropriate measures to control surface water run-on to and run-off from the open excavations and the material staging areas.
- J. Shoring during excavation shall be designed, furnished, installed, and maintained by the Contractor as necessary to protect workmen, banks, adjacent paving, structures and utilities. Shoring, bracing, and sheeting shall be removed, as the excavation is backfilled in such a manner as to prevent serious caving. Shoring, bracing, and sheeting shall be as required by OSHA regulations and to support structures. Shoring Plan must be submitted to the Owner for approval prior to commencement of shoring of excavations.
- K. The Contractor shall remove and dispose of the excavated materials (including but not limited to regulated soil, debris, and fill material) in accordance with all local, State, and Federal rules and regulations and as specified herein.
- L. The Contractor shall maintain the job site in a neat and orderly condition. This includes the daily removal of rubbish, waste, tools, equipment, and material not required for the Work in progress.
- M. Use appropriate vehicles and operating practices to prevent spillage or leakage of impacted materials from occurring during operations. Inspect vehicles leaving the Work Area to ensure that no impacted materials adhere to the wheels or undercarriage. The Contractor shall be responsible for any clean-up required as a result of leaks which result from damage or mishandling of the tank or fuel lines by the Contractor, at no additional cost to the Owner.

2.1.11 BACKFILLING AND COMPACTION



- A. The Contractor shall provide gradation tests on proposed backfill material prior to backfill.
- B. The Contractor shall provide one optimum moisture-density curve using American Society for Testing and Materials, ASTM D-1557 test method for each type of material proposed for use as backfill prior to backfilling.
- C. The Contractor shall provide clean fill documentation prior to placement of the clean fill.
- D. The Contractor shall backfill the excavation using select clean fill material with a maximum six-inch particle size with less than 20 percent passing a #200 sieve. The select clean fill shall be placed in six-inch lifts and shall be compacted to 95 percent of the modified proctor.
- E. The Contractor shall retain services of an independent properly certified testing and inspection agency to perform and verify compaction testing of all fill material placed at the site.
- F. In the event the compaction testing reveals the compaction does not meet requirements herein, the Contractor shall repeat the compaction and re-test the compacted area. The Contractor is responsible for the costs associated with additional compaction and testing and meeting the compaction requirements.

2.1.12        TEST DOCUMENTATION AND REPORTING

- A. The Contractor shall document all testing and provide copies to the Environmental Consultant, the Owner, and authorities having jurisdiction. Test records shall include:
  - 1.     Date and time of tests;
  - 2.     Name of a firm and an inspector performing tests;
  - 3.     Names of persons witnessing inspections;
  - 4.     Test procedures followed; and,
  - 5.     Test results.
- B. The Contractor shall provide documentation for all testing with Contract close-out documentation to the Owner.

2.1.13 DISPOSAL DOCUMENTATION

- A. The Contractor shall provide disposal (or recycling) documentation to the Owner for the disposal of tank contents, tank and piping, regulated soil/fill material, cleaning fluids, and impacted groundwater (if any). This documentation shall be provided with Contract close-out documentation.

**END OF SECTION 001735 – UNDERGROUND STORAGE TANK REMOVAL**

## **SECTION 070800 - COMMISSIONING OF BUILDING ENCLOSURE**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. The School District of Philadelphia has procured a third party Commissioning Authority (CA) to act on its behalf regarding Commissioning of Systems included in the scope of this project. The General Contractor is required to coordinate with the Commissioning Authority and assist the Commissioning Authority with execution of the Commissioning process including the items detailed in this specification section.
- B. This section covers the General Contractors' responsibilities for building enclosure commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use. It is the responsibility of the General Contractor to complete these Checklists and Procedures.
- D. The General Contractor may be responsible for portions of Commissioning Scope associated with Mechanical, Plumbing, or Electrical Systems. Refer to those respective Commissioning Specifications Sections.
- E. The design intent of the building enclosure is to provide exterior floor, wall, and roof assemblies which prevent uncontrolled air and water infiltration and include products and assemblies that are technically sound, durable and serviceable. This section includes requirements for non-structural commissioning of the building exterior enclosure, including, but not limited to the following:
  - 1. Below-grade construction, including foundation walls and slabs-on-grade.
  - 2. Building enclosure construction, above grade including exterior wall materials and assemblies, windows and doors including sheathing, framing, insulation, and vapor barrier (as required).
  - 3. Roofing, including roofing system, roofing insulation, hatches and other roof openings and penetrations.
  - 4. Interface conditions (flashings, expansion joints, and sealant) between each of the materials, components and systems that comprise the above and below-grade building exterior enclosure.
- F. The purpose of the building enclosure commissioning is to provide a process for independent, third-party verification that the installed performance of the building enclosure meets and exceeds the minimum performance requirements set forth by the Contract Documents for this project. The materials, components, systems, and assemblies that comprise the above and below-grade building exterior enclosure will be evaluated and tested as outlined in this Section, as well as in accordance with each of the technical Sections associated with the design and construction of the building exterior enclosure.

#### **1.02 RELATED DOCUMENTS**

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

#### **1.03 REFERENCE STANDARDS**

- A. ASHRAE NIBS Guideline 3-2012 "Building Enclosure Commissioning Process"
- B. S. Army Corps of Engineers "Air Leakage Test Protocol for Measuring Air Leakage in Buildings"
- C. AAMA 501.2 "Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain walls, and Sloped Glazing Systems"
- D. AAMA 502-08 "Voluntary Specification for Field Testing of Newly Installed Fenestration Products"

- E. ASTM C794-18 “Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants”
- F. ASTM C1153-10 “Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging”
- G. ASTM C1193-11 “Standard Guide for Use of Joint Sealants”
- H. ASTM C1521-19 “Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints”
- I. ASTM D4263-83 “Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method”
- J. ASTM D4541-17 “Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers”
- K. ASTM D5957-98 “standard Guide for Flood Testing Horizontal Waterproofing Installations”
- L. ASTM E779 “Standard Test Method for Determining Air Leakage Rate by Fan Pressurization”
- M. ASTM E783-02 “Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors”
- N. ASTM E1105-15 “Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference”
- O. ASTM E1186-17 “Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems”
- P. ASTM E1827-11 “Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door”
- Q. ISO 6781-3:2015 “Detection of heat, air and moisture irregularities in buildings by infrared methods” – Part 3: Qualifications of equipment operators, data analysts and report writers

#### **1.04 SUBMITTALS**

- A. Refer to General Conditions and Supplementary Conditions for Submittal Requirements.
- B. Copy Commissioning Authority on all submittal communications.
- C. Shop Drawings and Product Data: The Contractor shall provide shop drawings and submittal data for materials, products, systems and equipment that will be part of the Building Enclosure Commissioning (BECx) Process.
  - 1. The contractor shall forward to the Building Enclosure Commissioning Authority (BECxA) one copy of Shop Drawings and Product Data concurrent with distribution to the Architect/Engineer-of-Record (A/E), who will then review and incorporate the BECxA comments at their discretion and return to the Contractor. The Contractor shall then copy BECxA with the reviewed submittal with A/E submittal review stamp.
  - 2. Any action taken by the A/E or Contractor based in whole or in part on the comments and recommendations provided by the BECxA as part of its submittal review shall be the sole responsibility of the A/E or Contractor.
- D. Factory/Laboratory Test Reports: The Contractor shall provide any factory or laboratory testing documentation or certified test reports required by the specifications. These shall be provided prior to acceptance and installation of the specified item.
- E. Building Air Barrier System Test Report: No later than 60 days after completion of the pressure test and thermography, the Contractor shall provide the Building Air Barrier System Test Report, which contains the following:
  - 1. Table of contents
  - 2. Executive summary
  - 3. Leakage rate test chart/graph
  - 4. Field reports
  - 5. Pressure test system verification checklist
  - 6. Pressure test functional performance test

7. Thermographic Investigation Report
8. Appendices (includes Testing Equipment and Calibration Certificates)
- F. Maintenance Schedule: The Contractor shall provide a summary table that indexes the building enclosure component requiring maintenance and indicates the frequency each component will require repair or replacement (i.e. replacement of sealants, gaskets, insulated glass units (IGUs), repair of paints or coatings).
- G. Maintenance Information: The Contractor shall provide Maintenance Information for each entry containing the following:
  1. Product Data Sheet: Provide a summary of performance data.
  2. Extended Warranty Information: Include all warranties for products, equipment, components, and sub-components whose duration exceeds one year. Include warranties on components with the system they are a part of. Reference all specific operation and maintenance procedures that must be performed to keep the warranty valid.
  3. Sources of Material: Include reference to contact information where specific materials can be obtained.
  4. Installation and Maintenance Instructions: For each material, component, or system.
- H. Record Drawings: The Contractor shall maintain at the site an updated set of record or 'As-Built' documents reflecting actual installed conditions and all approved changes and modifications to the contract documents. The Contractor shall provide access to the BECxA to review the As-Built and Record Drawings. The Record Drawings shall be maintained concurrently with construction.

#### **1.05 QUALITY ASSURANCE**

- A. Pressure Test Agency
  1. Submit information certifying that the pressure test agency is an independent third-party agency, not an affiliate or subsidiary of the prime contractor, subcontractors, equipment or material vendors, or A/E firm. The work of the pressure test agency is limited to pressure testing the building enclosure, performing a thermography test and investigating, through various methods, the location of air leaks through the air barrier.
  2. The agency is to be regularly engaged in pressure testing of commercial/industrial building enclosures. If using blower door, the lead test technician must have at least two years of experience in using such equipment in building pressurization tests. Formal training using pressure test equipment is highly recommended.
- B. Thermographer Qualifications
  1. The thermographer must have at least two years of building science thermography experience in IR testing commercial or industrial buildings. The thermographer must also have experience in building enclosures and building science in order to make effective recommendations to the contractor should the building enclosure require additional sealing.
  2. Submit the thermographer's Infrared Training Center Level I Certificate for approval.
  3. Submit a list of at least ten commercial/industrial buildings on which the thermographer has performed IR thermography in the past three years. The thermographer is to have a current active Level I certification.
- C. Test Instruments and Data of Last Calibration
  1. Submit a signed and dated list of test instruments, application, manufacturer, model, serial number, range of operation, accuracy and date of most recent calibration.

#### **1.06 CLIMATE CONDITIONS SUITABLE FOR PRESSURE TEST AND INFRARED THERMOGRAPHY**

- A. As the test approaches, monitor the weather forecast for the test site. Avoid testing on days forecast to experience high winds, rain, or snow. Monitor weather forecasts prior to shipping pressure test equipment to the site. Preferred ambient weather test conditions as stated in ASTM E779 are 0 to 4 mph winds and an ambient temperature range of 41 to 95 °F. Based on current and forecast weather conditions, the Commissioning Team will coordinate scheduling for the test to occur.

- B. Rain can temporarily seal roof and wall assemblies so that they leak less than under no-rain conditions. Do not test during rain or if rain is anticipated during testing. If pneumatic hoses are installed and exposed to rain observe the hose to ensure rainwater has not migrated into the hose ends. Orient all exposed hose ends to keep them out of water puddles. Success in temporarily sealing outdoor ventilation components such as louvers and exhaust fans may also be compromised by rain. Do not seal roof-mounted ventilation components during times of potential lightning.
- C. Snow piled against a wall or on top of a roof can make a building enclosure appear to be more airtight than it actually is. Snow may also impact thermography readings. Remove snow from around and on top of the building prior to testing.
- D. Because wind can skew pressure test results, test only on days and times when winds are anticipated to be the calmest. Avoid pressure testing during gusty or high wind conditions.

## **PART 2 PRODUCTS**

### **2.01 TEST EQUIPMENT**

- A. Pressure Test and Infrared Thermography Equipment
- B. The testing agency is to supply sufficient quantity of blower equipment that will produce a minimum of 75 Pa differential pressure between the envelope and outdoors using the test methods described herein. Supplying additional blower test equipment to provide additional airflow capacity or to act as a backup is highly recommended.
  - 1. Blower Door Fans:
  - 2. Each airflow measuring system including blower door fans are to be calibrated within the last 3 years in accordance with ASTM E1827. Calibrated blower door fans must measure accurately to within plus or minus 5 percent of the flow reading. Blower door equipment and trailer mounted fans are to be specifically designed to pressurize building envelopes. Each set of blower door equipment is to include fan(s), digital gage(s), door frame, door fabric or hard panels.
  - 3. Digital Gages as Test Instruments:
  - 4. Use only digital gages as measuring instruments in the pressure test; analog gages are not acceptable. The gauges must be accurate to within 1.0 percent of the pressure reading or 0.15 Pa, whichever is greater. Each gage is to have been calibrated within two years of the test. The calibration is to be checked against a National Institute of Standards and Technology (NIST, formerly National Bureau of Standards) traceable standard.
- C. Thermal Imaging Infrared Camera Requirements
- D. The thermal imaging infrared camera used in the thermography test must have a thermal sensitivity (Noise Equivalent Temperature Difference) of +/- 0.2°F at 18°F at 86°F or less. The camera's operating spectral range must fall between 2 and 15 micrometers. The camera's IR image viewing screen resolution must measure at least 240x180 pixels. The camera must have a means of recording thermal images seen on the camera viewing screen. The camera is to display output as individual still frame images that also can be downloaded and inserted into an electronic Thermographic Investigation Report. Submit camera make and model, and catalog information that defines the camera thermal sensitivity for approval.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. The General Contractor and applicable subcontractor shall attend the initial kickoff commissioning meeting conducted at the start of construction and the commissioning meeting held 30 days prior to startup of the primary equipment.
- B. The General Contractor shall attend bi-weekly commissioning team meetings throughout construction.
- C. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

D. Furnish additional information requested by the Commissioning Authority.

### 3.02 BUILDING ENCLOSURE PERFORMANCE TESTING

A. Adhesion Tests:

1. Arrange for field tests to take place with joint-sealant and adhered membrane manufacturer's technical representative present. Field test sealant joints and self-adhering membranes for adhesion to substrates as follows:
  - a. Test each type of sealant/membrane in each installation at every substrate indicated.
  - b. Perform sealant tests in compliance with ASTM C1521 Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints, Method A, ASTM C1193 X1- Method A, Guide for Use of Joint Sealants: Field-Applied Sealant Joint Hand Pull Tab, ASTM C794 Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants, and ASTM D4541 Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.
  - c. For joints between dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - d. For sealants that fail adhesively, retest until satisfactory adhesion is obtained. Do not use sealants that fail to adhere to joint substrates during testing.

B. Fenestration Field Water Tests:

1. Test installed fenestration systems according to AAMA 501.2 "Field Check of Metal Storefronts, Curtain Walls and Sloped Glazing Systems For Water Leakage," and ASTM E-1105: Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Differential.
2. Complete testing prior to installation of interior insulation and gypsum board.
3. The Contractor to provide powered scaffold, hose, water supply, communication system and manpower to perform tests.
4. The Contractor will work with the Test Engineer and CxA to determine necessity for additional test methods and for field chamber tests based upon evaluation of initial test results. The BECxA will interpret marginal results and adjust the test procedures as appropriate.
5. The Contractor to perform out-of-sequence work as required facilitating system tests.

C. Fenestration Field Air Leakage Tests:

1. Test installed fenestration systems and interfaces with adjacent substrates according to AAMA 502-08 "Voluntary Specifications for Field Testing of Newly Installed fenestration Products", and AAMA 503-08 "Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls and Sloped Glazing Systems".
2. Test installed fenestration systems and interfaces with adjacent substrates according to ASTM E-783: Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
3. Complete testing prior to installation of interior insulation, gypsum wall board and interior finishes or systems that may impede the completion of the tests.
4. Test specimen to include the perimeter material substrate and the perimeter seals.
5. The Contractor to provide powered scaffold, hose, water supply, communication system and manpower to perform tests.
6. The Contractor will work with the Test Engineer and BECxA to determine necessity for additional test methods and for field chamber tests based upon evaluation of initial test results. The CxA will interpret marginal results and re-write the test procedures as appropriate.
7. The Contractor to perform out-of-sequence work as required facilitating system tests. Contractor to install all air seals / dams concealed within the mullions to facilitate air tests at curtain wall assemblies.

D. Air Barrier Field Air Leakage Tests:

1. Test installed air barrier systems and interfaces with adjacent substrates according to ASTM E1186 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems and ASTM E-783 Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
  2. Complete testing prior to installation of interior insulation, gypsum wall board and interior finishes.
  3. Test specimen to include the perimeter material substrate and the perimeter seals.
  4. Provide powered scaffold, water, electric supply, communication and manpower to perform tests.
  5. The Contractor will work with the Test Engineer and CxA to determine necessity for revised test methods and for field chamber tests based upon evaluation of initial test results. The CxA will interpret marginal results and adjust the test procedures as appropriate.
  6. Contractor to perform out-of-sequence work as required facilitating system tests.
- E. Roof and Waterproofing Field Water and Air Leakage Tests:
1. Test installed roofing systems and interfaces with adjacent substrates using high- or low-voltage electronic leak detection and ASTM C1153 Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging and Capacitance.
  2. Test installed roofing systems and interfaces with adjacent substrates according to ASTM E1186 Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.
  3. Test installed horizontal waterproofing systems and interfaces with adjacent substrates according to ASTM D5957 Guide for Floor Testing Horizontal Waterproofing Installations.
  4. Complete testing prior to installation of interior insulation, gypsum wall board and interior ceiling finishes.
  5. The Contractor will work with the Test Engineer and CxA to determine necessity for revised or supplemental test methods. The CxA will interpret marginal results and adjust the test procedures as appropriate.
- F. Concrete Moisture Tests:
1. Test installed concrete that will serve as a substrate to coating systems, roofing materials, and associated flashings for moisture according to ASTM D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

### **3.03 PRESSURE AND THERMOGRAPHY TEST AGENCY**

- A. Execute building air leakage diagnostic testing by fan pressurization for quantitative analysis and correlated thermography for qualitative analysis per ASTM E779 and ISO 6781, respectively.
- B. Field Work
- C. The lead pressure test technician and thermographer are to be present at the project site while testing is performed and are to be responsible for conducting and supervising their respective test work under management of the BECxA.
- D. Reporting Work
  1. The lead pressure test technician and thermographer present at the project site while testing is performed are to be responsible for conducting, supervising, and reporting of their respective test work under management of the BECxA.
  2. The lead pressure test technician is to prepare, sign, and data the test agenda, equipment list, and submit an Air Leakage Test Report. The thermographer is to prepare, sign, and data the test agenda, equipment list, and submit a Thermographic Investigation Report. These reports are contained in the Building Air Barrier System Test Report.

### **3.04 PREPARING THE BUILDING ENVELOPE FOR THE PRESSURE TEST**

- A. Testing During Construction



- B. The pressure test cannot be conducted until components of the air barrier system have been installed. After sealing as described in related sections has been completed, the installer and CxA will observe the envelope to ensure it has been adequately prepared. During the pressure test, stop all ongoing construction within and neighboring the envelope, which may impact the test or the air barrier integrity. The pressure test may be conducted before finishes that are not part of the air barrier envelope have been installed. For example, if suspended ceiling tile, interior gypsum board or cladding systems are not part of the air barrier the test can be conducted before they are installed. Testing prior to installing the finished ceilings within the envelope and immediately surrounding it is recommended. The absence of finished ceilings allows for observation and diagnostic testing of the roof/wall interface and for implementation of repairs to the air barrier, if necessary, to comply with the maximum allowed leakage.
- C. Sealing the Air Barrier Envelope
- D. Installers shall seal penetrations through the air barrier. Unavoidable penetrations due to electrical boxes or conduit, plumbing, and other assemblies that are not airtight are to be made so by sealing the assembly and the interface between the assembly and the air barrier or by extending the air barrier over the assembly. Support the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage. The Contractor shall durably construct the air barrier to last the anticipated service life of the assembly and to withstand the maximum positive and negative pressures placed on it during pressure testing.
- E. Minimize Potential for Blowing Dust and Debris
- F. Because high velocity air may be blown into and out of the envelope during the test, debris, including dust and litter, may become airborne, debris may become trapped or entangled in test equipment, thereby skewing test results and possibly damaging the test equipment. Areas within and surrounding the envelope are to be free of dust, litter and construction materials that are easily airborne. If pressurizing existing, occupied areas, provide adequate notice to the building occupants of blowing dust and debris, and general disruption of normal activities during the test.
- G. Installing Blower Door Equipment in a Door Opening
- H. Where blower door fans are used, before installing blower door equipment, select a door opening that does not restrict air flow into and out of the envelope and has at least 5 feet clear distance in front of and behind the door opening. Disconnect the door actuator and secure the door open to prevent it from being drawn into the fan by suction pressure.

### **3.05 LOCATING LEAKS BY DIAGNOSTIC TESTING**

- A. Use diagnostic test methods described herein to discover obvious leaks through the envelope. Perform diagnostic tests on the building envelope regardless of the envelope meeting or failing to meet the designated leakage rate goal. Use diagnostic test methods in accordance with ASTM E1186 and in conjunction with pressurization equipment as necessary. Use the thermography diagnostic test to establish a baseline for envelope leakage. Using a variety of diagnostic tests may help locate leaks that would otherwise go undetected if only a single diagnostic test were used. Pay special attention to locating leaks at interfaces where there is a change in materials or a change in direction of like materials. These interfaces, at a minimum, include roof/wall, wall/wall, floor/wall, wall/window, wall/door, wall/louver, roof mounted equipment/roof curb interfaces and all utility penetrations (ducts, pipes, conduits, etc) through the envelope's architecture. Also use diagnostic tests to check for leakage between the air duct and duct damper, when the damper, under normal control power, is placed in the closed position. Should leaks be discovered during diagnostic tests, thoroughly document their exact locations on a floor plan so that sealing can be later applied. If the envelope passes the leakage test, use the diagnostic test procedure described above to identify obvious leakage locations. Seal the leaks at the discretion of the Architect-of-Record based on the magnitude, location, potential for liquid moisture penetration or retention, potential for condensation, presence for condensation, presence of daylight through an architectural surface or if the leakage location could potentially cause rapid deterioration or mold growth of, or in the building

envelope materials and assemblies. Installer shall apply sealing measures after diagnostic testing is complete and all pressurization blowers are off. To verify that the applied sealing measures are effective, re-test for leaks using the same diagnostic methods that discovered the leak. Reseal and retest until the envelope meets the leakage rate goal and all obvious leaks through the envelope are sealed.

1. Infrared Thermography Test
  2. Coordinate thermography examination with the pressure test agency and the test agency's pressurization equipment as directed by the CxA. The pressure test agency is to allow adequate time for the thermographer to perform a complete thermographic examination, as described hereinafter, of the envelope interior under negative relative pressure conditions and exterior under positive relative pressure conditions.
  3. Thermography Testing of the Air Barrier
- B. Keep the envelope at a pressure differential of -20 Pa with respect to the outdoors using pressure test equipment.

### **3.06 AFTER COMPLETION OF THE PRESSURE AND/OR DIAGNOSTIC TEST**

- A. After all pressure and/or diagnostic testing has been completed the Contractor will unseal all temporarily sealed items. Under direction of the Contractor, return all dampers, doors, and windows to their pre-test conditions. The Contractor shall remove taps and plastic from all temporarily sealed openings, being careful not to deface painted surfaces. If paint is removed from finished surface, the Contractor will repaint to match existing surfaces. Return all fans and air handling units to pre-test conditions.

### **3.07 REPAIR AND PROTECTION**

- A. Repair and protection are the Contractor's responsibility, regardless of the assignment of responsibility for testing, observation, and similar services. Upon completion of observation, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

**END OF SECTION**

## **SECTION 220800 - COMMISSIONING OF PLUMBING**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. The School District of Philadelphia has procured a third party Commissioning Authority (CA) to act on its behalf regarding Commissioning of Systems included in the scope of this project. The Plumbing Contractor is required to coordinate with the Commissioning Authority and assist the Commissioning Authority with execution of the Commissioning process including the items detailed in this specification section.
- B. This section covers the Plumbing Contractors' responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use. It is the responsibility of the Plumbing Contractor to complete these Checklists and Procedures.
- D. The Plumbing Contractor may be responsible for portions of Commissioning Scope associated with General, Mechanical, or Electrical Systems. Refer to those respective Commissioning Specifications Sections.
- E. The new Plumbing equipment is to be commissioned, including - but not limited to - the following
  - 1. Domestic Water Heater
  - 2. Plumbing Control systems.
  - 3. Pumps.
  - 4. Plumbing Fixtures.
  - 5. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- F. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

#### **1.02 REFERENCE STANDARDS**

- A. ASHRAE Guideline 1.1 - The HVAC&R Technical Requirements for the Commissioning Process 2007, with Errata (2012).

#### **1.03 SUBMITTALS**

- A. See General Conditions and Supplementary Conditions for Submittal Requirements.
- B. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- C. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
  - 1. System name.
  - 2. List of devices.
  - 3. Step-by-step procedures for testing each controller after installation, including:
    - a. Process of verifying proper hardware and wiring installation.
    - b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
    - c. Process of performing operational checks of each controlled component.
    - d. Plan and process for calibrating valve and damper actuators and all sensors.

- e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
  - 4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has "passed" and is operating within the contract parameters.
  - 5. Description of the instrumentation required for testing.
  - 6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.
- D. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- E. Plumbing Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
- 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
  - 2. Full as-built set of control drawings.
  - 3. Full as-built sequence of operations for each piece of equipment.
  - 4. Full points list.
  - 5. Full print out of all schedules and set points after testing and acceptance of the system.
  - 6. Full as-built print out of software program.
  - 7. Electronic copy on disk of the entire program for this facility.
  - 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC and Plumbing drawings with their control system designations.
  - 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
  - 10. Control equipment component submittals, parts lists, etc.
  - 11. Warranty requirements.
  - 12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
  - 13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
    - a. Sequences of operation.
    - b. Control drawings.
    - c. Points lists.
    - d. Controller and/or module data.
    - e. Thermostats and timers.
    - f. Sensors and DP switches.
    - g. Valves and valve actuators.
    - h. Dampers and damper actuators.
    - i. Program setups (software program printouts).
- F. Project Record Documents: See Section General Conditions and Supplementary Conditions for additional requirements.
- 1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
  - 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- G. Draft Training Plan: In addition to requirements specified in General Conditions and Supplementary Conditions, include:
- 1. Follow the recommendations of ASHRAE Guideline 1.1.
  - 2. Control system manufacturer's recommended training.

3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC and Plumbing control systems.
- H. Training Manuals: See Section General Conditions and Supplementary Conditions for additional requirements.
  1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

#### **1.04 WARRANTY**

- A. Provide five year extended warranty for all equipment, accessories, and workmanship.

### **PART 2 PRODUCTS**

#### **2.01 TEST EQUIPMENT**

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Provide documentation that all testing equipment is calibrated and calibration has not expired.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. The Plumbing Contractor and appropriate subcontractor shall attend the initial kickoff commissioning meeting conducted at the start of construction and the commissioning meeting held 30 days prior to startup of the primary equipment.
- B. The Plumbing Contractor shall attend bi-weekly commissioning team meetings throughout construction.
- C. Cooperate with the Commissioning Authority in execution of the Prefunctional Checklists and Functional Test Procedures.
- D. Furnish additional information requested by the Commissioning Authority.
- E. Prepare a preliminary schedule for Plumbing pipe testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- F. Notify the Commissioning Authority when pipe system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- G. Put all Plumbing equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
- H. Provide temperature and pressure taps in accordance with Contract Documents.

#### **3.02 INSPECTING AND TESTING - GENERAL**

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform and clearly document all completed startup, pre-functional checklists, and system operational checkout procedures, providing a copy to the Commissioning Authority.
  1. Provide the Commissioning Authority 14 calendar days' notice to schedule startup, pre-functional checklists, and checkout procedures so that Commissioning Authority can be present to observe execution.

2. Provide executed documentation within 5 business days.
- C. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
  1. The Commissioning Authority writes, coordinates, witnesses, and conducts functional performance test procedures. Contractors for each trade shall provide the necessary support to the Commissioning Authority to complete functional testing.
  2. Address all punch list items and Commissioning corrective action items before functional testing. Air TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air related systems.
  3. Provide the Commissioning Authority 14 calendar days' notice to schedule Functional Performance Testing.
    - a. Discrepancies or miscommunications regarding the status of HVAC equipment and systems' status that lead to lost or wasted effort for the Commissioning Authority are the sole liability of the HVAC Contractor.
  4. Sign-off on all completed Functional Performance Tests.
- D. Provide two-way radios for use during the testing.
- E. Valve Stroke Setup and Check:
  1. For all valve actuator positions checked, verify the actual position against the control system readout.
  2. Set pump to normal operating mode.
  3. Command valve closed; visually verify that valve is closed and adjust output zero signal as required.
  4. Command valve to a few intermediate positions.
  5. If actual valve position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
- F. Isolation Valve or System Valve Leak Check: For valves not by coils.
  1. With full pressure in the system, command valve closed.
  2. Use an ultra-sonic flow meter to detect flow or leakage.
- G. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

### **3.03 TAB COORDINATION**

- A. Coordinate commissioning schedule with TAB schedule.
- B. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
- C. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
- D. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.
- E. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

### **3.04 PLUMBING SYSTEM FUNCTIONAL TESTING**

- A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. The Contractor shall complete Systems Readiness Checklists to verify systems, sub-systems, and equipment installation is complete and systems are ready for Systems Functional Testing. The Commissioning Authority will prepare Systems Readiness Checklists to be used to

document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the OWNER and to the Commissioning Authority for review. The Commissioning Authority may spot-check a sample of completed checklists. If the Commissioning Authority determines that the information provided on the checklist is not accurate, the Commissioning Authority will return the marked-up checklist to the Contractor for correction and re-submission. If the Commissioning Authority determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Authority will select a broader sample of checklists for review. If the Commissioning Authority determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and re-submission. Refer to General Commissioning Requirements in Architectural Specifications for submittal requirements for System Readiness Checklists, Equipment Startup Reports, and other commissioning documents.

- C. Contractor tests as required by other sections of Division 22 shall be scheduled and documented. The Commissioning Authority will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.
- D. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Authority will prepare detailed Systems Functional Performance Test procedures for review and approval by the Owner's Representative. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Authority will direct and document the testing. The Contractor shall sign the test reports to verify tests were performed.
- E. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- F. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- G. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
  - 1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
  - 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- H. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- I. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
  - 1. Setpoint changing features and functions.
  - 2. Sensor calibrations.
- J. Demonstrate to the Commissioning Authority:
  - 1. That all specified functions and features are set up, debugged and fully operable.
  - 2. That scheduling features are fully functional and setup, including holidays.
  - 3. That all graphic screens and value readouts are completed.
  - 4. Correct date and time setting in central computer.
  - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.

6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
  7. Power failure and battery backup and power-up restart functions.
  8. Global commands features.
  9. Security and access codes.
  10. Occupant over-rides (manual, telephone, key, keypad, etc.).
  11. O&M schedules and alarms.
  12. All control strategies and sequences not tested during controlled equipment testing.
- K. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

### **3.05 OPERATION AND MAINTENANCE MANUALS**

- A. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- B. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- C. Commissioning Authority will add commissioning records to manuals after submission to Owner.

### **3.06 DEMONSTRATION AND TRAINING**

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative and Commissioning Authority. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans.
- B. Demonstrate operation and maintenance of Plumbing systems to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the Plumbing system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. TAB Review: Instruct Owner's personnel for minimum 4 hours, after completion of TAB, on the following:
  1. Review final TAB report, explaining the layout and meanings of each data type.
  2. Discuss any outstanding deficient items in control or design that may affect the proper delivery of water.
  3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
  4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
  5. Other salient information that may be useful for facility operations, relative to TAB.
- F. Plumbing Control System Training: Perform training in at least three phases:
  1. Phase 1 - Basic Control System: Provide minimum of 4 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate



documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.

- a. This training may be held on-site or at the manufacturer's facility.
  - b. If held off-site, the training may occur prior to final completion of the system installation.
  - c. For off-site training, Contractor shall pay expenses of up to two attendees.
2. Phase 2 - Integrating with Plumbing Systems: Provide minimum of 4 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
- a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
  - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
  - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
  - d. Every display screen, allowing time for questions.
  - e. Point database entry and modifications.
3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 4 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- G. Provide the services of manufacturer representatives to assist instructors where necessary.
- H. Provide the services of the Plumbing controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

**END OF SECTION**

SECTION 230990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.
- C. Measurement of final operating condition of HVAC systems.

1.2 REFERENCES

- A. AABC - National Standards for Total System Balance
- B. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems
- C. SMACNA - HVAC Systems Testing, Adjusting, and Balancing

1.3 SUBMITTALS

- A. Submit in accordance with provisions of Section 230010.
- B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Provide reports in binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include sets of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.
- E. Test Reports: Indicate data on Standard AABC or NEBB Forms.

1.4 SEQUENCING

- A. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION

3.1 AGENCIES

- A. Work shall be performed by HVAC Contractor who shall provide preliminary balancing.

- B. Mechanical Contractor shall hire an independent air balancing firm to do final air and water balancing and preparation of reports.

### 3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  1. Systems are started and operating in a safe and normal condition.
  2. Temperature control systems are installed complete and operable.
  3. Proper thermal overload protection is in place for electrical equipment.
  4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  5. Duct systems are clean of debris.
  6. Fans are rotating correctly.
  7. Fire and volume dampers are in place and open.
  8. Air coil fins are cleaned and combed.
  9. Access doors are closed, and duct end caps are in place.
  10. Air outlets are installed and connected.
  11. Duct system leakage is minimized.
  12. Hydronic systems are flushed, filled, and vented.
  13. Pumps are rotating correctly.
  14. Proper strainer baskets are clean and in place.
  15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance as soon as observed.
- C. Beginning of work means acceptance of existing conditions.

### 3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations.
- B. Provide additional balancing devices as required.

### 3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within  $\pm 5\%$  of design for supply systems and  $\pm 10\%$  of design for return and exhaust systems.
- B. Hydronic Systems: Adjust to within  $\pm 10\%$  of design.

### 3.5 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. Recheck points or areas as selected and witnessed by the Owner.

### 3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50% loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

### 3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

END OF SECTION 230990

## **SECTION 230800 - COMMISSIONING OF HVAC**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. The School District of Philadelphia has procured a third party Commissioning Authority (CA) to act on its behalf regarding Commissioning of Systems included in the scope of this project. The Mechanical Contractor is required to coordinate with the Commissioning Authority and assist the Commissioning Authority with execution of the Commissioning process including the items detailed in this specification section.
- B. This section covers the Mechanical Contractor's responsibilities for HVAC commissioning; each subcontractor (e.g. TAB Contractor, Controls Contractor) or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractors' use. It is the responsibility of the Mechanical Contractor to complete these Checklists and Procedures.
- D. The Mechanical Contractor may be responsible for portions of Commissioning Scope associated with General, Plumbing, or Electrical Systems. Refer to those respective Commissioning Specifications Sections.
- E. The entire HVAC system is to be commissioned, including - but not limited to - commissioning activities for the following specific items:
  - 1. Building Automation System (BAS)
  - 2. Rooftop Air Handling Units
  - 3. Fan Powered VAV Terminal Boxes
  - 4. Single Duct VAV Terminal Boxes
  - 5. Ductless Air Conditioning Units
  - 6. 4-Pipe Fan Coil Units
  - 7. Air cooled Chiller
  - 8. Condensing Boilers
  - 9. Circulating pumps
  - 10. Direct Expansion (DX) Makeup Air Unit
  - 11. Exhaust Fans
  - 12. Valves and Dampers
  - 13. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- F. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

#### **1.02 REFERENCE STANDARDS**

- A. ASHRAE Guideline 1.1 - The HVAC&R Technical Requirements for the Commissioning Process 2007, with Errata (2012).

#### **1.03 SUBMITTALS**

- A. Refer to General Conditions and Supplementary Conditions for Submittal Requirements.
- B. Copy Commissioning Authority on all submittal communications.
  - 1. Provide one copy of approved shop drawings, sequence of operations and startup reports for all commissioned equipment to the CA. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.
- C. The Contractor shall send one copy of product data, shop drawings and similar submittals to the at the same time they are submitted to the A/E. The Commissioning Authority will review the submittals and provide any comments to the A/E for inclusion in their comments. The

Architect will transmit to the Commissioning Authority, for the Commissioning Authority's use in preparing functional test procedures; one reviewed and approved copy of product data, shop drawings and similar submittals received from the HVAC, Controls and TAB Contractors, pertinent to equipment and systems to be commissioned.

- D. Provide calibration certificates for all field-installed instruments, factory-installed instruments, and instruments to be used during commissioning.
- E. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- F. Manufacturer's Startup Reports and Trend Logs: Submit for review by Commissioning Authority.
- G. BAS Checkout plan, executed point-to-point-checkout, calibration certificates, executed valve leak-by tests, and certification letter indicating that the BAS is ready for functional performance testing.
- H. HVAC Control System O&M Manual Requirements. The Operation and Maintenance Manuals shall be submitted to the CA prior to the start of training (3 weeks before start-up and training and at least 60 days before substantial completion).d. During the startup and initial checkout process, execute all portions of the manufacturer's start-up checklists, for all commissioned HVAC equipment. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
  - 1. Executed Pre-Functional Checklists
  - 2. Executed Functional Performance
  - 3. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
  - 4. Full as-built set of control drawings.
  - 5. Full as-built sequence of operations for each piece of equipment.
  - 6. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
    - a. Floor.
    - b. Room number.
    - c. Room name.
    - d. Air handler unit ID.
    - e. Reference drawing number.
    - f. Air terminal unit tag ID.
    - g. Heating and/or cooling valve tag ID.
    - h. Minimum air flow rate.
    - i. Maximum air flow rate.
  - 7. Full print out of all schedules and set points after testing and acceptance of the system.
  - 8. Full as-built print out of software program.
  - 9. Electronic copy on disk of the entire program for this facility.
  - 10. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
  - 11. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
  - 12. Control equipment component submittals, parts lists, etc.
  - 13. Warranty requirements.
  - 14. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
  - 15. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:

- a. Sequences of operation.
  - b. Control drawings.
  - c. Points lists.
  - d. Controller and/or module data.
  - e. Thermostats and timers.
  - f. Sensors and DP switches.
  - g. Valves and valve actuators.
  - h. Dampers and damper actuators.
  - i. Program setups (software program printouts).
- I. Project Record Documents:
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
  2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- J. Draft Training Plan:
1. Follow the recommendations of ASHRAE Guideline 1.1.
  2. Control system manufacturer's recommended training.
  3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- K. Training Manuals:
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

#### **1.04 WARRANTY**

- A. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
- B. Correct deficiencies and make necessary adjustments to O&M manuals for applicable issues identified in any seasonal testing.

### **PART 2 PRODUCTS**

#### **2.01 TEST EQUIPMENT**

- A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.
- C. The Controls Contractor shall provide all standard testing equipment required to test the Building
- D. The Controls Contractor shall provide all standard testing equipment required to test the Building Automation and Automatic Temperature Control System (BAS), including calibration of valve and damper actuators and all sensors. Trend logs for functional testing shall be generated through the BAS interface, as requested by the CA. Otherwise, the CA will collect test data with data loggers.
- E. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the following tolerances. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 degrees F and a resolution of  $\pm 0.1$  degrees F. Pressure sensors shall have an accuracy of  $\pm 2.0\%$  of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment



shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

### **PART 3 EXECUTION**

#### **3.01 PREPARATION**

- A. The Mechanical Contractor, BAS subcontractor, and TAB subcontractor shall attend the initial kickoff commissioning meeting conducted at the start of construction and the commissioning meeting held 30 days prior to startup of the primary equipment.
- B. The Mechanical Contractor shall attend bi-weekly commissioning team meetings throughout construction.
- C. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- D. Furnish additional information requested by the Commissioning Authority.
- E. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Authority; update the schedule as appropriate.
- F. Notify the Commissioning Authority when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- G. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
  - 1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.
- H. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- I. Provide temperature and pressure taps in accordance with Contract Documents.

#### **3.02 INSPECTING AND TESTING - GENERAL**

- A. The HVAC, Controls and TAB Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section. Equipment start-up is required to complete systems and sub-systems so they are fully functional, in compliance with the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Authority or Owner.
- B. Testing is intended to begin upon completion of a system. Coordinate scheduling of testing with SDP and the Commissioning Authority.
- C. The HVAC, Controls, and TAB Contractors shall provide the necessary support to the CA to complete functional testing. The Controls Contractor shall fully test and verify all aspects of the BAS Contract Work on a point / system / integrated operational basis for all points, features and functions specified. The following requirements apply to all mechanical and control systems and features that are to be commissioned when referenced below. Tests shall:
  - 1. Verify functionality and compliance with the basis of design for each individual sequence module in the sequence of operations. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance. Tests shall include startup, normal operation, shutdown, scheduled 'on' and 'off', unoccupied, and manual modes, safeties, alarms, over-rides, lockouts, and power failure.
  - 2. Verify operation of systems and components that may be impacted during low, normal, and high load conditions and during combinations of environmental and interacting equipment conditions that could reasonably exist and potentially result in adverse system reaction.

3. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.
  4. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
  5. Verify shutdown and restart capabilities both for scheduled and unscheduled events (e.g. power failure recovery and normal scheduled start / stop).
  6. Verify proper sequencing of heat transfer elements as required to prevent simultaneous heating and cooling, unless specifically required for dehumidification operation.
  7. Verify system response and stability of control loops under different load conditions and determine if additional loop tuning is required by the Controls Contractor.
  8. When applicable, demonstrate a full cycle from 'off' to 'on' and 'no load' to 'full load' and then to 'no load' and 'off'.
  9. Verify time of day schedules and setpoints.
  10. Verify all energy saving control strategies.
  11. Verify that all control system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
  12. Verify operator control of all adjustable control system points including proper access level as agreed to during the controls system demonstration.
- D. In addition to specific details, and/or standards referenced for acceptance testing indicated in other Division 23 sections, the following common acceptance criteria apply to all mechanical equipment, assemblies, and features:
1. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequence of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications.
  2. Systems shall accomplish their intended function and performance (e.g. provide supply air and water at designated temperature and flow rate, etc., and maintain space conditions in terms of air temperature, relative humidity, and CO2 concentration) at specified levels at varying conditions.
  3. Control loops shall be stable under all operating conditions. Control loops shall exhibit a quarter decay ratio type responses to a step change or other upset and return to stable operation in a time frame that is reasonable and realistic for the system that they are associated with.
  4. All safety trips shall require a manual reset to allow a system restart, unless otherwise explicitly stated in the specified sequence of operation.
  5. Resetting a manual safety shall result in a stable, safe, and predictable return to normal operation by the system.
  6. Safety circuits and permissive control circuits shall function in all possible combinations of selector switch positions (hand, auto, inverter, bypass, etc.).
  7. Additional acceptance criteria will be defined by the CA when detailed tested procedures are developed.
- E. At the Commissioning Authority's discretion, if large numbers or repeated deficiencies are encountered, the Commissioning Authority shall suspend functional testing until the Contractor corrects the deficiencies and troubleshoots all remaining systems at issue on their own. The Contractor shall be responsible for any resulting schedule delays that increase the overall time period to complete functional testing.
- F. Perform and clearly document all completed startup, pre-functional checklists, and system operational checkout procedures, providing a copy to the Commissioning Authority.
1. Provide the Commissioning Authority 14 calendar days' notice to schedule startup, pre-functional checklists, and checkout procedures so that Commissioning Authority can be present to observe execution.
  2. Provide executed documentation within 5 business days.

- G. Perform the Functional Performance Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
  - 1. The Commissioning Authority writes, coordinates, witnesses, and conducts functional performance test procedures. Contractors for each trade shall provide the necessary support to the Commissioning Authority to complete functional testing.
  - 2. Address all punch list items and Commissioning corrective action items before functional testing. Air TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air related systems.
  - 3. Provide the Commissioning Authority 14 calendar days' notice to schedule Functional Performance Testing.
    - a. Discrepancies or miscommunications regarding the status of HVAC equipment and systems' status that lead to lost or wasted effort for the Commissioning Authority are the sole liability of the HVAC Contractor.
  - 4. Sign-off on all completed Functional Performance Tests.
- H. Provide skilled technicians to execute starting of equipment and to perform tests in accordance with all Division 23 sections. Where specified, startup shall be performed by a factory authorized service representative. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- I. Provide two-way radios for use during the testing.
- J. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

### **3.03 HVAC CONTRACTOR RESPONSIBILITIES**

- A. The responsibilities of the HVAC Contractor, during construction and acceptance phases in addition to those listed above are:
  - 1. Provide startup for all HVAC equipment.
  - 2. Calibrations: The HVAC Contractor is responsible to calibrate all factory installed sensors and actuators. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated by the HVAC Contractor.
  - 3. Supervise all commissioning activities executed by subcontractors, including the Controls Contractor and TAB Contractor.
  - 4. The HVAC contractor is responsible to calibrate all factory installed sensors and actuators.
    - a. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
  - 5. List and clearly identify on the as-built duct and piping drawings the locations of all fire dampers, duct detectors, temperature sensors, relative humidity sensors, static and differential pressure sensors (air and building pressure).
  - 6. Provide As-Built documentation clearly indicating any changes from the design documentation.

### **3.04 TESTING, ADJUSTING, AND BALANCING (TAB) CONTRACTOR RESPONSIBILITIES**

- A. Refer to Section 230990.
- B. The responsibilities of the TAB Contractor, during construction and acceptance phases in addition to those listed above are:
  - 1. Coordinate TAB schedule with commissioning schedule.
  - 2. Review the TAB plan to determine the capabilities of the control system toward completing TAB.
  - 3. Provide all necessary unique instruments and instruct the TAB technicians in their use; such as handheld control system interface for setting terminal unit boxes, etc.
  - 4. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Authority prior to starting TAB.

5. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.
6. Submit draft of report format to Commissioning Authority for review no fewer than 30 days prior to start of TAB.
7. Submit executed TAB report to Commissioning Authority within 5 business days of TAB execution.

### **3.05 CONTROLS CONTRACTOR RESPONSIBILITIES**

- A. The commissioning responsibilities of the Controls Contractor, during construction and acceptance phases in addition to those listed above are:
  1. Sequences of Operation Submittals. The Controls Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the bid document specifications. They shall include:
    - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components, and function.
    - b. Logic diagrams detailing the flow of information for each control algorithm. These diagrams should include all inputs, outputs, and computations.
    - c. All interactions and interlocks with other systems.
    - d. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
    - e. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included but will generally require additional narrative).
    - f. Start-up sequences.
    - g. Warm-up mode sequences.
    - h. Normal operating mode sequences.
    - i. Unoccupied mode sequences.
    - j. Shutdown sequences.
    - k. Capacity control sequences and equipment staging.
    - l. Temperature and pressure control: setbacks, setups, resets, etc.
    - m. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
    - n. Effects of power or equipment failure with all standby component functions.
    - o. Sequences for all alarms and emergency shutdowns.
    - p. Seasonal operational differences and recommendations.
    - q. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
    - r. Schedules, if known.
    - s. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference. Where possible, the numbering sequence shall correspond with Section 230900 "ATC Systems".
  2. Control Drawings Submittal:
    - a. The control drawings shall have a key to all abbreviations.
    - b. The control drawings shall contain graphic schematic depictions of the systems and each component as well as the proposed graphical Human Machine Interface (HMI) screens.
    - c. The schematics shall include the system and component layout of any equipment that the control system monitors, enables, or controls, even if the equipment is primarily controlled by packaged or integral controls.

- d. Provide a full points list with at least the following included for each point:
  - 1) Controlled system
  - 2) Point abbreviation
  - 3) Point description
  - 4) Display unit
  - 5) Control point or setpoint (Yes / No)
  - 6) Input point (Yes / No)
  - 7) Output point (Yes / No)
  - 8) The Controls Contractor shall keep the Owner, Architect, Engineer, Commissioning Authority, HVAC Contractor, and TAB Contractor informed of all changes to this list during programming and setup.
3. Submit a written checkout plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional testing. At minimum, the checkout plan shall include for each type of equipment controlled by the building automation system:
  - a. System name.
  - b. List of devices.
  - c. Step-by-step procedures for testing each controller after installation, including:
    - 1) Process of verifying proper hardware and wiring installation.
    - 2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
    - 3) Process for performing and documenting point-to-point checkout for each digital and analog input and output.
    - 4) Process of performing operational checks of each controlled component.
    - 5) Plan and process for calibrating valve and damper actuators and all sensors.
    - 6) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
  - d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor, controller or command has "passed" and is operating within the contract parameters.
  - e. A description of the instrumentation required for testing.
  - f. Indicate the portion of the controls checkout plan that should be completed prior to TAB using the controls system for TAB work. Coordinate with the CA and TAB Contractor for this determination.
4. Point-to-Point Checkout: Include in the checkout plan a point-to-point checkout. Each control point tied to a central control system shall be verified to be commanding, reporting, and controlling according to its intended purpose. For each output, commands shall be initiated and verified to be functioning by visually observing and documenting the status of the controlled device in the field (e.g. valve or damper actuator response, pump, or fan status). For each input, the system or conditions shall be altered to initiate the input response being tested and the response in the control system observed and recorded (e.g. high duct static pressure alarm).
5. The Controls Contractor is responsible to calibrate all field installed sensors and actuators using test and documentation methods approved by the Commissioning Authority.
  - a. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated
6. The Controls Contractor is responsible to providing valve leak-by testing for control valves.
  - a. All Isolation valves not near coils: with full pressure in the system, command valve closed, use an ultra-sonic flow meter to detect flow or leakage.
  - b. All Isolation valves at coils with greater than or equal to 15 GPM: provide balancing valve leak-by testing.

- c. Isolation valves at coils with less than 15 GPM: Sample 25% of isolation valves with discharge air monitoring, leaving water temperature monitoring, infrared thermometer monitoring, or coil drain-down leak-by testing.
    - d. Furnish a report to the Commissioning Authority indicating the results of all leak-by tests.
  7. All procedures used shall be fully documented by the Controls Contractor on suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate, and final results.
  8. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as indicated in the Specifications.
  9. Provide a signed and dated certification to the Commissioning Authority upon completion of the Building Automation and Automatic Temperature Control System (BAS) installation, including checkout and calibration of each controlled device, that all system programming is complete as to all respects of the Contract Documents. This shall be submitted by the Controls Contractor prior to the start of functional testing by the Commissioning Authority.
- B. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- C. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- D. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- E. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
  1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
  2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- F. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- G. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
  1. Setpoint changing features and functions.
  2. Sensor calibrations.
- H. Demonstrate to the Commissioning Authority:
  1. That all specified functions and features are set up, debugged and fully operable.
  2. That scheduling features are fully functional and setup, including holidays.
  3. That all graphic screens and value readouts are completed.
  4. Correct date and time setting in central computer.
  5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
  6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
  7. Power failure and battery backup and power-up restart functions.
  8. Global commands features.
  9. Security and access codes.

10. Occupant over-rides (manual, telephone, key, keypad, etc.).
  11. O&M schedules and alarms.
  12. Occupancy sensors and controls.
  13. All control strategies and sequences not tested during controlled equipment testing.
- I. Perform and submit trend logging on the following using the control system, for minimum period of 5 days including one weekend, if the control points are monitored by the control system:
  - J. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

### **3.06 OPERATION AND MAINTENANCE MANUALS**

- A. See General Conditions and Supplementary Conditions for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

### **3.07 DEMONSTRATION AND TRAINING**

- A. See General Conditions and Supplementary Conditions for additional requirements.
- B. Provide training of Owner's operating staff as specified in Division 23 Sections. Use expert qualified personnel.
- C. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- D. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- E. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- F. TAB Review: Instruct Owner's personnel for minimum 4 hours, after completion of TAB, on the following:
  1. Review final TAB report, explaining the layout and meanings of each data type.
  2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
  3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
  4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
  5. Other salient information that may be useful for facility operations, relative to TAB.
- G. HVAC Control System Training: Perform training in at least three phases:
  1. Phase 1 - Basic Control System: Provide minimum of 8 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
    - a. This training may be held on-site or at the manufacturer's facility.
    - b. If held off-site, the training may occur prior to final completion of the system installation.

- c. For off-site training, Contractor shall pay expenses of up to two attendees.
- 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 8 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
  - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
  - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
  - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
  - d. Every display screen, allowing time for questions.
  - e. Point database entry and modifications.
- 3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 8 hours of training. Tailor training session to questions and topics solicited beforehand from Owner . Also be prepared to address topics brought up and answer questions concerning operation of the system.
- H. Provide the services of manufacturer representatives to assist instructors where necessary.
- I. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

**END OF SECTION**



## **SECTION 260800 - COMMISSIONING OF ELECTRICAL**

### **PART 1 GENERAL**

#### **1.01 SUMMARY**

- A. The School District of Philadelphia has procured a third party Commissioning Authority (CA) to act on its behalf regarding Commissioning of Systems included in the scope of this project. The Electrical Contractor is required to coordinate with the Commissioning Authority and assist the Commissioning Authority with execution of the Commissioning process including the items detailed in this specification section.
- B. This section covers the Contractors' responsibilities for Electrical commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C. The Commissioning Authority directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use. It is the responsibility of the Electrical Contractor to complete these Checklists and Procedures.
- D. The Electrical Contractor may be responsible for portions of Commissioning Scope associated with General, Plumbing, or Mechanical Systems. Refer to those respective Commissioning Specifications Sections.
- E. Electrical systems to be commissioned include the following specific systems and associated items:
  - 1. Lighting Control System
  - 2. Photovoltaic System
- F. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.
- G. Commissioning work shall be a team effort to ensure that all electrical equipment and systems have been completely and properly installed, function together correctly to meet the design intent, and document system performance. Commissioning shall coordinate system documentation, equipment start-up, and verification and performance testing.
- H. The commissioning team shall be made up of representatives from the Owner, design professionals, major equipment suppliers, and electrical contractor. The lead person for each trade who will actually perform or supervise the work is to be designated as the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.
- I. The Commissioning Authority shall have responsibility for coordinating and directing each step of the commissioning process. The Authority shall be a true third party, not affiliated with any of the companies involved with the project design.
- J. Electrical system installation, start-up, testing, preparation of O&M manuals, and operator training are the responsibility of the Division 26 Electrical Contractor, with coordination, observation, verification and commissioning the responsibility of Commissioning Authority.
- K. The commissioning process does not relieve the Division 26 Electrical Contractor from the obligations to complete all portions of work in a satisfactory and fully operational manner.

#### **1.02 REFERENCE STANDARDS**

- A. IES DG-29-11 – The Commissioning Process Applied to Lighting and Control Systems.

#### **1.03 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. The CTC (Certified Testing Company) performing the work of this section shall be qualified to test electrical equipment and is a NETA (National Electrical Testing Association)-certified testing agency. The CTC shall not be associated with the manufacturer of equipment or systems under test.

#### 1.04 SUBMITTALS

- A. Refer to General Conditions and Supplementary Conditions for Submittal Requirements.
- B. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- C. DRAFT Prefunctional Checklists and Functional Test Procedures:
  - 1. Lighting Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
    - a. Room/Area name.
    - b. List of devices.
    - c. Step-by-step procedures for testing each lighting room controller or lighting control panel after installation, including:
      - 1) Process of verifying proper equipment and wiring installation.
      - 2) Process of downloading programs to local room controllers or lighting control panels and verifying that they are programmed correctly.
      - 3) Process of performing operational checks of each room's component.
      - 4) Plan and process for calibrating all sensors.
      - 5) Description of the expected field adjustments for room controllers, lighting control panels, local control switches, and automatic lighting control devices should control responses fall outside of expected values.
    - d. Copy of proposed log and field checkout sheets to be used to document the process.
    - e. Description of the equipment required for testing.
  - 2. Photovoltaic System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
    - a. Panel/Inverter name.
    - b. List of devices.
    - c. Step-by-step procedures for testing each photovoltaic panel after installation, including:
      - 1) Process of verifying proper equipment and wiring installation.
      - 2) Process of verifying panel is functional.
      - 3) Description of the expected field adjustments for panels should they be partially functional or non-functional.
    - d. Copy of proposed log and field checkout sheets to be used to document the process.
    - e. Description of the equipment required for testing along with the equipment's most recent calibration information.
- D. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- E. Lighting Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the lighting control system:
  - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents.
  - 2. Full as-built set of lighting control drawings.
  - 3. Full as-built sequence of operations for typical control scenarios in different areas (i.e. classrooms, cafeteria, gymnasium, offices, corridors, exterior, etc.).
  - 4. Marking of all system room controllers, control panels, and sensors on the as-built floor plan and Electrical drawings.
  - 5. Maintenance instructions, including sensor calibration requirements, and cleaning methods by sensor type, etc.
  - 6. Control equipment component submittals, parts lists, etc.

7. Warranty requirements.
8. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
  - a. Sequences of operation.
  - b. Control and Wiring Diagram drawings.
  - c. Room Controllers
  - d. Sensors
  - e. Wiring/Accessories
  - f. Room Controller program setups.
- F. Photovoltaic System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the photovoltaic system:
  1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents.
  2. Full as-built set of all system equipment drawings.
  3. Full as-built sequence of operations for each Inverter.
  4. Marking of all system equipment on the as-built floor plan and Electrical drawings.
  5. Maintenance instructions per equipment manufacturers recommendations for photovoltaic panels, inverters, and accessories.
  6. Equipment component submittals, parts lists, etc.
  7. Warranty requirements.
  8. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
    - a. Sequences of operation
    - b. Control and Wiring Diagram drawings
    - c. Photovoltaic Panels
    - d. Inverters
    - e. Wiring/Accessories
- G. Project Record Documents:
  1. Submit latest version of all equipment documentation for inclusion with operation and maintenance data.
  2. Show actual locations of all devices on project record drawings.
  3. Document all cable lengths for DC cabling along with voltage drop calculations for the resulting lengths that differ from the design drawings.
- H. Draft Training Plan:
  1. Lighting Control System manufacturers; recommended training.
  2. Photovoltaic System manufacturer's recommended training.
- I. Training Manuals:
  1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

## **PART 2 PRODUCTS**

### **2.01 TEST EQUIPMENT**

- A. Standard Testing Equipment: Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted, such testing equipment will NOT become the property of Owner.
- B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments shall be turned over to the Owner at the completion of testing and commissioning activities to become the property of Owner.

## **PART 3 EXECUTION**

### **3.01 PREPARATION**

- A. The Electrical Contractor, and appropriate subcontractor shall attend the initial kickoff commissioning meeting conducted at the start of construction and the commissioning meeting held 30 days prior to startup of the primary equipment.
- B. The Electrical Contractor shall attend bi-weekly commissioning team meetings throughout construction.
- C. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- D. Furnish additional information requested by the Commissioning Authority.
- E. Prepare a preliminary schedule for Lighting Controls Testing and Photovoltaic System equipment start-up and testing and expected completion for use by the Commissioning Authority; update the schedule as appropriate.
- F. Notify the Commissioning Authority when lighting controls and photovoltaic system testing and startup of each piece of equipment will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Authority has the scheduling information needed to efficiently execute the commissioning process.
- G. Put all Lighting Controls and Photovoltaic System equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

### **3.02 INSPECTING AND TESTING - GENERAL**

- A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B. Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

### **3.03 ELECTRICAL CONTRACTOR RESPONSIBILITIES**

- A. Include cost to complete commissioning requirements for electrical systems in the contract price.
- B. Include requirements for submittal data, O&M data, and training in each purchase order or sub-contract written.
- C. Ensure cooperation and participation of specialty sub-contractors such as communications, data, etc.
- D. Ensure participation of major equipment manufacturers in appropriate training and testing activities.
- E. Attend Construction Phase coordination meetings scheduled by the Commissioning Authority.
- F. Conduct electrical system orientation and inspection when equipment is set.
- G. 7. Respond to (in writing) and address items documented in the Contractor Commissioning Issues Log.
- H. Respond to (in writing) and address items documented in the Contractor Commissioning Issues Log.
- I. Submit copies of all test results to the CxA.
- J. Execute Pre-Functional Checklists for all equipment.
- K. Assist the Commissioning Authority in all Pre-Functional Checklist verifications and Functional Performance Tests.

- L. Prepare preliminary schedule for electrical system orientation and inspections, O&M manual submission, training sessions, testing, equipment start up, and task completion for use by the Commissioning Authority. Update schedule as appropriate throughout the construction period.
- M. Conduct training session.
- N. Conduct electrical system orientation and inspection at the equipment placement completion stage.
- O. Update drawings to the record condition to date, and review with the Commissioning Authority.
- P. Gather O&M data on all equipment and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority for review prior to the completion of construction.
- Q. Notify the Commissioning Authority a minimum of two weeks in advance, so that witnessing equipment and system start-up and testing can begin.
- R. Participate in, and schedule vendors and Contractors to participate in the training sessions as set up by the Commissioning Authority.
- S. Provide a complete set of as-built records to the Commissioning Authority.

**3.04 EQUIPMENT SUPPLIERS AND MISCELLANEOUS SUBCONTRACTORS RESPONSIBILITIES:**

- A. Include cost for commissioning requirements in the contract price.
- B. Provide submittals, and appropriate O&M manual sections.
- C. Attend initial commissioning coordination kickoff meeting scheduled by the Commissioning Authority.
- D. Conduct training sessions.
- E. Demonstrate performance of equipment as applicable.

**3.05 LIGHTING CONTROL SYSTEM FUNCTIONAL TESTING**

- A. Prefunctional Checklists for the lighting control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all control components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the lighting control system as required by the Commissioning Authority.
- D. Functional Testing of the lighting control system constitutes demonstration that devices are being monitored and controlled by the control system that the devices are connected to (i.e. Room controllers or lighting control panels).
- E. Demonstrate to the Commissioning Authority for 100% of all rooms/areas (including exterior areas) with automatic lighting controls:
  - 1. The specified lighting control system functions and features are set up, debugged and fully operable.
  - 2. Any graphic screens and readouts are readable and accurate.
  - 3. Simulated time-of-day operation for time scheduled lighting controls
  - 4. Correct date and time setting in each lighting control panels.
  - 5. Occupancy sensors, Daylight Sensors, and associated controls are installed, programmed and fully functional.
  - 6. Manual Controls are installed, programmed, and fully functional.
  - 7. Simulated power outages and lighting control system response for all areas with an "emergency mode".
  - 8. Exterior photocontrols are installed and fully functional.

- F. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

### **3.06 PHOTOVOLTAIC SYSTEM FUNCTIONAL TESTING**

- A. Prefunctional Checklists for the system components will require a signed and dated certification that the system is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- E. Demonstrate the following to the Commissioning Authority during testing of equipment, coordinate with commissioning of equipment.
  - 1. Inverter features and functions.
- F. Demonstrate to the Commissioning Authority:
  - 1. Each photovoltaic panel is secured to the structural system to which it attached.
  - 2. Structural system supporting panels is fully assembled and secure.
  - 3. All wiring connectors are waterproof and secured to avoid physical damage.
  - 4. All wiring is secured to avoid physical damage.
  - 5. All accessories are secured and waterproof.
  - 6. The polarity of all DC cables are correct.
  - 7. Inverter cabling connections are complete and secured to avoid physical damage.
  - 8. Provide startup for each Inverter per the manufacturer (Perform Inverter startup from deenergized state).
  - 9. Confirm all system equipment functions and features are set up, debugged and fully operable.
  - 10. Inverter graphic screens and readouts are readable and accurate.
  - 11. No alarms are present.
  - 12. Any remote monitoring capabilities are fully functional.
- G. If the equipment, integral components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

### **3.07 OPERATION AND MAINTENANCE MANUALS**

- A. See General Conditions and Supplementary Conditions for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

### **3.08 DEMONSTRATION AND TRAINING**

- A. See General Conditions and Supplementary Conditions for additional requirements.

- B. Demonstrate operation and maintenance of Lighting Controls and the Photovoltaic System to Owner's personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- D. Provide classroom and hands-on training of Owner's designated personnel on operation and maintenance of the Lighting controls and the Photovoltaic System, and all equipment items indicated to be commissioned. Provide the following minimum durations of training:
- E. Lighting Control System Review: Instruct Owner's personnel for minimum 8 hours, after completion of the system, on the following:
  - 1. Detailed review of each system component for each control area.
  - 2. Detailed review of the layout and initial programming.
  - 3. Allow for personnel to modify, reset, or perform lighting controls programming in person.
  - 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
  - 5. Procedures to reset the system or portions of the system
  - 6. Procedures to reprogram or modify programming.
  - 7. Discuss potential "issues" and troubleshooting strategies that could be implemented.
  - 8. Ongoing maintenance requirements.
- F. Photovoltaic System Review: Instruct Owner's personnel for minimum 8 hours, after completion of the system, on the following:
  - 1. Detailed review of each system component.
  - 2. Detailed review of the layout and initial setup.
  - 3. Procedures to reset the system or portions of the system
  - 4. Procedures to reprogram or modify programming.
  - 5. Discuss potential "issues" and troubleshooting strategies that could be implemented.
  - 6. Ongoing maintenance requirements.
- G. Provide the services of manufacturers' representatives to assist instructors.

**END OF SECTION**

## SECTION 31 0000 - EARTHWORK

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

- A. The work under this Section shall include all labor, material, equipment and all else necessary for cutting, proof rolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements as hereinafter specified and/or as otherwise required for the proper and timely completion of this Contract. Work under this Section includes, but is not limited to, subgrade preparation, excavating, backfilling, and compaction for structures and foundations, pavements, sidewalks, landscaping areas, and utilities. The contractor shall pay for and coordinate the services of a geotechnical engineer and testing agency to perform quality control of the earthwork.
- B. Scarifying, compaction, moisture content conditioning and control, and removal of unsuitable material to ensure proper preparation of areas for the proposed improvements.
- C. Undertake any special construction procedures for the project as shown in the drawings and described by these specifications for preparation of pavement areas.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.3 REFERENCE STANDARDS

- B. American Society for Testing and Materials (ASTM) - latest edition
  - 1. C33 Concrete Aggregates
  - 2. D 422 Method for Particle Size Analysis of Soils
  - 3. D 698 Test for Moisture - Density Relations of Soils - Standard Proctor Method
  - 4. D 2216 Laboratory Determination of Moisture content of Soil
  - 5. D 2487 Classification of Soils for Engineering Purposes
  - 6. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 7. D 3017 Test for Water Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - 8. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
- C. American Association of State Highway and Transportation Officials (AASHTO) - latest edition
  - 1. T 88 Particle Size Analysis of Soils
- D. Associated General Contractors of America
  - 1. Manual of Accident Prevention in Construction

#### 1.4 QUALITY ASSURANCE

- A. A geotechnical engineer familiar with the project requirements, selected and paid by the Owner, will be retained to perform construction inspection on site based on density testing, visual



observation, and judgement. This inspection will not relieve the Contractor from his responsibility to complete the work in accordance with the drawings and specifications.

- B. Visual field confirmation and density testing of subgrade preparation and fill placement procedures shall be performed by the field geotechnical engineer as part of the construction testing requirements. The Contractor shall be informed as soon as possible of the test results.
- C. The geotechnical engineer shall prepare field reports that indicate compaction test location, elevation data, testing results and acceptability. The Owner, engineer, and Contractor shall be provided with written copies of the results within 24 hours of time test was performed.
- D. All costs related to reinspection due to failures shall be paid for by the Contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.

### 1.5 SUBMITTALS

- A. Material Test Reports: Shall be provided from the testing agency indicating and interpreting test results for compliance on the following:
  - 1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
  - 2. Laboratory compaction curve according to ASTM D 698 for each on-site or borrow soil material proposed for fill and backfill; provide for each material type and for every 5,000 cubic yards of each material.
  - 3. Material Gradation Tests.
  - 4. Electrical Resistivity and pH tests for sand used for water pipe bedding and backfill.
- B. Within 30 days after award of the contract, the Contractor shall submit to the Owner and engineer a schedule detailing the sequence, and time of completion of all phases of work under this section.
- C. At least two weeks in advance of imported fill use, the Contractor shall submit the following laboratory test data to the geotechnical engineer for each type of imported soil/gravel material to be used as compacted fill.
  - 1. Moisture and Density Relationship: ASTM D 698;
  - 2. Mechanical Particle-Size Analysis: ASTM D422; and,
  - 3. Plasticity Index: ASTM D 4318.
- D. Together with the above test data, the Contractor shall submit a 25-pound sample of each type of off-site fill material in an air tight container for the approval of the geotechnical engineer.
- E. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Owner and the engineer.

### 1.6 Definitions

- A. Backfill: Soil materials used to fill an excavation.
- B. Base Course: Layer placed between the subgrade and paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Approved soil materials imported from off-site for use as fill or backfill.

- E. Classification: No consideration will be given to the nature of earthen materials, and all excavation required for this Project will be designated as unclassified.
- F. Degree of Compaction: Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698 abbreviated hereinafter as percent laboratory maximum density. For granular material, relative density is determined in accordance with ASTM D 4254.
- G. Excavation: Removal of material encountered down to subgrade elevations:
  - 1. Bulk Excavation: Excavation more than 10 feet in width.
  - 2. Overexcavation: Excavation of existing unsuitable material beyond limits shown on the Drawings for replacement with structural fill as directed by the Owner.
  - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond limits shown on the Drawings without direction by the Owner.
- H. Hard Material: Weathered rock, dense consolidated deposits, or buried construction debris (i.e., demolished brick walls, concrete, etc.) which are not included in the definition of "rock" but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.
- I. Rock:
  - 1. General Excavation - Any material that cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rated at not less than 71,000 lbs. (Caterpillar D9N or equivalent), and occupying an original volume of at least 2 cubic yards or more; and,
  - 2. Trench Excavation - Any material that cannot be excavated with a backhoe having a breakout force rated at not less than 44,000 lbs. (Caterpillar 235D or equivalent), and occupying an original volume of at least 2 cubic yards.
- J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base or topsoil materials.
- K. Subbase: Material shown on the Drawings between the pavement base and subgrade.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

## 1.7 REGULATORY COMPLIANCE

- A. Codes and Standards: Perform earthwork complying with federal, state, and local regulations including the Occupational Safety and Health Act of 1970 as amended. Excavation and trenching are regulated by OSHA. The Contractor shall perform all excavation and trenching work in accordance with 29 CFR 1926 Subpart P.
- B. Conform with Pennsylvania Act 287 and all amendments and other applicable regulations regarding notification of utility companies.
- C. Any pumped water shall be discharged from the Site in accordance with federal, state and local codes and regulations. Comply with all Philadelphia Water Department permit requirements.

## 1.8 PROJECT CONDITIONS

- A. Utility Identification: Notify PA One-Call System at 1-800-242-1776 at least 3 days prior to excavation.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify the Owner not less than 72 hours in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without the Owner's written permission.
- C. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- D. Existing improvements, adjacent property, and other facilities and trees and plants that are not to be removed shall be protected from injury or damage, which may result from Contractor's operation.

### 1.9 GEOTECHNICAL ENGINEERING STUDY

- A. The Owner employed a geotechnical engineer to investigate sub-surface soil conditions and make recommendations regarding site work construction procedures. A report of geotechnical exploration for the Rhawnhurst School was completed for the School District of Philadelphia on July 22nd, 2020 by ECS Mid-Atlantic, LLC. Copies of the report are on file with the Owner, Engineer and Architect. Perform all work in accordance with any recommendations and requirements therein. If conflicts exist between the geotechnical engineering study and the construction drawings and specifications, the more stringent requirements shall apply.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. On-site fill
  - 1. On-site excavated materials may be used as backfill provided they meet the following criteria:
    - a. Suitable backfill materials include soil that complies with ASTM D2487 soil classifications GW, GP, GM, SW, SP, and SM and having a maximum particle size of six (6) inches in any one dimension.
    - b. Unsuitable backfill materials include any material having an excess of wood, timber, metal, rebar, organics, debris, or any other deleterious materials.
  - 2. Excavated materials unsuitable for fill in their as-is state may be processed on-site to comply with suitable backfill requirements. Concrete, brick, asphalt debris may be broken or crushed on site to meet the above particle size requirement;
  - 3. All processed (broken, crushed, etc.) debris shall be thoroughly mixed with suitable gravel/sand/silt sized particles to disperse evenly the large-sized particles within the soil matrix. The soil-debris mixture must be mixed, placed, and compacted such that voids will not exist;
  - 4. The Contractor shall use the on-site soil judiciously to facilitate the construction schedule.
  - 5. Excess topsoil may be re-used as fill on-site in accordance with the recommendations contained in the geotechnical engineering study. In general, topsoil shall be used first as fill in landscape areas and secondarily in parking areas at least 5 feet below finished grade. Topsoil shall never be used in building areas; and,
  - 6. Prior to placement, on-site material to be used as fill shall not contain:
    - a. Debris other than crushed concrete and brick meeting the above requirements.
    - b. Timber or railroad ties.

- c. Other deleterious materials such as steel rails, rebar, trash, etc.
  - d. Hazardous material - Unsuitable and deleterious materials and debris shall be disposed of off-site in accordance with all applicable regulations.
- B. Off-site imported fill
- 1. If necessary, off-site fill shall be obtained and provided by the Contractor;
  - 2. Fill shall be clean, well graded granular soil which is non-expansive and non-collapsible and shall have less than 20% by weight passing the #200 sieve. The portion passing the #200 shall be non-plastic. Fill with less fines (less than #200) may be required on project specific basis and as required by geotechnical engineer. Likewise, fill with more than 20% fines may be acceptable on a project specific basis or as identified in the geotechnical engineering study;
  - 3. Imported fill shall be free of all hazardous substances. Certification of compliance and, if requested, test results substantiating compliance shall be furnished to the Owner and geotechnical engineer by the Contractor not less than one week prior to its intended use;
  - 4. The Owner reserves the right to test off-site fill material for conformance with these specifications; and,
  - 5. The Contractor shall be responsible for all permits and regulatory requirements associated with off-site borrow sources.
- C. Rock is defined as follows:
- 1. General Excavation - Any material that cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rated at not less than 71,000 lbs. (Caterpillar D9N or equivalent), and occupying an original volume of at least 2 cubic yards or more; and,
  - 2. Trench Excavation - Any material that cannot be excavated with a backhoe having a breakout force rated at not less than 44,000 lbs. (Caterpillar 235D or equivalent), and occupying an original volume of at least 2 cubic yards.
- D. Any bituminous concrete on the site shall be milled/removed prior to placing any fill and shall be reused only onsite immediately below the pavement stone base course.

## 2.2 STONE BACKFILL

- A. In accordance with PennDOT Publication 408, Section 703 for No. 2A Stone

## 2.3 EQUIPMENT

- A. Compactor for mass earthwork shall be minimum 10-ton static-drum weight vibratory roller or 10-ton static-drum weight sheep foot compactor as appropriate for the type of soil material at the site or other compactor approved by the geotechnical engineer.
- B. Compactor for trenches and where access or maneuverability is limited, use a double drum walk-behind roller or vibratory plate compactor or "jumping jack" tampers.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Prior to all work of this section, the Contractor shall become thoroughly familiar with the geotechnical engineering study as well as the site, site conditions, and all portions of the work falling under this section.
- B. The Contractor shall refer to the soil erosion and sediment control drawings for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.
- C. Locate and identify existing utilities that are to remain and protect them from damage.
- D. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.
- E. Protect fences, structures, sidewalks, paving, curbs, etc. to remain from equipment and vehicular traffic.
- F. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the Owner.
- G. Remove from the site, material encountered in grading operations that, in opinion of Owner or geotechnical engineer, is unsuitable or undesirable for backfilling in pavement or building areas as per Article 2.01.
- H. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the drawings.
- I. Do not allow or cause any of the work performed or installed to be covered by work of this section prior to all inspections, tests and approvals.
- J. Perform excavation using capable, well maintained equipment and methods acceptable to the Owner and regulatory authorities having jurisdiction.
- K. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and ground water control, and moisture control of soils (i.e., wetting or drying, scarify and discing) so as to place and compact the soil within the moisture content range a few percentage points of its optimum water content. Any disturbed areas should be proofrolled at the end of each day.
- L. Sloping, shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all regulatory authorities having jurisdiction.
- M. Allow no debris to accumulate on-site. Haul debris away from the site and dispose of at no cost to the Owner.

### 3.2 COMPACTION OF SUBGRADE SURFACES

- A. In areas to receive fill, excluding areas marked for bioinfiltration, and at the final cut subgrade, proof roll and compact the exposed ground surface following clearing and grubbing and any required excavation with a minimum of 4 passes of an approved compactor and obtain at least the following density requirement:

LOCATION	PERCENT COMPACTION (ASTM- D698)
Foundations	98%
Floor Slabs	95%
Pavements	95%
Berms (non-structural)	93%

- B. The proof roll, truck and compactor equipment shall traverse the area at speed that permits the geotechnical engineer to comfortably walk alongside the equipment.
- C. Any soft areas exhibiting excessive weaving or unsatisfactory material identified during excavation, fill placement, compaction and proof testing shall be removed, replaced with suitable fill, and compacted as specified above.
- D. Excavation within area marked for bioinfiltration shall be performed in the dry and shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The existing subgrade shall not be compacted or subject to excessive construction equipment prior to or during the placement of geotextile and crushed stone. If it is essential that equipment be used in the excavated area of bioinfiltration facilities, all equipment must be approved by the Owner or authorized representative. Use of equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires that will cause excessive compaction shall not be permitted within the excavation.

### 3.3 UNDERCUT EXCAVATION

- A. When approved by Owner and recommended by the geotechnical engineer, the Contractor may be required to remove natural soil materials in areas where fills are to be placed when determined to be undesirable in their location or condition. The Contractor shall be required to remove the undesirable material and backfill with approved material properly compacted.
- B. At locations where unstable or unsuitable soil is shown on the drawings or identified within the geotechnical engineering study, the removal and replacement of such soil shall be as directed on the drawings or as directed by the geotechnical engineer and the Owner.
- C. All material removed in the work of undercut excavation will be classified by the geotechnical engineer and Owner as either suitable for other use without excessive manipulation and utilized by the Contractor elsewhere in the work, or unsuitable for future use and manipulated as per Article 2.01.
- D. The Contractor shall conduct undercut operations in such a way that the necessary measurements can be taken before any backfill is placed.
- E. Backfill in undercut areas shall be placed as a continuous operation along with the undercutting operation. No backfill material shall be placed in water unless otherwise permitted by the geotechnical engineer.

### 3.4 EXCAVATION, FILL AND SUBGRADE PREPARATION

- A. GENERAL

1. Refer to Section 024119, Selective Demolition, for demolition information and requirements pertaining to below-grade utilities.
2. The Contractor shall cut or fill to the proposed subgrade elevations based on finished grades and the pavement thicknesses as shown on the drawings. Subgrade elevations shall be constructed to within 0 to minus ½ inch of the proposed grades specified.

**B. EXCAVATION**

1. Where existing grades are above proposed subgrade elevation, excavate materials to line and grade as shown in the drawings being careful not to over excavate beyond the elevations needed for building subgrades;
2. Excavate organic soils that do not provide adequate foundation support. Excavated on-site organic soils, which are unsuitable for fill may be used in landscaped areas and, if approved by the geotechnical engineer, as fill in parking area at least 5 feet below final elevation. Otherwise this material shall be disposed of as directed by Owner;
3. Excavated on-site soils, which meet the requirements of suitable fill may be used as fill; and,
4. Unsuitable material, such as wood and any other deleterious materials determined to be unsuitable by the geotechnical engineer for use as on-site fill, shall be disposed of as directed by Owner.

**C. SUBGRADE PREPARATION FOR FILL**

1. Existing grades below proposed grades and thus requiring fill shall be leveled prior to fill placement. The Contractor shall remove existing lawn and top soil in these areas prior to placement of any fill; and,
2. All existing grades to receive fill areas shall be proof rolled and compacted per Article 3.02.

**D. FILL PLACEMENT**

1. Rock or processed suitable debris pieces larger than six inches (6 inches) across shall not be part of fill;
2. Reduce soil clod size to a maximum of 2 inches before placement. Do not place frozen fill material;
3. No fill material shall be placed in areas of standing water, in areas of frozen or thawing ground, or in areas that have not been approved by the geotechnical engineer;
4. No fill materials shall be placed during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to a satisfactory moisture content as determined by the geotechnical engineer;
5. Fill lift surfaces shall be made smooth and free from ruts or indentations at the end of any work day when precipitation is forecast to prevent saturation of surficial fill material. Fill surfaces shall be graded to drain and sealed with a smooth drum roller at the completion of each work day;
6. The fill shall be placed in uniform loose lifts not exceeding 12-inches thick and compacted with at least 4 coverages of a 10-ton static-drum weight roller;
7. Each lift shall be compacted to the minimum densities listed in Article 3.02 as appropriate for the project and as specified in the geotechnical engineering study;
8. The Contractor shall adjust the water content by aeration or adding water to achieve the required density. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to achieve proper compaction and facilitate the construction schedule;
9. Wet, saturated material shall be air dried as necessary to achieve the field densities specified in this Section. Removal and replacement shall not occur without prior approval or Owner. Removal and replacement shall be used if necessary to facilitate the construction schedule;
10. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace with suitable compacted fill as approved by the Owner or Owners representative. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section; and,

11. Fill placed on slopes greater than 1 vertical to 3 horizontal shall have each lift benched onto the slope at least 3 feet.

### 3.5 PROOFROLLING

- A. The work covered by this subsection consists of furnishing and operating, proofrolling equipment at the direction of the Owner's representative and/or geotechnical engineer.
- B. Proofrolling shall be under the observation of the Owner's representative and/or the geotechnical engineer as described herein and under the following schedule:
  1. Immediately following the completion of excavation to proposed subgrades in cut areas, proofrolling shall be performed as specified; and,
  2. Immediately prior to and following stone base course placement, in pavement and building pad areas for final floor slab preparation, all subgrade and stone base areas shall be proofrolled. Any areas which deflect, rut or pump under the roller shall be undercut and replaced with compacted fill material or stone base course as directed by the geotechnical engineer and approved by the Owner.
- C. Proofrolling shall be done with 1 pass of a fully loaded tandem dump truck equal to or exceeding 50,000 lbs., or other construction equipment if approved by the geotechnical engineer.
- D. Construction methods shall be as follows:
  1. After the subgrade or stone base course has been completed within 0.50 foot of final grade, the subgrade or stone base course shall then be compacted and tested prior to commencement of proofrolling. The coverage areas and methods will be identified by the Owner's representative and/or geotechnical engineer. However, the roll shall be operated in a systematic manner so that the number of coverages over all areas to be proofrolled can be readily determined and recorded;
  2. The equipment shall be operated at a speed that the geotechnical engineer can comfortably and slowly walk alongside the equipment;
  3. If it becomes necessary to take corrective action, such as but not limited to underdrain installation, undercut and backfill of an unsuitable material, and aeration of excessively wet material in areas that have been proofrolled, see Article 3.03. These areas shall be proofrolled again following the completion of the necessary corrections. If the corrections are necessary due to the negligence of the Contractor or weather, the corrective work and additional proofrolling shall be performed by the Contractor at no cost to the Owner; and,
  4. The Contractor shall protect all structural facilities on the project, such as but not limited to box culverts, pipe culverts, and utilities, from damage by the proofrolling equipment.

### 3.6 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified by the Contractor to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive construction traffic and wheel loading including concrete and dump trucks.
- C. Remove areas of finished subgrade judged to be unsatisfactory to the depth necessary and replace in a manner that will comply with compaction requirements by use of material equal to or better than the best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

### 3.7 FINISH ELEVATIONS AND LINES



- A. For setting and establishing finish elevations and lines, secure the services of a licensed land surveyor acceptable to the Owner and engineer.
- B. Provide elevation grade stakes and any other surveying necessary for the layout of the work. The Contractor shall conduct his work in such a manner that survey stakes will be protected as long as their need exists. Grade stakes, which are damaged or stolen, shall be replaced by the Contractor's surveyor at the Contractor's expense.
- C. Graded areas shall be uniform, hard and smooth, free from rock, debris, or irregular surface changes. Any deviation shall not result in changes in drainage areas or ponding. All ground surfaces shall vary uniformly between indicated elevations. Finish drainage ditches shall be graded to allow for proper drainage without ponding and in a manner that will minimize the potential for erosion.
- D. Correct all settlement and eroded areas for one year after date of project completion at no additional expense to Owner. Bring paved and landscaped areas to proper elevation. Replant or replace any grass, shrubs, bushes, or other vegetation disturbed by construction using corrective measures.

### 3.8 FIELD QUALITY CONTROL

- A. The contractor shall coordinate all earthwork with the testing agency and geotechnical engineer to allow for inspection and testing. The geotechnical engineer shall provide full-time observation and testing of the compaction operations and provide documentation to the Owner.
- B. Allow geotechnical engineer to inspect and test each subgrade and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. The geotechnical engineer shall test compaction of soils in place according to ASTM D 1556, ASTM D 698, ASTM D 2167, ASTM D 2922, ASTM D 2937, and ASTM D 4254 as applicable. Tests shall be performed at the following locations and frequencies:
  - 1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2200 sq. ft. or less of paved areas or building slab, but in no case fewer than three tests.
  - 2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.
  - 3. Structural Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.
- D. When the geotechnical engineer reports that subgrades, fills or backfills have not achieved degree of compaction specified, recompact and retest until specified compaction is obtained.

**END OF SECTION 31 0000**

## SECTION 31 5000 - EXCAVATION SUPPORT AND PROTECTION

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. The work under this Section shall include all labor, on-site materials, and equipment necessary for the excavation of trenching and grading as hereinafter specified and/or as otherwise required for the proper and timely completion of this Contract.

#### 1.2 RULES AND REGULATIONS

- A. American Society for Testing and Materials (ASTM):

ASTM C131	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 C 535	Test Method for Resistance to Degradation of Large- Size Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM D422	Standard Method for Particle-Size Analysis of Soils
ASTM D427	Standard Test Method for Shrinkage Factors of Soils
ASTM-D1140	Standard Test Method of Material in Soils Finer than 200 (75-um) Sieve
ASTM D1557	Standard Test Methods for Moisture-Density Relations of Soil-Aggregate Mixtures Using 10-lbs (4.54-kg.) Rammer and 18-in. (457-mm) Drop
ASTM D2216	Method fir Laboratory Determination of Water (moisture) Content of Soil, Rock, and Soil- Aggregate Mixtures.
ASTM D2487	Standard Test for Classification of Soils for Engineering Purposes
ASTM D2922	Standard Test Methods for Density of Soil Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTMD4253	Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table
ASTM D4254	Standard Test Methods for Minimum Index Density of Soils and Calculations of Relative Density
ASRMD4318	Standard test Method for Liquid Limit, Plastic Index of Soils

#### 1.3 SUBMITTALS

- A. Samples

- 1. Furnish and deliver samples of fill and backfill materials as required by the Owner/Authorized Representative.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. TOLERANCES

- 1. Construct finished sub-grades to plus 0 inches minus ½ inch of the elevation indicated.
  - 2. Construct finished grade of slopes not steeper than 3:1 to plus or minus 1/2 inch and on slopes steeper than 3:1 to plus or minus 2 inches. Slopes shall not encroach upon roadbeds.
  - 3. Maintain the moisture content of fill material as it is being placed within plus or minus 3 percent of the optimum, moisture content of the material as determined by the laboratory test herein specified.

4. Protect all existing and new construction including utilities, finishes and equipment from water, damage, weakening or other disturbance.

## 1.5 DEFINITIONS

- A. Earthwork Terminology used in this Section and not defined herein shall be interpreted in accordance with the definitions given in ASTM D653.

1. Sub-grade: Sub-grade is the lowest elevation of excavation and the highest elevation if embankment required to accommodate the indicated construction.
2. Backfill: Soil or soil-rock material used to backfill excavations and to backfill excavated spaces around building walls.
3. Imported Material: Soil or granular material which is hauled in from off-site areas.
4. Unsuitable Material: Excavated material or material below the natural ground surface in embankment areas or below sub-grade elevation in excavated areas, which is unsuitable for its planned use.
5. Relative Compaction: The ratio, expressed as a percentage, of the in-place dry density of fill material as compacted in the field to the maximum dry density of the same material as determined by laboratory test ASTM 698, Method D.
6. Optimum Moisture Content: The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.
7. Relative Density: Refer to ASTM D4253 and ASTM D4254.
8. Excavation: Excavation is the removing of all materials encountered with the Contract Limits, regardless of the nature of the material encountered and the method by which it is removed, for grading, sub-grading for roadways or paved areas and other structures not specified elsewhere in these specifications. All excavation is unclassified and no additional compensation will be made for rock.

## 1.6 PROJECT CONDITIONS

- A. Protection

1. Provide the necessary barricades, signs, lights, etc. to prevent accidents, to avoid all hazards and to protect the public, the work and property at all times, including Saturday, Sunday and holidays.
2. Be responsible for any and all damages which may arise or occur to any party whatsoever by reason of neglect in providing proper lights, guards, barriers or any other safeguards to prevent damage to property, life and limb.
3. Prior to any excavation the Contractor, with the cooperation of the Owner of the respective existing utility or its agents shall locate and paint the location of all water services, gas services, gas mains, water mains, sanitary sewers, telephone raceways or conduits and drains, within five (5) feet of the proposed excavations.
4. In case water, gas pipes, conduits, or other utilities are broken in the prosecution of the work, the Contractor shall stop work and give immediate notice to the proper authorities and shall be responsible for any damage to persons or property caused by such breaks. Failure to give

prompt notice to the authorities shall deem the Contractor responsible for any damages legal or otherwise caused by the interruption or loss of utility service.

B. Parking and Storage

1. Parking of vehicles and storage of materials shall be confined to designated areas approved by the Owner.

C. Dust Control

1. During the progress or work, the Contractor shall conduct his operation and maintain the area of his activities so as to minimize the creation and dispersion of dust.

1.7 ENVIRONMENTAL REQUIRMENTS

A. Unfavorable Weather Conditions

1. Excavating, filling, backfilling, and grading work shall not be performed during weather conditions which might damage the condition of existing ground, in-progress work, or completed work. When the work is interrupted by rain, excavating, filling, backfilling and grading work shall not resume until the site is suitable for the work.
2. Sub-grade shall be free from mud, snow, ice, and deleterious material when work is resumed.

**PART 2 - PRODUCTS**

2.1 FILL AND BACKFILL

- A. Material suitable for use as fill and backfill shall be an inert, non-expansive soil, free from organic matter and of such quality that it will compact thoroughly without the presence of voids. Excavated on-site material will be considered suitable for fill and backfill.
- B. Suitable excavated material shall be conditioned for reuse and properly stockpiled for later filling and backfilling operations. Conditioning shall consist of spreading material in layers not to exceed 8 inches and raking free of debris and rubble. Rocks exceeding four inches in largest dimension and deleterious material shall be moved from the site and disposed of.

**PART 3 - EXECUTION**

3.1 EXISTING UTILITIES

- A. Verify on site the location and depth (elevation) of all existing utilities and services before performing any excavation work. Excavation within 3 feet of a utility line shall be performed by hand.

3.2 EXCAVATION

A. GENERAL

1. Excavation consists of the removal and on-site placement or disposal of whatever material is encountered when establishing required sub-grade elevations.
2. Excavation shall be made to the grades as shown on the Contract Drawings.
3. Where excavation grades are not shown on the Contract drawings, excavation shall be made as required to accommodate the installation of all facilities.

B. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 °F.

C. Stability of Excavations

1. Sloped sides of excavation shall comply with state and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

D. Shoring and Bracing

1. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
2. Establish requirements for trench shoring and bracing to comply with local Codes and authorities having jurisdiction.
3. Maintain shoring and bracing excavations regardless of the time period excavations will open carry down shoring and bracing as excavation progresses.

E. Material Storage

1. Stockpile suitable excavated materials where directed, as required for fill.
2. Locate and retain soil materials away from edge of excavation.

3.3 BACKFILL

- A. Backfill excavation as promptly as work permits, but not until waterproofing membrane is applied and is ready to be backfilled.

B. Placement and Compaction

1. Place backfill materials in layers not more than 4" in loose depth for materials by hand-operated tampers.
2. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each life.

3.4 GRADING

- A. Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish below the required sub-grade elevations.

3.5 CLEAN-UP

- A. Upon completion of the work of this section, place in stockpile areas all excess excavated material, rubbish, trash and debris resulting from operations. Leave the site in a neat and orderly condition.

**END OF SECTION 31 5000**

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## SECTION 321613 – SITE CAST-IN-PLACE CONCRETE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SCOPE OF WORK

- A. This Section includes the following applications for site concrete:
  - 1. Concrete Sidewalks
  - 2. Concrete Curbs
  - 3. Concrete Pads

#### 1.3 REFERENCES

- A. The most current version of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Commonwealth of Pennsylvania, Department of Transportation, Specifications, Publication 408, (PennDOT 408), except that measurement and payment sections do not apply
- C. AMERICAN CONCRETE INSTITUTE (ACI)
  - 1. ACI 301: Specification for Structural Concrete
  - 2. ACI 347: Guide to Formwork for Concrete
  - 3. ACI 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
  - 4. ACI 309R: Guide for Consolidation of Concrete
  - 5. ACI 306.1: Standard Specification for Cold Weather Concreting
  - 6. ACI 311.4R: Guide for Concrete Inspection
  - 7. ACI 311.5R: Batch Plant Inspection and Field Testing of Ready-Mixed Concrete
  - 8. ACI 350R: Code Requirements for Environmental Engineering Concrete Structures
  - 9. ACI SP 66: ACI Detailing Manual
- D. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
  - 1. ASTM A 185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
  - 2. ASTM A 615: Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
  - 3. ASTM C 31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
  - 4. ASTM C 33: Standard Specification for Concrete Aggregates
  - 5. ASTM C 39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - 6. ASTM C 42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  - 7. ASTM C 94: Standard Specification for Ready-Mixed Concrete
  - 8. ASTM C 143: Standard Test Method for Slump of Hydraulic Cement Concrete
  - 9. ASTM C 150: Standard Specification for Portland Cement
  - 10. ASTM C 171: Standard Specification for Sheet Materials for Curing Concrete



11. ASTM C 172: Standard Practice for Sampling Freshly Mixed Concrete
12. ASTM C 231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
13. ASTM C 260: Standard Specification for Air-Entraining Admixtures for Concrete
14. ASTM C 309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
15. ASTM C 494: Standard Specification for Chemical Admixtures for Concrete
16. ASTM C 618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
17. ASTM C 1064: Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
18. ASTM D 1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
19. ASTM D 1752: Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

- E. The Contractor is required to have one copy of the latest edition of each of the following publications available for review in the job-site construction office at all times while performing the work described in this Section. The Contractor is to comply with each of the following unless more stringent requirements are indicated on the Drawings or within these specifications.
1. City of Philadelphia Department of Streets - Standard Construction Items, except that measurement and payment sections do not apply
  2. ACI 301: Specification for Structural Concrete

#### 1.4 SUBMITTALS

- A. General: Submit each item in accordance with the General Requirements and Conditions of the Contract documents.
- B. Product Data: For each type of manufactured material and product indicated.
- C. Design Mixes: For each concrete pavement mix and class. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- D. Joint Layout: Submit a sketch showing the location of all expansion and control joints and scoring prior to placing concrete. Indicate method of installing score lines.
- E. Shop Drawings: For concrete reinforcement, including dowels, wire fabric, bar layout, and all other reinforcement. Shop drawings shall be in accordance with the ACI SP66, and detailed at scales to clearly show the layout of all new reinforcing steel.
- F. Laboratory test reports: From a testing laboratory meeting the requirements of paragraph 1.05.C below, indicating and interpreting test results for compliance with the requirements indicated within these specifications and based on comprehensive testing of current materials and mix designs.
- G. Material Certificates: Signed by manufacturers and the Contractor certifying that each of the following materials complies with or exceeds requirements:
  1. Cementitious materials and aggregates.
  2. Admixtures.
  3. Curing compounds.
  4. Applied finish materials.
  5. Bonding agent or adhesive.

6. Joint fillers and sealers.
7. Forming accessories.
8. Steel reinforcement.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that required for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
  1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- C. Testing Agency Qualifications: "Testing Agency Qualifications": An independent testing agency conforming to the requirements of the American Concrete Institute Publications ACI 311.4R and ACI 311.5R (latest editions), and also acceptable to the project team
- D. Source Limitations: Obtain each type of class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.
- E. ACI Publications: Comply with ACI 301, unless modified by the requirements of the Contract Documents.
- F. Concrete Testing Service: Engage a qualified independent testing laboratory to perform material evaluation tests and to design concrete mixes.

#### 1.6 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans.

#### 1.7 REGULATORY REQUIREMENTS

- A. Traffic Control: Maintain access of and protection for vehicular and pedestrian traffic as required for construction activities in accordance with local regulations.
- B. Contractor shall obtain a curb permit for each City of Philadelphia Highway District the work is being performed in.
- C. Contractor shall obtain all necessary City of Philadelphia Streets Department road opening permits and approvals, and City of Philadelphia Department of Licenses and Inspections permits and approvals, upon the Contractor receiving Notice to Proceed and prior to proceeding with the Work.

### **PART 2 - PRODUCTS**

#### 2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces. Use flexible or curved forms for curves of a radius 100 feet or less.
- B. Form Release Agent: Provide commercially formulated form-release agent with a maximum of 350 g/l volatile organic compound (VOCS) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

## 2.2 CONCRETE MATERIALS

- A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.
- B. Portland Cement: ASTM C 150, type IA.
- C. Fly Ash: ASTM C 618, Class C or F including supplementary optional requirements relating to reactive aggregates and alkalis, and loss on ignition (LOI) not to exceed 5 percent.
- D. Normal-Weight Aggregates: ASTM C 33, class 4, uniformly graded, from a single source, with coarse aggregate as follows:
  - 1. Size 67.
  - 2. Maximum size of coarse aggregates not more than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, nor three-fourth of minimum clear spacing between reinforcing bars.
  - 3. Do not use fine or coarse aggregate containing substances that cause spalling.
- E. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a No. 4 sieve, 10 percent maximum shall pass a No. 100 sieve.
- F. Water: Potable, ASTM C 94.

## 2.3 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Joint Dowel Bars: ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.
- C. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

## 2.4 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain no more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures. Use only one manufacturer as a source for all admixtures. Contractor is responsible for verifying that any and all admixtures, when used in combination, are compatible with any other admixture used in mix design. Verification to be provided with mix design and product data submittals, for review by the Owner.
- B. Air-Entraining Admixtures: ASTM C 260, certified by manufacturer to be compatible with other required admixtures and not containing more chloride ions than are present in municipal drinking water.

- C. Water-Reducing Admixture: ASTM C 494, Type A, certified by manufacturer to be compatible with other required admixtures and not containing more chloride ions than are present in municipal drinking water.
- D. High-Range Water-Reducing Admixture: ASTM C 494, Type F or G, and not containing more chloride ions than are present in municipal drinking water.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
- G. Prohibited Admixtures: Calcium chloride, thiocyanate or admixtures containing more than 0.05 percent chloride ions are not permitted.

## 2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq.yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular film-forming compound, manufactured for application to fresh concrete for temporary protection from rapid moisture loss.
- E. Clear or white Liquid-Membrane-Forming Curing Compound: PENNDOT 408 Section 711.2

## 2.6 CONCRETE PROTECTION MATERIALS

- A. Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

## 2.7 RELATED MATERIALS

- A. Expansion-and-Isolation-Joint-filler-Strips: PENNDOT 408, Section 705.1, Type (b) filler
- B. Joint Sealer: In accordance with PennDOT 408, Section 705.4.
- C. Graphite Lubricant: In accordance with PennDOT 408, Section 705.6.

## 2.8 CONCRETE MIXES

- A. Prepare design mixes, proportioned according to PENNDOT 408, for each type and strength of concrete.
- B. Use an independent testing agency meeting the requirements of paragraph 1.5.C for preparing and reporting proposed mix designs for the trial batch method.

- C. Proportion mixes to provide concrete with the following properties.
1. Compressive strength: Class C – 2,000 psi (28 day); Class A – 3,300 psi (28 day); Class AA – 3,750 psi (28 day); Class AAA - 4,500 psi (28 day); H.E.S – 3,000 psi (3-day).
    - a. Sewer Lateral Connection – Class C
    - b. Concrete Pads – Class A
    - c. Pipe Bollard Foundations – Class A
    - d. Chain Link Fence Foundations – Class A
    - e. Concrete Footway – Class A
    - f. Concrete Curb - Class A
    - g. Concrete Wheel Stop – Class A
  2. Maximum Water-Cementitious Materials Ratio: at point of placement, 0.45.
  3. Slump Limit: 3 inches, in accordance with ASTM C143.
    - a. Slump Limit for concrete containing high-range-water admixture (superplasticizer): not more than 8 inches after adding admixture to plant-or-site verified, 2-to-3 inch slump concrete.
- D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
1. Fly Ash: 15 percent.

## 2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94.
1. When air temperature is between 85 degrees F and 90 degrees F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degrees F, reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Compact subgrade as indicated in Section 321116. Proceed with pavement only after nonconforming conditions have been corrected and subgrade and base course are stable and ready to receive pavement. Subgrade shall be in a moist condition when concrete is placed.
- B. Remove loose material from compacted base course surface immediately before placing concrete.

### 3.2 FORMWORK, EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure formwork, including edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement. Form work shall be in accordance with ACI 347.
- B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendation in CRSI's "Placing Reinforcing bars" for placing and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, dirt, ice or other bond reducing materials.
- C. Arrange, space, and securely tie bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.4 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 or ACI 350R and as indicated on the Drawings.
- B. Inspection: Before placing concrete, inspect and complete formwork installation, and installation of all items to be embedded or cast in. Notify other trades so that they may install any embedded or cast in items required for their work prior to Contractor's inspection.
- C. Remove snow, ice, or frost from subbase or base course surface before placing concrete. Do not place concrete on surfaces that are frozen.
- D. Moisten base course to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- E. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- F. Do not add water to concrete during delivery, at Project, or during placement.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- H. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- I. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Immediately lay welded wire fabric or bar mats in final position. Place top layer of concrete, strike off, and screed.
  - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by the Engineer.
- J. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open texture and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations.

- K. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.
- L. Cold-Weather Placement: Comply with ACI 306.1 and as follows: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F and not more than 80 degrees F at point of placement.
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
- M. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as specified when hot weather conditions exist.
  - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 degrees F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  - 3. Fog spray forms and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.5 JOINTS

- A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless otherwise indicated on the Drawings.
  - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless indicated otherwise on the Drawings.
- B. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, manholes, inlets, structures, sidewalks, other fixed objects, and where otherwise indicated on the Drawings.
  - 1. Locate expansion joints at maximum intervals of 150 feet, unless shorter intervals are otherwise indicated on the Drawings.
  - 2. Extend joint fillers full width and depth of joint.
  - 3. Terminate joint filler not less than ½ inch or more than 1 inch below finished surface if joint sealant is indicated to be used above joint filler.
  - 4. Place top of joint filler flush with finished concrete surface if joint sealant is not to be used.
  - 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  - 6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
  - 7. Install joint sealer in accordance with Manufacturer's instructions.
- C. Transverse Control Joints: Form weakened-plane transverse control joints, sectioning concrete into areas as indicated on the Drawings. Where sectioning is not indicated on the Drawings, space joints as described within this Section. Construct transverse control joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a 3/8-inch radius unless shown otherwise on the Drawings.

Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

- D. Edging: Tool edges of pavement, curbs, and joints formed in concrete after initial floating with an edging tool to a 3/8-inch radius unless shown otherwise on the drawings. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.
  - 1. Sealant: Provide joint sealant at all isolation joints in accordance with sealant manufacturer's written instructions.

### 3.6 CONCRETE FINISHING

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Comply with ACI-302-1R, regarding slab construction, regarding overworking of slab surfaces during finishing operations; in such cases where the air entrainment exceeds 3%.
- C. Float Finish: Begin the second floating operation when bleed water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Re-float surface immediately to a uniform granular texture.
- D. Surface Texture: Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. Any type of transverse texturing shall produce grooves in straight lines across each lane within a tolerance of plus or minus 1/2 inch of a true line.
  - 1. Produce a surface which is free from porous spots, irregularities, depressions, and small pockets or rough spots which may result from accidentally disturbing particles of coarse aggregate embedded near the surface.
  - 2. Broom Texturing – Concrete pavement and sidewalks. Surface texture shall be applied using an approved mechanical stiff bristle broom drag of a type that will uniformly score the surface. The broom shall be operated to score the surface transverse to the pavement center line. The broom shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the broom shall be overlapped the minimum necessary to obtain a uniformly textured surface. Brooms shall be washed thoroughly at frequent intervals during use. Worn or damaged brooms shall be removed from the job site. Brooming should be completed before the concrete has hardened to the point where the surface will be unduly torn or roughened, but after hardening has progressed enough so that the mortar will not flow and reduce the sharpness of the scores. Specific requirements for the texturing will be given on the drawings, but, if not given, the scores shall be uniform in appearance and approximately 1/16 inch in depth but not more than 1/8 inch in depth. Hand brooming will be permitted only on isolated odd shaped slabs or slabs where hand finishing is permitted. For hand brooming, the brooms shall have handles longer than half the width of slab to be finished. The hand brooms shall be drawn transversely across the surface from the centerline to each edge with slight overlapping strokes.
  - 3. On inclined slab surfaces including sidewalk curb ramps, provide a coarse, non slip finish by scoring surface with a stiff bristled broom, perpendicular to line of traffic.

### 3.7 CONCRETE PROTECTION AND CURING



- A. General: Protect freshly placed concrete from premature drying and excessive cold and hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and follow recommendations in ACI 305R for hot weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy weather conditions cause moisture loss approaching 0.2 lb./sq. ft x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials.
    - a. Water.
    - b. Continuous water-fog-spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

### 3.8 TOLERANCES

- A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 inch and -3/4 inch.
- B. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +3/4 inch and - 1/4 inch.
- C. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 3, 4, and 5 (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 inch and -1/2 inch where gross bar length is less than 12 feet, or +0 inch and -3/4 inch where gross bar length is 12 feet or more.
- D. Slab Finishes: ACI 117, Section 4.5.6, F-number method in accordance with ASTM E1155 for exterior slabs, except as follows:
  - 1. Test entire slab surface, including those areas within 2 feet of construction joints and vertical elements that project through slab surface.
  - 2. Maximum elevation change which may occur within 2 feet of any column or wall element is 0.25 inches.
  - 3. Allow sample measurement lines that are perpendicular to construction joints to extend past joint into previous placement no further than 5 feet.

### 3.9 FIELD QUALITY CONTROL TESTING

- A. Testing Laboratory: As part of this contract the Contractor shall retain the services of an independent testing and inspection laboratory meeting the qualifications of paragraph 1.5.C to sample materials, perform tests and prepare and submit reports during concrete placement.
  
- B. Testing Services: Testing shall be performed according to the following requirements:
  - 1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C 172, except modified for slump to comply with ASTM C 94.
  - 2. Slump: ASTM C 143: One test at point of placement for each concrete truck delivery. Slump testing is to be performed prior to concrete placement. Addition of water to the concrete mix is not permitted after slump test.
  - 3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
  - 4. Concrete temperature: ASTM C 1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each set of compressive-strength specimens.
  - 5. Compression Test Specimens: ASTM C 31 one set of four standard cylinders for each compression-strength test, unless directed otherwise. Cylinders shall be molded and stored for laboratory-cured test specimens except when field-cured test specimens are required. Contractor shall provide an insulated storage box for concrete cylinders.
  - 6. Compression-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., plus one for each additional 50 cu. yd. One specimen shall be tested at 7 days and two specimens at 28 days; and one specimen shall be retained in reserve for later testing if required.
  - 7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - 8. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive compressive-strength test results equal or exceed specified compressive-strength and no individual compressive-strength test result falls below specified compressive-strength by more than 500 psi.
  - 9. Thickness Evaluation: The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section.
  
- C. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor, within 24 hours of testing. Reports of compressive-strength tests shall contain the concrete manufacturer and Contractor name, Project identification name and number, date of concrete placement, name of concrete testing laboratory, concrete type and class, location of concrete batch in pavement, design compressive-strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day and 28-day tests.
  
- D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but shall not be used as the sole basis for approval or rejection.
  
- E. Additional Tests: Testing laboratory shall make additional tests of concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by the Owner. Testing laboratory may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.
  
- F. Appearance: Exposed surfaces of the finished work will be inspected by the Owner and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the works shall be removed and replaced at the Contractor's sole expense.

3.10 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet the requirements in this Section. Concrete sections shall be removed to the nearest regularly spaced joint.
- B. Drill test cores where directed by the Owner when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.
- C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete pavement free of stains, discoloration, dirt and other foreign material. Sweep concrete pavement not more than 2 days before date scheduled for Substantial Completion inspections.
- E. Repair Surface Defects in accordance with ACI 301.

**END OF SECTION 321613**

## SECTION 334001 – SOIL PROPERTIES INVESTIGATION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SCOPE OF WORK

- A. General Site Contractor is required to complete double ring infiltrometer testing at the base of stormwater management systems to confirm any results completed during design and to ensure existing subbase has not been over compacted during excavation and demolition.
- B. The double-ring infiltrometer test is a field method to determine the infiltration of water into soil at locations as specified on the contract documents or in accordance with the minimum requirements by PWD.
- C. Soil classification testing is a field test to determine the general classification of soils per the USDA/NRCS Soils Textural Triangle and Standard Soils Classifications.
- D. Both tests are to be performed in the actual footprint of any proposed stormwater system, prior to any associated demolition or construction activities (aside from those necessary to secure the site for the soil investigation) are completed for the stormwater system in that location.

#### 1.3 REFERENCES

- A. All work and materials under this section shall conform to the following standard specifications where not otherwise required by the Contract Documents (including the Water Department Standard Specifications):
  1. ASTM C 294 Descriptive Nomenclature of Constituents of Natural Mineral Aggregates.
  2. ASTM C 420 Investigating and Sampling Soil and Rock for Engineering Purposes.
  3. ASTM D 1586 Method for Penetration Test and Split-Barrel Sampling of Soils.
  4. ASTM D 1587 Method for Thin-Walled Tube Sampling of Soils.
  5. ASTM D 2487 Test Method for Classification of Soils for Engineering Purposes.
  6. ASTM D 2488 Recommended Practice for Description of Soils (Visual-Manual Procedure).
  7. ASTM D 2573 Method for Field Vane Shear Test in Cohesive Soil.
  8. ASTM D 3385 Infiltration Rate of Soils in Field Using Double-Ring Infiltrimeters.
  9. Pennsylvania Department of Environmental Protection (PADEP), Chapter 73, Standards for on-lot sewage treatment facilities, Percolation Test.
  10. Pennsylvania Stormwater Best Management Practices Manual; Appendix C, Soil Evaluation and Soil Infiltration Testing.
  11. National Soil Survey Center (NRCS) Field Book for Describing and Sampling Soils
  12. ASTM D 6913 Test Methods for Particle-Size Distribution of Soils using Sieve Analysis.
  13. National Soil Survey Center (NRCS) Soils Textural Triangle

#### 1.4 SUBMITTALS

- A. Field Records shall include all pertinent information developed. Unofficial copies of field records shall be submitted to the Project Manager within 3 working days of testing.
  - 1. At each assigned site, record the project name and location, and a description of the assigned site. If on Railroad Property, record presence of Railroad Watchmen and other safety personnel.
  - 2. For each testing location, record the assigned number; location; ground surface elevation; name of driller; name of Inspector; day, date, and time work begun; method and apparatus used; details of the character of materials encountered, the depths at which encountered, and the thickness of strata; identification of soils in accordance with ASTM D 2488 and of rock materials in accordance with ASTM C 294; all observations pertaining to groundwater; day, date, and time work completed; time of sunset and/or sunrise; times work interrupted for Standby Time; weather.
  - 3. For each Soil Sample or Rock Core Sample, record the boring number; sample number, method and apparatus used; depth below ground surface; identification of soil or rock material; penetration resistance; core recovery.
- B. Final testing logs shall be submitted to the Project Manager as part of the final as-built package.
  - 1. Logs shall be neatly organized reports typed on white bond paper, containing all information from the Field Records, plus results of groundwater observations and physical tests on soil samples, and tabulations of data for soil sampling in a vertical scale of one inch to five feet.
  - 2. Logs shall include a location map indicating the actual location of the testing related by dimension to a fixed point (or points) to remain after construction.

#### 1.5 CONTRACTOR QUALIFICATIONS

- A. The infiltration tests for soil shall be performed by a Contractor with at least 5 years of experience in geotechnical engineering services. The Contractor shall have demonstrated experience with infiltration testing in soils. Field supervision by a Professional Geologist or Engineer is required; final testing logs shall be signed and certified by a licensed professional.

### **PART 2 - PRODUCTS**

NOT USED

### **PART 3 - EXECUTION**

#### 3.1 SOIL EVALUATIONS

- A. SAMPLING – GENERAL
  - 1. Sampling shall include split barrel, thin walled tube, hydraulic piston, or test pit sampling as designated herein or as required by the Project Manager. A pilot hole shall be drilled, and all soils shall be sampled every five feet (5') and at changes in strata unless otherwise directed by the Project Manager.
  - 2. Soil sampling shall include (at a minimum) an evaluation of the following conditions, described by initial depth encountered below ground surface:
    - a. Soil horizons (upper and lower boundary)
    - b. Soil texture, classification, and color
    - c. Color patterns (mottling) and observed depth
    - d. Depth to water table or redoximorphic effects (if encountered)

- e. Depth to bedrock (if encountered)
  - f. Observance of pores, roots, voids, or other non-soil components
  - g. Estimated type and percent coarse fragments
  - h. Hardpan or limiting layers encountered
  - i. Strike and dip of horizons (especially lateral direction of flow at limiting layers)
  - j. Any additional comments or observations
- 3. Sampling shall be done within the proposed footprint of each stormwater system. Additional sampling locations may be proscribed by the Project Manager during the Work to ensure sufficient data collection.
  - 4. Sampling shall continue to a minimum of two feet (2') beyond the excavated depth of the encompassing system, unless groundwater or bedrock is encountered. Bedrock shall be defined for this requirement as resistant to a blow count greater than fifty (50) blows to drive 12 inches (12").
- B. SPLIT BARREL SAMPLING**
- 1. Two-inch diameter split barrel samples shall be obtained and resistance to soil penetration shall be measured using the split barrel sampler in accordance with ASTM D 1586. Penetration resistance (blow count) for each 6-inch increment shall be required.
  - 2. The coupling head for the split barrel sampler shall be provided with a ball check valve and shall have open vents. The sampler shall also be equipped with a spring-type sampler retainer or an equivalent retainer acceptable to the Project Manager. The Contractor shall have three complete split barrel samplers on the drill rig. The barrel for the sampler shall be at least 24 inches in length to allow for 2-foot long samples. The split barrel sampler shall be decontaminated after obtaining each sample. Sample jars for split barrel samples submitted for physical analysis shall be supplied by the Contractor and shall not be larger than 2-3/8 inches in diameter. Sample jars for split barrel samples shall be moisture-proof and vapor-proof, wide-mouth glass jars with self-sealing screw covers. Sample jars will be labeled by the geotechnical engineer under the supervision of the Owner/Authorized Representative. The Contractor shall supply labels with space for the job name, boring number, interval sampled, and blow count in 6-inch increments.
- C. THIN-WALLED TUBE SAMPLING**
- 1. Three-inch diameter thin-walled tube samples shall be obtained using thin-walled tubes in accordance with ASTM D 1587. The coupling head of the thin-walled tube sampler shall be provided with a ball check valve and shall have open vents. Tubes shall be new and coated with a suitable plastic lacquer. Tubes shall recover a sample at least 3 inches in diameter. Tubes shall be furnished in 30-inch lengths and shall be constructed of either seamless steel or welded seam steel, provided welds do not project at the seam. The Contractor shall have eight complete thin-walled tube samplers on the drill rig. Thin-walled tubes will be labeled by the geotechnical engineer under the supervision of the Owner/Authorized Representative. The Contractor shall supply labels with space for job name, boring number, and interval sampled.
  - 2. The coupling head for the thin-walled tube sampler shall be decontaminated after obtaining each sample. Thin-walled tubes shall be decontaminated during the initial decontamination. They shall not be used more than once.
  - 3. The ends of the thin-walled tubes shall be sealed by the Contractor with wax, providing a spacer for partial recovery and taping an air-tight plastic cap over each end of the tube, as approved by the Project Manager.
- D. HYDRAULIC PISTON SAMPLING**
- 1. Sampling of soft clays and silts shall be performed using a hydraulic piston sampler, as approved by the Project Manager. Piston sampler type and general procedures shall be in accordance with EM 1110-2-1907, Chapter 3. Cased or uncased boreholes in soft soils may have to be supplemented with heavy drilling fluids to assist in retaining the sample in the device and increasing sample recovery. Recovered samples shall be handled and packaged as described for thin-walled tube samples.

E. TEST PIT SAMPLING

1. Test pits are encouraged for all off-street site work. For on-street locations, soil sampling may be appropriate to consider as a limited portion of the excavation for a given system. In either instance, the soil test pit shall consist of a backhoe-excavated trench, three feet (3') wide and to the appropriate depth (two feet beyond the desired system excavated depth). The trench should be benched at a depth of two to three feet (2-3') for access and accessibility.

3.2 INFILTRATION RATE OF SOIL USING DOUBLE-RING INFILTROMETER

- A. The Double-ring Infiltrometer consists of two concentric metal rings. The rings are driven into the ground and filled with water. The outer ring helps to prevent divergent flow. The drop in water level or volume in the inner ring is used to calculate an infiltration rate. The infiltration rate is determined as the amount of water per surface area and time unit that penetrates the soils. The diameter of the inner ring should be approximately 50% to 70% of the diameter of the outer ring, with a minimum inner ring size of 4 inches, preferably much larger (Bower, 1986). Double-ring infiltrometer testing equipment that is designed specifically for this purpose may be purchased.
- B. Conduct a Double-Ring Infiltrometer Field Test as follows:
1. Infiltration testing shall not be performed during any precipitation event or within twenty-four (24) hours after the end of any event equivalent to a half-inch (½") or greater. Infiltration testing shall not take place when the temperature is below freezing, or in frozen soils. Tests performed from 1 June to 31 December shall require a twenty-four hour presoaking period prior to testing.
  2. The test requires an area sufficient to set up the equipment (typically ten feet square), and should be nearly level. The test shall be set up at the same elevation as the finished bottom of the proposed stormwater feature. (Usually the lowest excavated elevation.) Excavation shall be performed as necessary to reach this desired elevation (concurrent soils testing is suggested) and provide a stable and level testing location.
    - a. Place outer ring in place; place flat board on ring and drive ring into soil to a minimum depth of two inches
    - b. Place inner ring in place; place flat board on ring and drive ring into soil a minimum of two inches. The bottom rim of both rings should be at the same level.
    - c. The test area should be presoaked immediately prior to testing. Fill both rings with water to water level indicator mark or rim at 30 minute intervals for 1 hour. The minimum water depth should be 4 inches. The drop in the water level during the last 30 minutes of the presoaking period should be applied to the following standard to determine the time interval between readings:
      - d. If the water level drop is 2 inches or more, use 10-minute measurement intervals.
      - e. If the water level drop is less than 2 inches, use 30-minute measurement intervals
  3. Obtain a reading of the drop in water level in the center ring at appropriate time intervals. After each reading, refill both rings to water level indicator mark or rim. Measurement to the water level in the center ring shall be made from a fixed reference point and shall continue at the interval determined until a minimum of eight readings are completed or until a stabilized rate of drop means a difference of ¼ inch or less of drop between the highest and lowest readings of four consecutive readings.
  4. The drop that occurs in the center ring during the final period or the average stabilized rate, expressed as inches per hour, shall represent the infiltration rate for that test location.

3.3 PAVING RESTORATION

- A. If necessary, following the tests properly abandon the sampling locations to prevent contaminant from entering the groundwater and maintain a safe condition for traffic. Encompassing site

protection specified for other parts of the Work of this Contract shall be considered sufficient temporary protection.

- B. The test holes shall be plugged with bentonite or other approved equal plugging material at the bottom or slightly below the groundwater table. Place, up to subgrade elevation, ordinary backfill material (with all stones and other objectionable material removed). Compact the hole plug and ordinary backfill material by tamping.
- C. If not otherwise to be restored or protected, place High Early Strength (H.E.S.) Cement Concrete to match existing surrounding grade. No testing location may be left unprotected and/or unrestored.
- D. Restore grass or other surfacing as appropriate to the satisfaction of the abutting property owners as necessary.

END OF SECTION 3340



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## **SECTION 33 4004 – SURFACE STORMWATER MANAGEMENT BASINS**

### **PART 1 - GENERAL**

#### **1.01 SCOPE**

- A. In general, the work to be done under this section consists of construction activities pertaining to the surface stormwater management basins. This work may include earthwork and excavation, protection of existing features, preparation of subgrade, check dam construction, grading, sheathing and shoring, construction of stormwater storage structures, installation of velocity dissipators, installation of geotextiles, impermeable liners, and erosion control blankets, connection of distribution and drainage piping, backfilling, installation and grading of soils, and any incidental and related operations.

#### **1.02 REFERENCE STANDARDS**

- A. The following apply to work in this section:
  - 1. ASTM: Specifications of the American Society for Testing and Materials latest editions. Modifications specified herein shall govern where conflicts with ASTM standards occur.
  - 2. PennDOT: Publication 408 current edition of the Commonwealth of Pennsylvania Department of Transportation Specifications.
  - 3. AASHTO: American Association of State Highway and Transportation Officials, current published standards.
  - 4. PTM: Pennsylvania Test Methods, current published standards.
  - 5. APWA: American Public Works Association, Uniform Color Code.
  - 6. PWD: Philadelphia Water Department, Stormwater Management Guidance Manual, latest edition.
- B. Commonwealth of Pennsylvania, Department of Transportation (PennDOT)
  - 1. Bulletin No. 15: Approved Construction Materials

#### **1.03 SUBMITTALS**

- A. Submit a list of materials to be provided for work under this Section including the name and address of the materials producer and the location from which the materials are to be obtained.
- B. Submit certificates, signed by the materials producer, stating that materials meet or exceed the specified requirements.
- C. Submit samples:
  - 1. Aggregate: Sieve analysis and samples of loose material in sealed bag labeled with name of material and manufacturer to be submitted upon request for analysis by Owner/Authorized Representative. Quantity of sample by weight shall be in accordance with ASTM standards, and may be confirmed by contacting BLS directly at (215) 685-1430.
  - 2. Non-woven geotextile: product manufacturer and specification sheets.

#### **1.04 QUALITY ASSURANCE**

- A. All materials, methods of construction, and workmanship shall conform to applicable requirements

of ASTM, PWD, PTM, PennDOT Standard Specifications and AASHTO Standards, unless otherwise specified.

- B. Upon completion of relevant excavation work, and prior to placement of any materials under this section, subgrade shall be inspected by Owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished subgrade elevation in accordance with the construction plans.
- C. Upon completion of placement of subgrade storage (stone fill or as otherwise specified) and geotextile, and prior to backfilling or surface restoration, the structure shall be inspected by Owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished elevation(s) of the subsurface stormwater trench in accordance with the construction plans.
- D. Upon completion of placement of surface stormwater features, and prior to backfilling or surface restoration, the structure shall be inspected by Owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished elevation(s) of all features in accordance with the construction plans.

#### 1.05 DELIVERY STORAGE AND HANDLING

- A. Bagged materials such as fertilizer, lime, etc. shall be delivered to the site, mixed as specified, in the original unopened standard size bags showing weight, analysis and name of manufacturer and indication of conformance with state and federal laws, as applicable. Containers shall bear the manufacturer's certificate of compliance covering analysis shall be furnished to Owner/Authorized Representative. Store bagged materials in a weatherproof place and in such a manner that it will be kept dry and its effectiveness will not be impaired.
- B. Deliver, store, and handle all materials to ensure protection from damage.

### PART 2 - PRODUCTS

#### 2.01 AGGREGATE

- A. Coarse aggregates shall be uniformly graded, crushed, clean washed stone that meet the size and grading requirements as defined in Standard Sizes of Course Aggregate, Table 4, AASHTO Specifications, Part I, 19<sup>th</sup> Edition, 1998 or latest edition, unless otherwise specified.
  - 1. Maximum wash loss of 1% by mass (ASTM C117)
  - 2. Minimum Durability Index of 35 (ASTM D3744)
  - 3. Maximum abrasion of 40% for 500 revolutions per ASTM C535 or C131 as appropriate to aggregate size.
  - 4. All aggregate shall be clean and thoroughly washed.
  - 5. Aggregate shall be 100% crushed material.
- B. Unless otherwise approved by Owner/Authorized Representative and PWD, coarse aggregate for the stormwater management basins shall be uniformly graded as defined in Standard Sizes of Coarse Aggregate, Table 4, AASHTO Specifications, Part I, 19<sup>th</sup> Ed., 1998, or latest edition, unless otherwise specified.

1. Grading Requirements for AASHTO No. 57

U.S. Standard Sieve Size	Percent Passing
1 ½"(37.5 mm)	100
1" (25 mm)	95-100
½ " (12.5 mm)	25-60
No. 4 (4.75 mm)	0-10
No. 8 (2.36 mm)	0-5

2. Any and all other specified coarse aggregates shall conform in gradation and type to the current standards of PennDOT Publication 408, Section 703 Table C.

C. Crushed concrete shall not be an acceptable substitute for coarse aggregate unless specifically authorized in writing by Owner/Authorized Representative prior to placement.

2.02 SAND

A. Sand used to line the bottom of stormwater trenches (if required) shall be AASHTO M-43 No. 9 or 10.

1. Grading Requirements for AASHTO No 9

U.S. Standard Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	85-100
No. 8 (2.36 mm)	10-40
No. 16 (1.18 mm)	0-10
No. 50 (300 µm)	0-5

2. Grading Requirements for AASHTO No 10

U.S. Standard Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	85-100
No. 100 (150 µm)	10-30

2.03 GEOTEXTILES

A. Non-woven geotextile (drainage filter fabric) must consist of polypropylene fibers and shall be a

qualified product listed in PennDOT Bulletin 15 or approved equal and meet the following criteria (AASHTO Class 1 or class 2 geotextile is recommended):

1. Minimum flow rate 95 gal/min/ft<sup>2</sup> (ASTM D-4491)
2. Minimum grab tensile strength 120 lbs (ASTM D-4632)
3. Minimum Mullen Burst Strength 225 psi (ASTM-D3786)
4. Minimum CBR puncture strength 300 psi (ASTM D-6241)
5. Minimum tear resistance 50 lbs (ASTM D-4533)
6. Minimum UV resistance 70% retained strength after 500 hours (ASTM D-4355)
7. Heat-set or heat-calendared fabrics are not permitted.

#### 2.04 BACKFILL MATERIALS

- A. Ordinary Backfill Material may include all material excavated from the trench and free of objectionable matter, unless rejected by Owner or authorized representative. The Contractor shall furnish any deficiency of Ordinary Backfill Material.
- B. Select Backfill Material shall be furnished where specified in accordance with PennDOT Publication 408 Specifications, Section 703.3, Select Granular Material-2RC (as amended). The use of slag as Select Backfill Material is hereby prohibited.

#### 2.05 DETECTABLE UNDERGROUND TAPE

- A. Detectable Underground Utility Warning Tape shall be six inches wide (6"), 5-mil thickness, with aluminum foil core. Tape shall be printed with an appropriate legend ("Caution: Buried Storm Sewer Below" or as approved) and shall conform to the color standards of the APWA for buried utilities (green for sewer).

#### 2.06 EROSION CONTROL BLANKETS

- A. Erosion Control Blanket shall be a 100% jute fiber hand-woven into a one-inch by one-inch (1" x 1") net. Jute netting shall be of a uniform, open, plain weave, undyed and unbleached single jute yarn. Yarn shall be of loosely-twisted construction, and shall not vary in thickness by more than one-half its normal diameter. Blanket shall be 100% biodegradable.
- B. Minimum width shall be forty-eight inches (48") or plus/minus one inch (+/- 1") from manufacturer rated width. Weight shall average a minimum of 0.9 pounds per square yard.
- C. Netting shall at minimum consist of seventy-eight (78) warp ends per forty-eight-inch (48") width, and forty-one (41) weft ends per linear yard.
- D. Blanket shall be listed in PennDOT Bulletin 15, or approved equal. Furnish attachment devices as recommended by blanket manufacturer.

### **PART 3 - EXECUTION**

#### 3.01 EXCAVATION BELOW GRADE

- A. Subgrade shall be unfrozen, firm, and stable with no standing water, mud, or muck. If the Contractor fails to maintain the subgrade properly, the Contractor shall remove the unsuitable material at no additional cost to Owner. If the bottom of any excavation is taken out below the limits shown on the Drawings, it shall be restored at the Contractor's expense with six-inch (6") layers of AASHTO #57 aggregate to the elevations shown in the Drawings. Compacted earthen fill is not acceptable.
- B. If in the opinion of Owner or authorized representative the undisturbed natural subgrade, at or below the normal grade of the excavation as indicated on the Drawings, is unsuitable for construction, it shall be removed to such depth and width as Owner/Authorized Representative may direct and be replaced with suitable material as directed. These activities shall be included in the appropriate lump sum price bid for the related construction activities by location.
- C. Excavation of trenches required for the installation of all pipes and structures shall be made to the depths and widths indicated on the Drawings. The Contractor shall render the bottom of the excavations firm and dry and in all respects acceptable to Owner/Authorized Representative. Pavement, when encountered, shall be sawcut along straight lines before excavating.
- D. Excavation shall be performed in-the-dry and shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The existing subgrade shall not be compacted or subject to excessive construction equipment prior to placement of geotextile and crushed stone. If it is essential that equipment be used in the excavated area of infiltration facilities, all equipment must be approved by Owner or authorized representative. Use of equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires that will cause excessive compaction shall not be permitted within the excavation.

### 3.02 EXCAVATION SUPPORT

- A. Furnish, install, monitor and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc.) as required by Federal, State or local laws, ordinances, regulations and safety requirements. Support the sides of excavation, to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement or other damage.
- B. The Contractor shall take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with AASHTO #57 aggregate. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete.
- C. All excavation supports shall be carefully removed in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. All voids left or caused by withdrawal of supports shall be immediately filled with crushed stone and compacted. No sheeting shall be left in the trench following installation of improvements.
- D. No payment will be given for sheeting, bracing, etc., during the progress of the work. All payment for installing, maintaining, and removing sheathing and shoring or any other required excavation support shall be included in the price bid for excavation.

### 3.03 SUBGRADE PREPARATION AND GRADING

- A. Subgrade of infiltration beds shall be level: Plus or minus one-half inch (+/- ½") is acceptable as level.
- B. Grading shall be performed to the lines and grades shown on the Drawings. All objectionable material encountered within the limits indicated shall be removed and disposed of by the Contractor.
- C. In excavation faces, all loose or protruding rocks shall be barred loose or otherwise removed to

line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the Drawings or as directed by Owner or authorized representative.

- D. In locations where subsurface stone storage underlies the stormwater surface feature, all work to prepare the stone storage layer shall be completed prior to installation of surface features (see Section 334005). Subsurface stone storage shall be approved by Owner/Authorized Representative prior to installation of surface structures. Appropriate stone foundation shall be utilized in all locations for precast and cast-in-place concrete surrounds and curbing (stone storage may be considered as foundation if compacted stone extends completely under the concrete surrounds).
- E. As-built information of subsurface stone storage and infrastructure below finished grade shall be accurately collected and recorded per PWD latest requirements and approved Engineer prior to backfilling.

### 3.04 DISPOSAL OF UNSUITABLE OR SURPLUS MATERIAL

- A. Excavated materials that will not be reused shall be removed from the site of the work and disposed of by the Contractor. Disposal of excavated materials shall be included in the appropriate lump sum price bid for the related construction activities by location, and no additional payment shall be made for disposal of excavated materials regardless of class or condition. Excess material to remain onsite shall be protected in accordance with Section 312500.

### 3.05 BACKFILL

- A. Backfill other than planting soil or aggregate as described elsewhere in the Specifications (such as ordinary or select backfill used to fill over-excavation outside installed structures) shall be brought up evenly on all sides in 8-inch lifts. Each layer of backfill material shall be compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping to 95% compaction. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench. Use a pad foot roller for cohesive fill (silts and clay) and a smooth drum roller or vibrating plate for coarse grained fill (sands and gravels). If material is compacted by hand-tamping, there must be at least one laborer tamping for each laborer shoveling material into the trench. All backfilling operation shall be in accordance with the Standard Specifications for Excavation, Refilling, Grading, Landscaping and Repaving.

### 3.06 INSTALLATION OF SUBSURFACE STONE FOR BIOINFILTRATION BASINS

- A. Impermeable liner, non-woven geotextile, and sand layer shall be placed immediately after approval of subgrade preparation (to include infiltration testing). Subgrades shall not be subject to compaction during excavation or during installation of geotextile and aggregates. Subgrades shall be hand-raked to scarify bottoms of infiltration systems prior to geotextile and aggregate placement. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of non-woven geotextile at no extra cost to Owner.
- B. Geotextile shall be placed in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater. Secure non-woven geotextile at least four feet (4') outside of trench and take steps necessary to prevent any runoff or sediment from entering the trench.
- C. Install coarse aggregate in eight inch (8") maximum lifts. Lightly compact each layer with equipment, keeping equipment movement on storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings. Install detectable underground utility warning tape at the perimeter of the subsurface stone storage trench on all sides. Once aggregate is backfilled and compacted to grades indicated on the Drawings, geotextile shall be folded over and overlapped on top of the bed to prevent soil intrusion into the

aggregate bed.

- D. Impermeable liner shall be placed in accordance with manufacturer's instructions and as indicated in the Drawings. All seams and openings in the liner shall be sealed according to manufacturer's recommendations and specifications. Adjacent strips of impermeable liner shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater.
- E. Where an existing utility lateral or branch main intersects the stone stormwater storage system, a pass-through conduit (utility sleeve) shall be constructed to convey the existing utility. Owner/Authorized Representative shall review and approve any pass-through conduits for utility lines not indicated on the Drawings, and any utility laterals that may be reconstructed such that a pass-through conduit is not necessary shall be so reconstructed.
  - 1. Pass-through conduits shall be constructed of Schedule 40 PVC pipe of adequate diameter to convey the utility lateral within.
  - 2. Waterstops shall be installed at either end of the pass-through conduit, outside the geotextile wrap of the stone stormwater storage.
  - 3. The conduit shall be of watertight construction, and shall be sealed at either end around the existing pipe with non-shrink grout or sealant.
  - 4. Any pass-through conduits for utilities not indicated on the Drawings found to be necessary upon excavation will be paid at a contingency price.
  - 5. The Contractor shall coordinate sleeving of all existing and intersecting utility lines with the owners/operators of said utility lines.
  - 6. Split Pipe Conduit shall be listed in PennDOT Bulletin 15 or approved equal.

### 3.07 INSTALLATION OF STORMWATER SOIL

- A. Refer to Section 329200 – Green Stormwater Infrastructure Soils.

### 3.08 INSTALLATION OF BIOINFILTRATION BASIN SURFACE FEATURES

- A. All concrete structures shall be placed on stone bedding for stability. In the case where a concrete structure is atop a subsurface stone storage area, this may be considered adequate bedding. In all other cases, concrete structures shall be placed on a minimum four-inch (4") thick layer of clean AASHTO#57 stone, to extend a minimum of four inches (4") beyond the structure on all sides.
- B. Precast or cast-in-place concrete surrounds shall be installed to the dimensions and elevations indicated on the Drawings. Cast-in-place structures shall be allowed to cure prior to further operations. Connections to inlets, piping, and other associated structures shall be completed prior to backfilling operations. Detailed survey shall confirm installed structure elevations prior to additional work such as backfilling or connection to other systems.
- C. Install all supporting and accessory structures within the stormwater surface feature, such as but not limited to riser structures at specified elevations, splash blocks and velocity dissipators, inlet covers and lay-by inlets, check dams, and wheel stops.

### 3.09 FINE GRADING AND EROSION CONTROL BLANKETS



- A. After soil has been spread, it shall be carefully prepared by hand scarifying or rototilling, cultivating or hand raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign material shall be removed and disposed of in accordance with Federal, State, and local regulations. The areas shall also be free of smaller stones, in excessive quantities, as determined by Owner/Authorized Representative. Limit finish grading to areas that can be covered with stapled erosion control blanket and planted within two days.
- B. Coordinate construction to limit excessive traffic over installed soils. Once placed, eliminate trafficking of all vehicles and/or equipment in the areas that will be prepared for planting operations.
- C. The Contractor shall make all efforts to not destroy soil structure by excessive traffic, working, or compacting the soil throughout the planting operation. Utilize the smallest practicable piece of low ground pressure mechanical equipment in the adjacent areas.
- D. Prepare soil before installing blankets, including any application of fertilizer, lime, organic matter, and establishment of finished grades. Add any required soil amendments and weed preventer via broadcasting, shallow tilling, or appropriate minimally-destructive method to soil.
- E. Fine-grade placed soil to slopes and elevations indicated on the Drawings. Limit finish grading to areas that can be covered with stapled erosion control blanket or mulched covering within two days.
- F. Stapled erosion control blankets shall be installed on top of the finished grade inside each area to be covered. Each area shall receive one continuous stapled blanket. Overlaps, seams, or adjacent pieces of blankets are not acceptable, except where necessary to connect two complete rolls of blanket. Seams shall conform to manufacturer's specifications.
- G. Along the concrete wall and/or soil edge of each structure, anchor the edge of the blanket in a 6-in deep trench between the face of each concrete wall (or existing material) and the planting soil. At inside corners of structures, cut each corner of the blanket to prevent overlaps when blanket is turned down into trench. Secure the blanket over the finished grade soil with a row of staples spaced approximately 12-in apart, in staggered rows, and parallel to each wall of the structure.
- H. Final soil stabilization is subject to approval by Owner/Authorized Representative. Final payment for a structure may not be made without Owners acceptance of the final surface.

**END OF SECTION 334004**

## **SECTION 33 4007 - STORMWATER CONTROL STRUCTURES**

### **PART 1 - GENERAL**

#### 1.01 SUMMARY

- A. The work of this Section consists of the construction of the outflow control structures for stormwater management basins.
- B. All materials shall be manufactured, supplied, stored and placed according to the latest referenced standards and as outlined herein.

#### 1.02 RELATED DOCUMENTS

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

#### 1.03 SUBMITTALS

- A. Submit complete shop drawings and product information for all items to be furnished under this Section upon receipt of notice to proceed and prior to construction.
- B. Certificates of Compliance: Before installation of any Precast Concrete Products, submit an acceptable Certificate of Compliance to Owner/Authorized Representative
- C. Submit a list of materials to be provided for work under this Section including the name and address of the materials producer and the location from which the materials are to be obtained.
- D. Submit certificates, signed by the materials producer, stating that materials meet or exceed the specified ASTM and ACI requirements
- E. Submit detailed diagrams of all outflow structure depicting dimensions and materials used to construct the entire structure. Indicate knockout elevations and size for all pipe entering manhole structures or other concrete structures.

#### 1.04 QUALITY ASSURANCE

- A. All materials, methods of construction, and workmanship shall conform to applicable requirements of ASTM, PTM, PWD, PennDOT Standard Specifications and AASHTO Standards, unless otherwise specified.

### **PART 2 - PRODUCTS**

#### 2.01 INLET GRATE AND FRAME

- A. Inlet frame and grate shall be in accordance with PennDOT Publication 72M, Roadway Construction Standards RC-45M and PennDOT Publication 408, Section 605.

#### 2.02 PRECAST CONCRETE TOP UNIT, GRADE ADJUSTMENT RINGS, AND INLET BOX

- A. In accordance with PennDOT Publication 408, Section 605.

#### 2.03 CAST BASIN HOOD

- A. Provide Catch Basin Trap Number R-3711 manufactured by Neenah Foundry Inc. or Philadelphia Water department (PWD) approved alternative.

**PART 3 - EXECUTION**

3.01 INSTALLATION OF OUTFLOW STRUCTURES

- A. Install in accordance with PennDOT Publication 408, Section 605.

**END OF SECTION 334007**

## **SECTION 334726 - SUBSURFACE STORMWATER STORAGE**

### **PART 1 - GENERAL**

#### **1.1 SCOPE DESCRIPTION**

- A. In general, the work to be done under this section consists of construction activities pertaining to subsurface stormwater storage, including but not limited to earthwork and excavation, protection of existing features, preparation of subgrade, grading, sheathing and shoring, placement and compaction of clean stone, construction of stone and/or modular stormwater storage structures, installation of geotextiles and impermeable liners, connection of distribution and drainage piping, backfilling, and any incidental and related operations.
- B. The installation of the Modular storage units shall include any necessary bedding or subgrade preparation not otherwise accounted for, any observation or maintenance ports integral to the modular system, all interfaces required for piping, waterstops, geogrid and geotextile installation, onsite assembly of modular units, and furnishing and installing any additional fittings or appurtenant materials necessary to complete installation of the modular stormwater storage system.

#### **1.2 REFERENCE STANDARDS**

- A. The following apply to work in this section:
- B. ASTM: Specifications of the American Society for Testing and Materials latest editions. Modifications specified herein shall govern where conflicts with ASTM standards occur.
- C. PennDOT: Publication 408 current edition of the Commonwealth of Pennsylvania Department of Transportation Specifications.
- D. AASHTO: American Association of State Highway and Transportation Officials, current published standards.
- E. PTM: Pennsylvania Test Methods, current published standards.
- F. APWA: American Public Works Association, Uniform Color Code.
- G. PWD: Philadelphia Water Department Stormwater Management Guidance Manual, latest version

#### **1.3 SUBMITTALS**

- A. Submit a list of materials to be provided for work under this Section including the name and address of the materials producer and the location from which the materials are to be obtained.
- B. Submit certificates, signed by the materials producer, stating that materials meet or exceed the specified requirements. In addition, submit the following:
  - 1. Aggregate: sieve analysis
  - 2. Non-woven geotextile: product manufacturer and specification sheets
  - 3. Impermeable liner (if required): product manufacturer and specification sheets
  - 4. Modular stormwater storage units: product manufacturer and specification sheets, installation instructions and maintenance guidelines.

- C. Submit samples of coarse aggregates and sand.
  - 1. Aggregate and sand: Samples of loose material in sealed bag labeled with name of material and manufacturer to be submitted for analysis by owner. Quantity of sample by weight shall be in accordance with ASTM standards.
  - 2. Sub-surface stormwater storage modules; provide a single unit, height as specified in the contract drawings to be reviewed and retained by owner.

1.4 QUALITY ASSURANCE

- A. All materials, methods of construction, and workmanship shall conform to applicable requirements of ASTM, PTM, PennDOT Standard Specifications and AASHTO Standards, unless otherwise specified.
- B. Upon completion of relevant excavation work, and prior to placement of geotextile and aggregate, subgrade soil shall be inspected by owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished subgrade elevation in accordance with the construction plans.
- C. Upon completion of placement of subgrade storage (stone fill or as otherwise specified) and geotextile, and prior to backfilling or surface restoration, the structure shall be inspected by owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished elevation(s) of the subsurface stormwater trench in accordance with the construction plans.

1.5 DELIVERY STORAGE AND HANDLING

- A. Deliver, store, and handle all materials to ensure protection from damage.
- B. All plastic wrapping from the packaging should be removed and the units should be stored under a tarp or roof where they are protected from weather.
- C. If stored for an extended period of time, additional measures should be taken to prevent UV and weather damage
- D. Stored components should be checked at least once a week. A check of the stored area should be done to make any minor repairs to the cover or to restack any components that could have fallen over.

**PART 2 - PRODUCTS**

2.1 AGGREGATE

- A. Coarse aggregates shall meet the following requirements:
  - 1. Maximum wash loss of 1% by mass (ASTM C117)
  - 2. Minimum Durability Index of 35 (ASTM D3744)
  - 3. Maximum abrasion of 10% for 100 revolutions and maximum of 50% for 500 revolutions
  - 4. All aggregate shall be clean and thoroughly washed.
  - 5. Aggregate shall be 100% crushed material.
- B. Unless otherwise approved by PWD, coarse aggregate for the stormwater trenches shall be uniformly graded as defined in Standard Sizes of Coarse Aggregate, Table 4, AASHTO Specifications, Part I, 19<sup>th</sup> Ed., 1998, or latest edition, unless otherwise specified.

1. Grading Requirements for AASHTO No. 57

U.S. Standard Sieve Size	Percent Passing
1 ½" (37.5 mm)	100
1" (25 mm)	95-100
½" (12.5 mm)	25-60
No. 4 (4.75 mm)	0-10
No. 8 (2.36 mm)	0-5

3. Any and all other specified coarse aggregates shall conform in gradation and type to the current standards of PennDOT Publication 408, Section 703 Table C.

C. Crushed concrete shall not be an acceptable substitute for coarse aggregate.

2.2 SAND

A. Sand if used or required by the modular manufacture to line the bottom of stormwater trenches shall be AASHTO M-43 No. 9 or 10.

B. Sand shall not be an acceptable substitute for coarse aggregate

1. Grading Requirements for AASHTO No 9

U.S. Standard Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	85-100
No. 8 (2.36 mm)	10-40
No. 16 (1.18 mm)	0-10
No. 50 (300 µm)	0-5

2. Grading Requirements for AASHTO No 10

U.S. Standard Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	85-100
No. 100 (150 µm)	10-30

2.3 GEOTEXTILES

A. Non-woven geotextile (drainage filter fabric) minimum 6 oz.

1. Minimum flow rate 95 gal/min/ft<sup>2</sup> (ASTM D-4491)
2. Minimum grab tensile strength 120 lbs (ASTM D-4632)
3. Minimum CBR puncture strength 300 psi (ASTM D-6241)
4. Minimum tear resistance 50 lbs (ASTM D-4533)
5. Minimum UV resistance 70% retained strength (ASTM D-4355)

- B. Impermeable liner if used shall be 40 mil thick high density polyethylene geomembrane designed specifically for flexible geomembrane applications. Geomembrane liner shall be GSE Lining Technology product # HDE 040A000 or approved equivalent.
1. Minimum average thickness 40 mil (mm) (ASTM D 5199)
  2. Density 0.94 g/cm<sup>3</sup> (ASTM D 1505)
  3. Strength at break 152 lb/in-width
  4. Strength at yield 84 lb/in-width
  5. Elongation at break 700%
  6. Elongation at yield 12%
  7. Tear resistance 28 lb (ASTM D 1004)
  8. Puncture resistance 72 lb (ASTM D 4833)
  9. Carbon black content 2% (ASTM D 5596)
  10. Notched constant tensile load 300 hr (ASTM D 5397, Appendix)
- C. Geotextiles and geogrids associated with modular stormwater systems shall be as specified by the manufacturer.

#### 2.4 BACKFILL MATERIALS

- A. Ordinary Backfill Material may include all material excavated from the trench and free of objectionable matter, unless rejected by PWD or authorized representative. The Contractor shall furnish any deficiency of Ordinary Backfill Material.
- B. Select Backfill Material shall be furnished where specified in accordance with PennDOT Publication 408 Specifications, Section 703.3, Select Granular Material-2RC (as amended). The use of slag as Select Backfill Material is hereby prohibited.

#### 2.5 WATERSTOPS

- A. Waterstops (or antiseep collars) if required shall be quarter-inch (1/4") HDPE sheets cut to the dimensions indicated and installed per the Drawings. All metal fittings or attachments used shall be nylon or stainless steel (Grade 304 or better). Plastic sealant for weld shall be as suggested by manufacturer.

#### 2.6 DETECTABLE UNDERGROUND TAPE

- A. Detectable Underground Utility Warning Tape shall be six inches wide (6"), 5-mil thickness, with aluminum foil core. Tape shall be printed with an appropriate legend ("Caution: Buried Storm Sewer Below" or as approved) and shall conform to the color standards of the APWA for buried utilities (green for sewer).

#### 2.7 MODULAR STORMWATER STORAGE SYSTEMS

- A. Modular Stormwater Storage Systems shall be as indicated on the Drawings. Fittings, installation, and appurtenant materials (geogrids, geotextiles, etc) shall be as specified by the manufacturer.
  - 1. Brentwood Module 20 Series StormTank or Approved equal
- B. The sub-surface stormwater storage system modules under the requires 2.0 ft. cover must withstand, at a minimum live loading consisting of the design truck (HS-20) loading in accordance with AASHTO LRFD Bridge Design Requirements, without geogrid.
- C. The Modular storage units must have a 95% void space.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL CONDITIONS**

- A. Coordinate the installation with the product distributor, to have the distributor on-site during product installation.
- B. Review manufacture's installation procedures and coordinate Sub-surface stormwater storage system installation with other work affected, such as grading, excavation, utilities, construction access, erosion control, etc.
- C. Cold weather installation or assembly of modules should not be undertaken when temperatures are below 40°F, without utilization of a heated facility.
- D. Assembled modules may be walked on, but vehicle traffic if prohibited until properly backfilled and covered per Manufacturer's recommendations. Protect personnel and the installation against damage with highly visible construction tape, fencing or other means until construction is complete.

#### **3.2 EXCAVATION BELOW GRADE**

- A. Subgrade shall be unfrozen, firm, and stable with no standing water, mud, or muck. If the Contractor fails to maintain the subgrade properly, the Contractor shall remove the unsuitable material at no additional cost to owner. If the bottom of any excavation is taken out below the limits shown on the Drawings, it shall be restored at the Contractor's expense with six-inch (6") layers of AASHTO #57 aggregate to the elevations shown in the Drawings. Compacted earthen fill is not acceptable.
- B. If in the opinion of owner or authorized representative the undisturbed natural subgrade, at or below the normal grade of the excavation as indicated on the Drawings, is unsuitable for construction, it shall be removed to such depth and width as owner or authorized representative may direct and be replaced with suitable material as directed. These activities shall be included in the appropriate lump sum price bid for the related construction activates by location.
- C. Excavation of trenches required for the installation of all pipes and structures shall be made to the depths and widths indicated on the Drawings. The Contractor shall render the bottom of the excavations firm and dry and in all respects acceptable to owner or authorized representative. Pavement, when encountered, shall be sawcut along straight lines before excavating.
- D. Excavation shall be performed in-the-dry and shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The existing subgrade shall not be compacted or subject to excessive construction equipment prior to placement of geotextile and crushed stone. If it is essential that equipment be used in the excavated area of infiltration facilities, all equipment must be approved by PWD or authorized representative. Use of



equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires that will cause excessive compaction shall not be permitted within the excavation.

### 3.3 EXCAVATION SUPPORT

- A. Furnish, install, monitor and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc) as required by Federal, State or local laws, ordinances, regulations and safety requirements. Support the sides of excavation, to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement or other damage.
- B. The Contractor shall take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with AASHTO #57 aggregate. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete.
- C. All excavation supports shall be carefully removed in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. All voids left or caused by withdrawal of supports shall be immediately filled with crushed stone and compacted. No sheeting shall be left in the trench following installation of improvements.
- D. No payment will be given for sheeting, bracing, etc, during the progress of the work. All payment for installing, maintaining, and removing sheathing and shoring or any other required excavation support shall be included in the appropriate lump sum price bid for the related construction activities by location.

### 3.4 SUBGRADE PREPARATION AND GRADING

- A. Subgrade of infiltration beds shall be level: Plus or minus one-half inch (+/- ½") is acceptable as level.
- B. Grading shall be performed to the lines and grades shown on the Drawings. All objectionable material encountered within the limits indicated shall be removed and disposed of by the Contractor.
- C. In excavation faces, all loose or protruding rocks shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the Drawings or as directed by PWD or authorized representative.
- D. Prior to backfill for stone stormwater systems, Double Ring Infiltrometer Testing shall be conducted in one location for each system in accordance with ASTM Standard D 3385: Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer. Test holes shall be located within the limits of the proposed trench excavation and results of the testing shall be submitted to PWD or an authorized representative.

### 3.5 DISPOSAL OF UNSUITABLE OR SURPLUS MATERIAL

- A. Excavated materials that will not be reused shall be removed from the site of the work and disposed of by the Contractor. Disposal of excavated materials shall be included in the appropriate lump sum price bid for the related construction activities by location, and no additional payment shall be made for disposal of excavated materials regardless of class or condition.
- B. Excavated material shall be stacked without excessive surcharge on the trench bank and without obstructing free access to utilities, private drives and public rights-of-way. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated

material shall be segregated for use in backfilling as specified or shown on the Drawings, and protected as specified in Section 02270.

### 3.6 BACKFILL

- A. Backfill shall be brought up evenly on all sides in 8-inch maximum lifts (sand layer shall be placed in a single six-inch (6") lift). Each layer of backfill material shall be compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench. Use a pad foot roller for cohesive fill (silts and clay) and a smooth drum roller or vibrating plate for coarse grained fill (sands and gravels). If material is compacted by hand-tamping, there must be at least one laborer tamping for each laborer shoveling material into the trench.
- B. Where pipes are laid in off-street easements, the remainder of the trench (one foot (1') or more above the top of the pipe) shall be filled with common fill in layers not to exceed eight inches (8") and compacted by rolling, tamping or vibrating with mechanical compacting equipment. Wherever a loam or gravel surface exists prior to excavations, it shall be removed, conserved and replaced to the full original depth as part of the work unless specified or shown otherwise. In some areas it may be necessary to remove excess material during the clean-up process, so that the ground may be restored to its original level and condition. If the Contractor prefers not to store loam, gravel, or topsoil it shall be replaced with material as specified herein.
- C. Where pipes are laid in PennDOT or local roadways or rights-of-way, the remainder of the trench above the crushed stone backfill and up to the bottom of the specified paving or surface restoration shall be backfilled with fill materials as specified on the Drawings. Lifts shall at no time exceed eight inches (8") loose, and compaction shall be in accordance with these specifications. Preparation and paving shall be performed as shown on the Drawings or as specified herein.

### 3.7 INSTALLATION OF SUBSURFACE STONE STORMWATER TRENCHES

- A. Impermeable liner, non-woven geotextile, and/or sand layer shall be placed immediately after approval of subgrade preparation (to include infiltration testing). Subgrades shall not be subject to compaction during excavation or during installation of geotextile and aggregates. Subgrades shall be hand-raked to scarify bottoms of infiltration systems prior to geotextile and aggregate placement. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of non-woven geotextile at no extra cost to owner.
- B. Geotextile shall be placed in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater. Secure non-woven geotextile at least four feet (4') outside of trench and take steps necessary to prevent any runoff or sediment from entering the trench.
- C. Install coarse aggregate in eight inch (8") maximum lifts. Lightly compact each layer with equipment, keeping equipment movement on storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings. Install detectable underground utility warning tape at the perimeter of the subsurface stone storage trench on all sides. Once aggregate is backfilled and compacted to grades indicated on the Drawings, geotextile shall be folded over and overlapped on top of the bed to prevent soil intrusion into the aggregate bed.
- D. Impermeable liner shall be placed in accordance with manufacturer's instructions and as indicated in the Drawings. All seams and openings in the liner shall be sealed according to manufacturer's recommendations and specifications. Adjacent strips of impermeable liner shall

overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater.

- E. Where an existing utility lateral or branch main intersects the stone stormwater storage system, a pass-through conduit (utility sleeve) shall be constructed to convey the existing utility. PWD shall review and approve any pass-through conduits for utility lines not indicated on the Drawings, and any utility laterals that may be reconstructed such that a pass-through conduit is not necessary shall be so reconstructed.
1. Pass-through conduits shall be constructed of Schedule 40 PVC pipe of adequate diameter to convey the utility lateral within.
  2. Waterstops shall be installed at either end of the pass-through conduit, outside the geotextile wrap of the stone stormwater storage.
  3. The conduit shall be of watertight construction, and shall be sealed at either end around the existing pipe with non-shrink grout or sealant.
  4. Any pass-through conduits for utilities not indicated on the Drawings found to be necessary upon excavation will be paid at a contingency price.
  5. The Contractor shall coordinate sleeving of all existing and intersecting utility lines with the owners/operators of said utility lines.
  6. Split Pipe Conduit shall be P6F as manufactured by Conduit Repair Systems or approved equal.

### 3.8 INSTALLATION OF MODULAR SUBSURFACE STORMWATER STORAGE.

- A. Installation procedure as follows shall be followed by the Contractor. The Contractor shall also reference the manufacturer's installation guidelines, and where any discrepancy exists owner reserves the right to preempt the manufacturer's installation guidelines as specified herein.
1. Impermeable liner, non-woven geotextile, and/or sand layer shall be placed immediately after approval of subgrade preparation (to include infiltration testing). Subgrades shall not be subject to compaction during excavation or during installation of geotextile and aggregates. Subgrades shall be hand-raked to scarify bottoms prior to geotextile and aggregate placement. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of non-woven geotextile at no extra cost to owner.
  2. Geotextile shall be placed in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater. Secure non-woven geotextile at least four feet (4') outside of trench and take steps necessary to prevent any runoff or sediment from entering the trench.
  3. After installation of geotextile as specified above, install base layer of minimum six inches (6") of AASHTO #57 stone across footprint of modular structure. Compact stone to 75-80% relative density per ASTM D4253, and level as necessary to produce a consistent surface. Subgrade shall be visually inspected and approved prior to continuing installation.
  4. Place geotextile fabric and/or impermeable liner if required as specified to full extents of excavation. Geotextile shall be installed per manufacturer's directions. Geotextile and other liners shall be placed such that seaming shall be minimized. Additional material to

be utilized for wrapping above the structure shall be protected from damage until use. Geotextile used shall be in accordance with modular stormwater unit manufacturer's specifications.

5. Utilize a soluble paint to outline the footprint of the modular units to be placed. Care should be taken to note any connections, observation or maintenance ports, or other irregular units to be placed.
6. Install modules by placing side-by-side, attaching per manufacturer's instructions. Use caution to avoid debris or soil intrusion to the system components.
7. Attach all pipe connections, observation or maintenance ports, pass-through conduits, or other intrusions to the system. No penetrations other than manufacturer approved ports shall be placed in top or bottom panels of the system. Support pipe in trenches and during backfill operations to prevent damage. Pipe Connections should extend into the modular system a minimum of 6".
8. Upon completion of the layer course, wrap geotextile or impermeable liner as specified and backfill around the structure with AASHTO #57 to a minimum of twelve inches (12") width. Side backfill shall be laid in maximum twelve-inch (12") depth lifts and compacted to 75-80% relative density per ASTM D4253. Use caution to avoid damage to the geotextile and other components.
9. Repeat steps 1-6 as necessary to complete the full modular stormwater system.
10. Complete geotextile or liner wrap of system. Add any port connections to surface, ensuring a proper seal with geotextile or liner wrap.
11. Install detectable underground utility marking tape around perimeter of system to mark the area for future utility detection.
12. Prior to final backfilling and surface restoration, the structure shall be inspected by owner or authorized representative. Survey or acceptable measurement shall verify the finished elevations of the storage structure in accordance with the construction plans.
13. Upon approval under the provisions of step 10, install a twelve inch (12") lift of AASHTO #57 stone over the modular system. Compact to a 95% Proctor using vibrating plates or walk-behind non-vibratory rollers (do not use drivable rolling compactors). Driving on modules is prohibited until a minimum twenty-four inches (24") of cover is established.
14. Install remaining cover to a minimum finished cover depth of twenty-four inches (24") as indicated on the plans. Maximum overall depth from surface to invert of system is eleven feet (11'). Complete surface restoration as indicated on the Drawings and as described in Related Work Sections of these specifications.

### 3.9 INSTALLATION OF ANTISEEP COLLARS (WATERSTOPS)

- A. Antiseep collars shall be installed at transitions between stormwater storage areas and surrounding substances as depicted on the Drawings, or as directed by owner/authorized representative. Geotextile or impermeable liners in place at the interface shall be minimally cut to allow for the pass-through section and then sealed within the solid external sheets of the antiseep collar. All fittings and seals shall be installed to manufacturer's specifications for a watertight seal.

- B. All antiseep collars shall be placed continuously to form a watertight joint. All bends, corners, and splicing shall be made by standard rubber waterstop fittings or by vulcanizing. All collars projecting from the side of the joint shall be protected from damage during construction and be free from defects when the concrete on the adjacent side of the joint is poured in place. All waterstops shall be placed in the center of the joint, with 1/2 of the waterstop on each side of the joint.
- C. All waterstops shall be placed strictly in accordance with the manufacturer's specifications and requirements.

3.10 CLEANING

- A. Perform cleaning during the installation of work and upon completion of the work.
- B. Remove from the site all excess materials, debris, and equipment.

**END OF SECTION 334726**



# GENERAL LANDSCAPING PARAMETERS & REQUIREMENTS

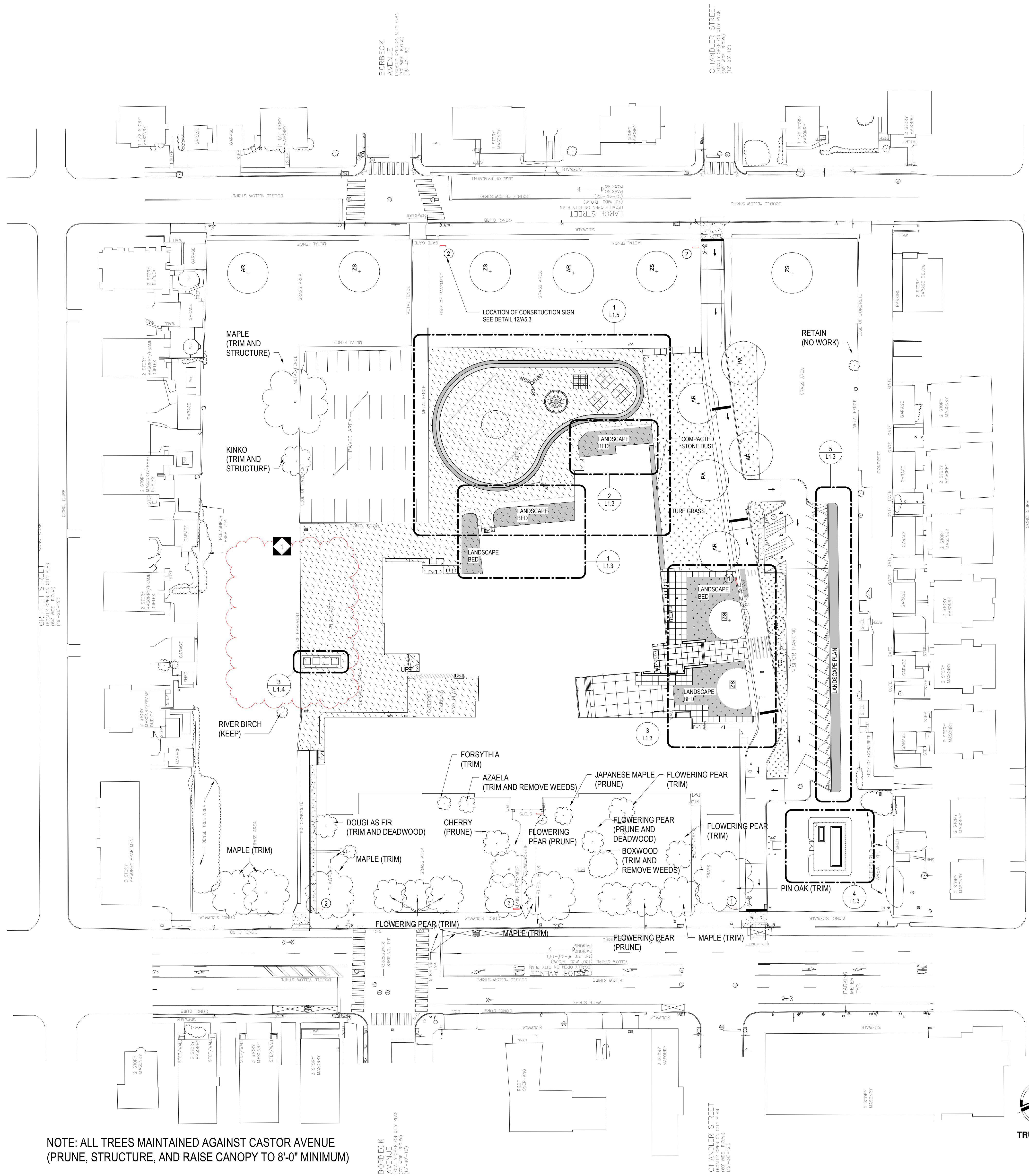
1. AVOID STAKING OF TREES. IF STAKING IS REQUIRED, UNDERGROUND ANCHORING SYSTEMS FOR THE ROOTBALL ARE PREFERRED TO ABOVE GROUND.
2. TREE PROTECTION FENCING SHALL BE USED AS DIRECTED BY THE OWNER'S REPRESENTATIVE.
3. PROVIDE GOOD SOIL FOR EACH TREE - ALL TREE PITS SHOULD BE A MINIMUM OF 3X10' PER ONE TREE, BUT 10X12' PITS ARE PREFERRED.
4. TREES SHOULD BE LIMBED UP TO 7' BUT THIS SHOULD NOT HAPPEN AT TIME OF PLANTING, AND GENERALLY WILL NEED TO HAPPEN DURING SUBSEQUENT YEARS DURING MAINTENANCE PERIOD.
5. ALL TREES SHALL BE TAGGED AT NURSERY WITH DESIGN CONSULTANT AND SDP LANDSCAPE ARCHITECT.
6. 3" DEPTH IMPORTED, CLEAN TOPSOIL FOR NEW TREE PLANTINGS (NOTE - NO TREES ARE PERMITTED TO BE PLANTED OVER SUBSURFACE STONE BEDS OF STORMWATER MANAGEMENT).
7. MULCH AROUND TREES, PROVIDED 2" SHREDDED HARDWOOD MULCH, EXTENDING TO DIAMETER OF 3' UNLESS IN A LARGER MULCH BED AS INDICATED ON THE DRAWING. FOR SHRUBS AND HERBACEOUS PLANTS, PROVIDE 3" OF DOUBLE SHREDDED MULCH.
8. ALL LANDSCAPING BEDS SHALL RECEIVE LANDSCAPING FABRIC INSTALLED AND PINNED TO SOIL PRIOR INSTALLING LANDSCAPING AND MULCH FOR LANDSCAPING BEDS.

# GENERAL NOTES FOR ALL PLANTINGS

1. ALL TREES, SHRUBS, AND PLANTS SHALL HAVE A NORMAL HABIT GROWTH, SHALL BE SOUND, HEALTHY, AND VIGOROUS, AND SHALL BE FREE FROM DISEASE, INSECTS, INSECT EGGS, AND LARVAE. PLANTS SHALL HAVE BEEN GROWN UNDER CLIMATIC CONDITIONS SIMILAR TO SOUTHEASTERN PENNSYLVANIA.
2. THE TYPE(S) OF PLANTINGS SHALL BE LIMITED TO SPECIES THAT WILL NOT DISTURB OR CONTRIBUTE TO CONDITIONS HAZARDOUS TO THE PUBLIC SAFETY WITHIN CRITICAL LOCATIONS, SUCH AS PUBLIC STREET RIGHTS-OF-WAY, UNDERGROUND AND ABOVE GROUND UTILITIES, AND CLEAR SIGHT TRIANGLES.
3. THE LOCATIONS, DIMENSIONS, AND SPACING OF REQUIRED PLANTINGS SHALL BE ADEQUATE FOR THEIR PROPER GROWTH AND MAINTENANCE, TAKING INTO ACCOUNT THE SIZES OF SUCH PLANTINGS AT MATURITY AND THEIR PRESENT AND FUTURE ENVIRONMENTAL REQUIREMENTS, SUCH AS MOISTURE AND SUNLIGHT.
4. ALL PLANTINGS SHALL BE PERFORMED IN ACCORDANCE WITH THE CODE OF STANDARDS RECOMMENDED BY THE AMERICAN ASSOCIATION OF NURSEYMEN, INC. IN THE AMERICAN STANDARD NURSERY STOCK, ANSIZ02, 1-1975, AS AMENDED.

## PLANT MENU

LARGE SHADE TREES						
KEY	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE	CONTAINER	COMMENTS
AR	5	Acer rubrum 'Franksred'	Red Sunset Maple	3" - 3-1/2"	B&B	Single Trunk
PA	2	Platanus x acerifolia 'Bloodgood'	Bloodgood Platane	3" - 3-1/2"	B&B	
TC	2	Tilia cordata 'Greenspire'	Greenspire Linden	3" - 3-1/2"	B&B	
ZS	6	Zelkova serrata 'Green Vase'	Green Vase Zelkova	3" - 3-1/2"	B&B	
SMALL / MEDIUM TREES						
KEY	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE	CONTAINER	COMMENTS
CC	3	Cercis canadensis	Apple Serviceberry	8" - 10"	B&B	Multi Stem
CF	2	Cornus Florida 'Cloud Nine'	Eastern Redbud	8" - 10"	B&B	Multi Stem
PY	1	Prunus x yedoensis	Cloud Nine Dogwood	8" - 10"	B&B	
EVERGREEN TREES						
KEY	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE	CONTAINER	COMMENTS
AC	14	Abies concolor	White Fir	7" - 8"	B&B	
AF	2	Abies fraseri	Fraser Fir	7" - 8"	B&B	
PO	8	Picea omorika	Serbian Spruce	7" - 8"	B&B	
SHRUBS						
KEY	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE	CONTAINER	COMMENTS
AB	16	Aronia a. 'Brilliantissima'	Brilliant Chokeberry	4" - 5"	5 Gal.	
CG	4	Chamaecyparis o. 'Gracilis'	Hindki Cypress	4" - 5"	5 Gal.	
CP	17	Chamaecyparis p. 'Fifera Aurea Nana'	Dwarf Gold Mop Cypress	18" - 24"	3 Gal.	
JO	22	Juniperus ch. 'Grey Owl'	Grey Owl Juniper	18" - 24"	3 Gal.	
JS	16	Juniperus squamata 'Blue Star'	Blue Star Juniper	12" - 18"	2 Gal.	3" O.C.
JD	76	Juniperus d. 'Expansa'	Parson's Juniper	18" - 24"	3 Gal.	
GROUND COVER AND GRASSES						
KEY	QTY	SCIENTIFIC NAME	COMMON NAME	SIZE / CONT	SPACING / COMMENTS	
LB	265	Liriope m. 'Big Blue'	Big Blue Liriope	1 Gal	18" O.C. / IN MULCH BED	
LV	592	Liriope muscari 'Silvery Sunproof'	Variegated Lily Turf	1 Gal	18" O.C. / IN MULCH BED	
NF	210	Nepeta f. 'Purston Blue'	Catmint	1 Gal	18" O.C. / IN MULCH BED	
SK	100	Sedum kamtschaticum	Russian Stonecrop	1 Gal	1' O.C. / IN MULCH BED	
SS	208	Sedum spurium 'Fulda Glow'	Fulda Glow Stonecrop	1 Gal	1' O.C. / IN MULCH BED	
GRASSES						
PH	298	Pennisetum a. 'Hamelii'	Fountain Grass	2 Gal	2' O.C.	
BULBS						
CV	757	Crocus vernus	Dutch Crocus	14 cm bulb	8" O.C. / IN MULCH BED	
TURF GRASS MIXES						
KEY	USE / AREA	SEED / MIX NAME	SEEDING RATE / NOTES			
--	Temporary Soil Stabilization	Annual Ryegrass	2 Pounds per 1,000 Square Feet			
--	General Lawn and Restoration	10% Zinger Kentucky Bluegrass 20% Grand Slam II Perennial Rye 35% Raptor II Tall Fescue 35% Titanium LS Tall Fescue	"Diamond Quality Mix" by Reed and Perrine, Ph. 732-466-6363, or approved equal. Rate per manufacturer's recommendation			
NOTE: CONTRACTOR TO VERIFY ALL PLANT TYPES AND QUANTITIES						



NOTE: ALL TREES MAINTAINED AGAINST CASTOR AVENUE (PRUNE, STRUCTURE, AND RAISE CANOPY TO 8'-0" MINIMUM)

1 OVERALL LANDSCAPE PLAN  
L1.2 1" = 40'-0"

1 2 3 4  
SEE CS 2 FOR EXTERIOR SIGNAGE



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03/02/2021

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NO.	DATE	REVISION
1	03/15/2021	ADDENDUM #1

SCHOOL & LOCATION  
**RAHNUNHUST ELEMENTARY SCHOOL**

7809 Castor Ave, Philadelphia, PA 19152

PROJECT TITLE  
**ADDITIONS & RENOVATIONS**

DRAWING TITLE  
**OVERALL LANDSCAPE PLAN / NO SMOKING SIGNAGE**

LOCATION NO.	FILE NO.
DRAWN BY	CHECKED BY
B-070	OF 2019 / 20
B-071	OF 2019 / 20
B-072	OF 2019 / 20
B-073	OF 2019 / 20

DRAWING NO.  
**L1.2**



SEAL:



R. JEFFREY STRAUB, AIA  
STATE AND LICENSE NO. RA03652

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03/02/2021

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NO. DATE REVISION  
**SCHOOL & LOCATION**  
**RHAWNURST ELEMENTARY SCHOOL**

7809 Castor Ave, Philadelphia, PA 19152

PROJECT TITLE

**ADDITIONS & RENOVATIONS**

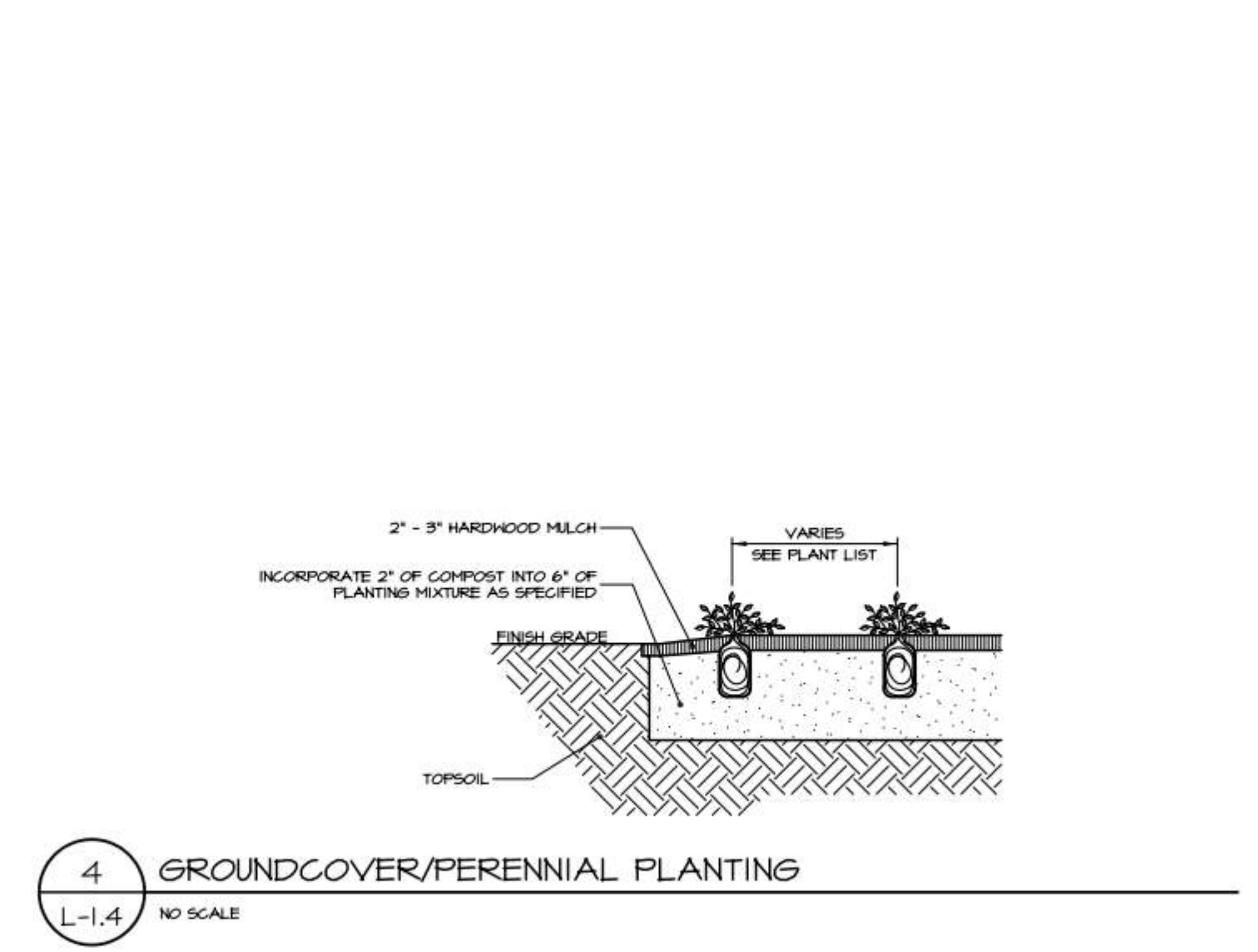
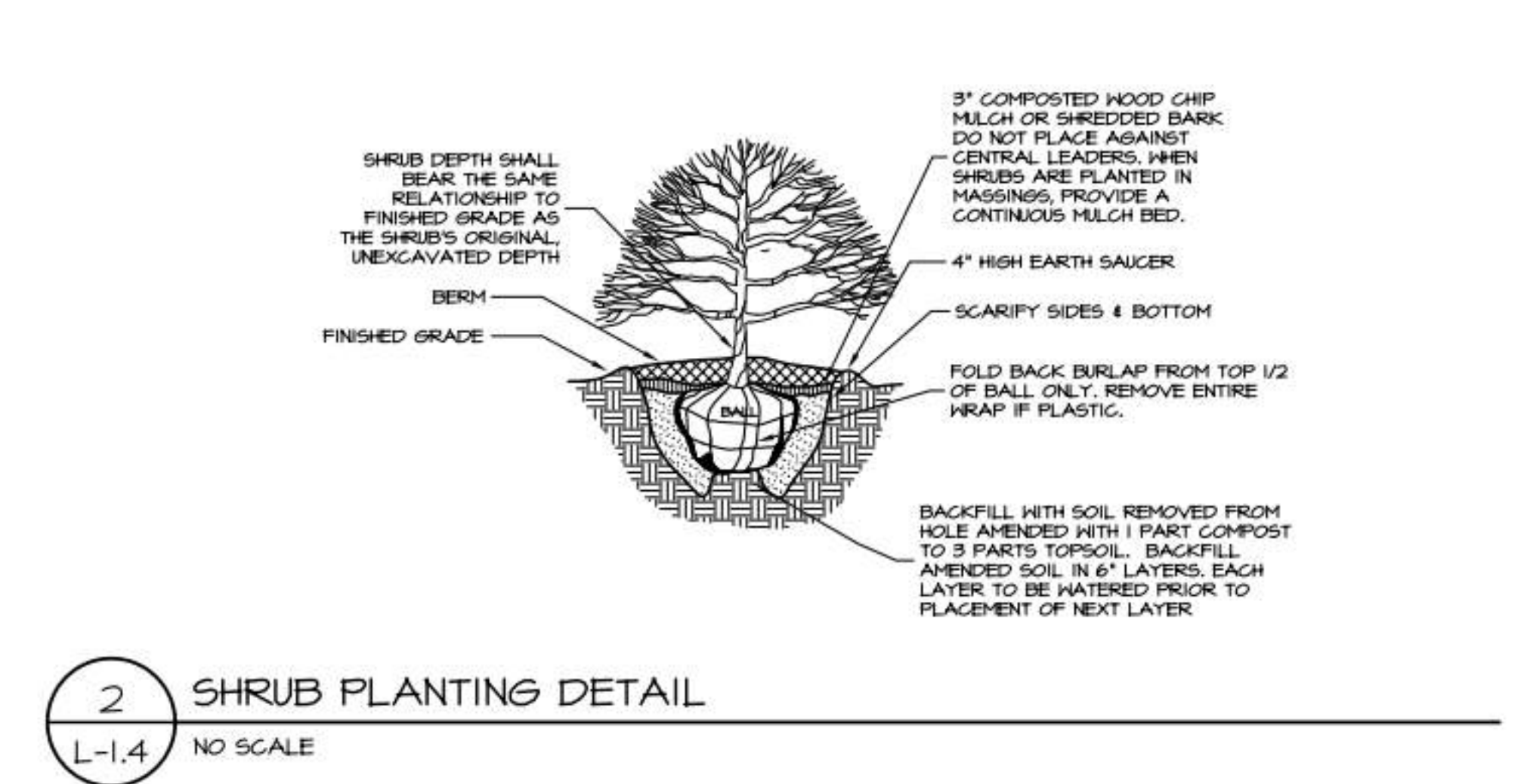
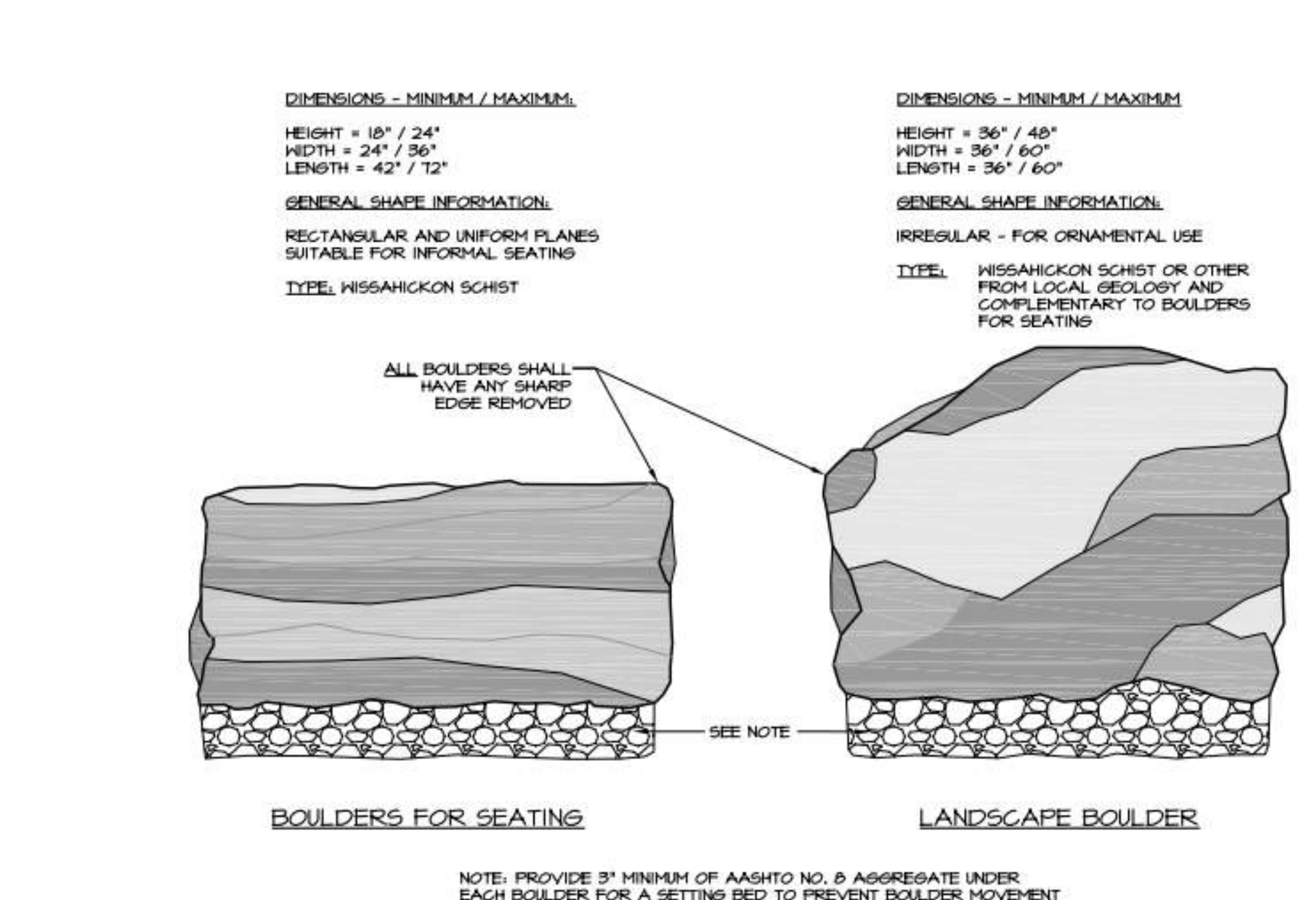
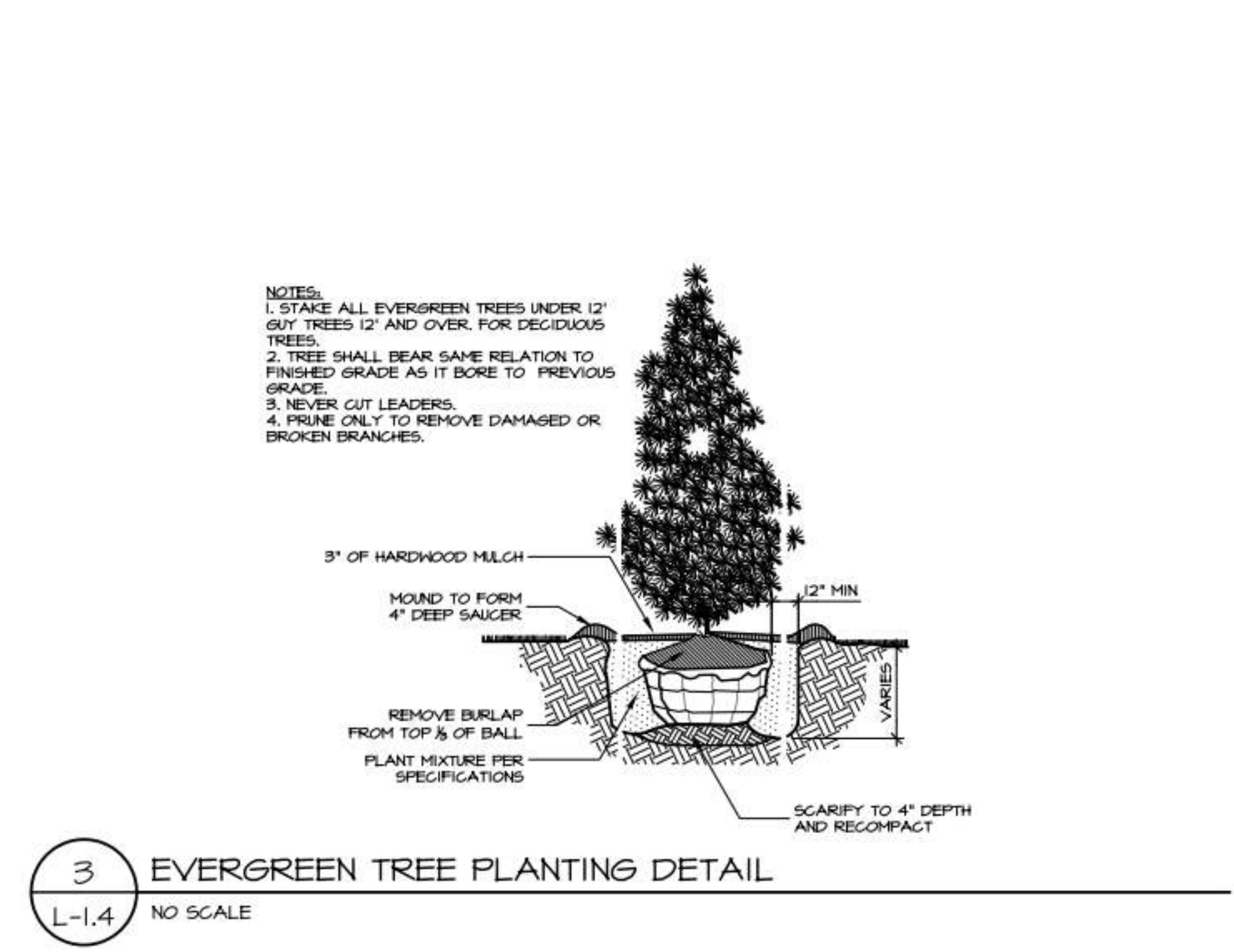
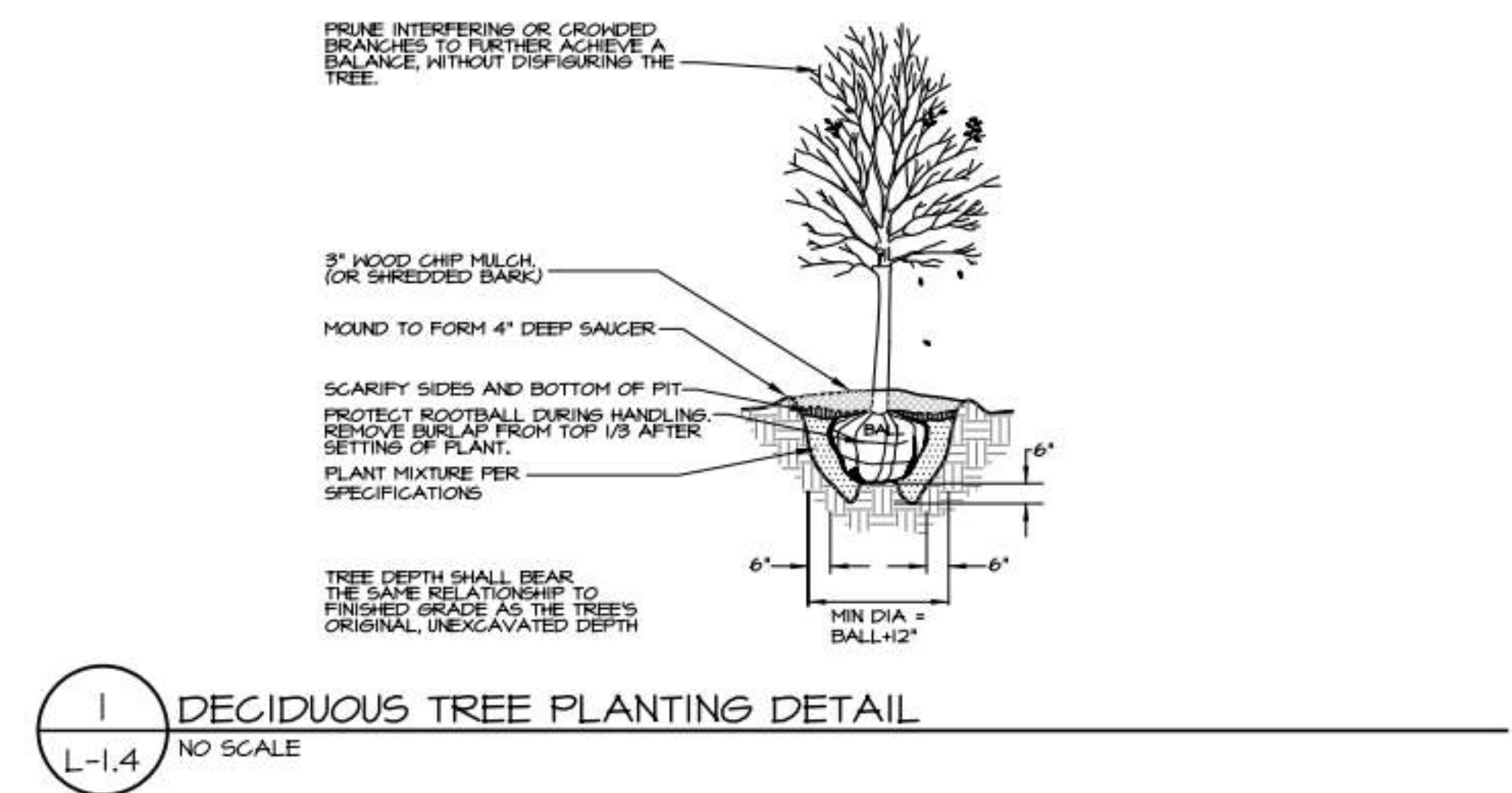
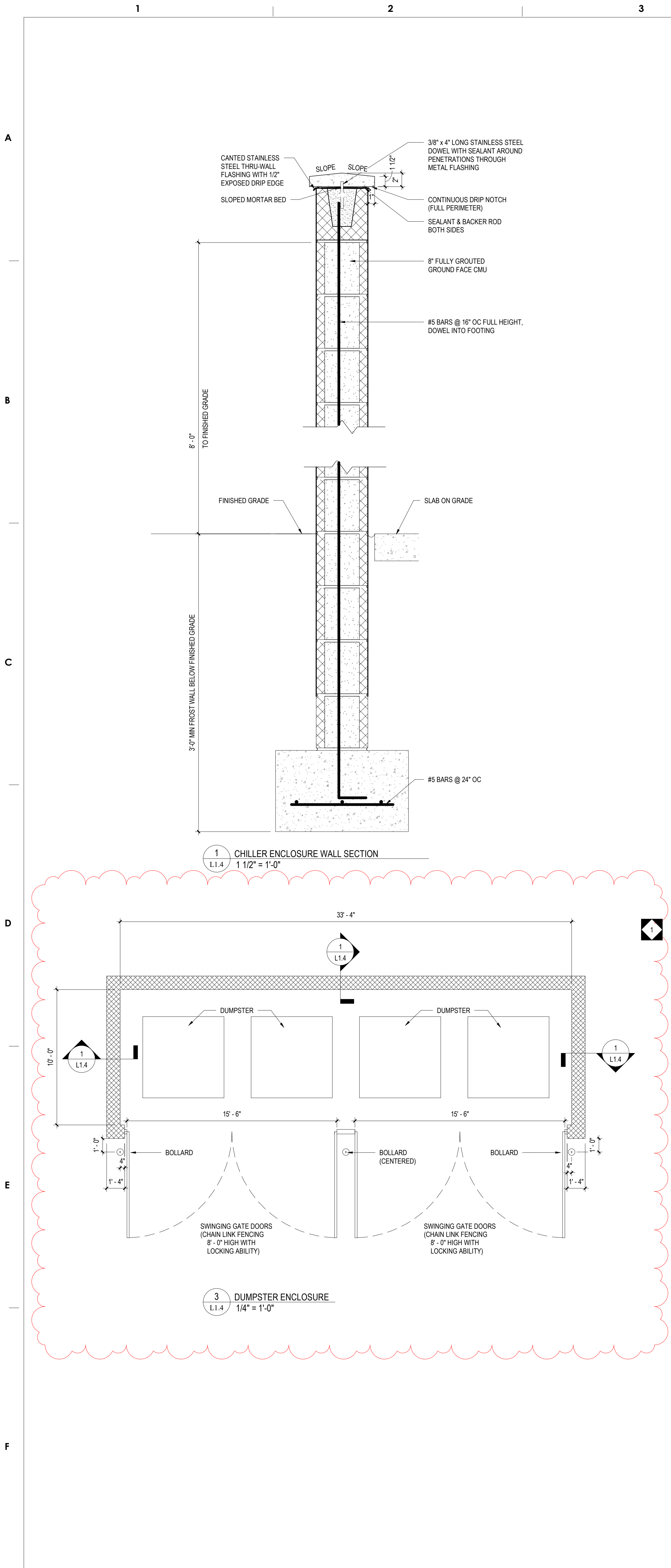
DRAWING TITLE

**LANDSCAPE DETAILS**

LOCATION NO.	FILE NO.
DRAWN BY	CHECKED BY
B-070	OF 2019 / 20
B-071	OF 2019 / 20
B-072	OF 2019 / 20
B-073	OF 2019 / 20

DRAWING NO.

**L1.4**





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NO. DATE REVISION	ADDENDUM #1

**SCHOOL & LOCATION**  
**RHAWNURST ELEMENTARY SCHOOL**

7809 Castor Ave, Philadelphia, PA 19152

**PROJECT TITLE**

**ADDITIONS & RENOVATIONS**

**DRAWING TITLE**

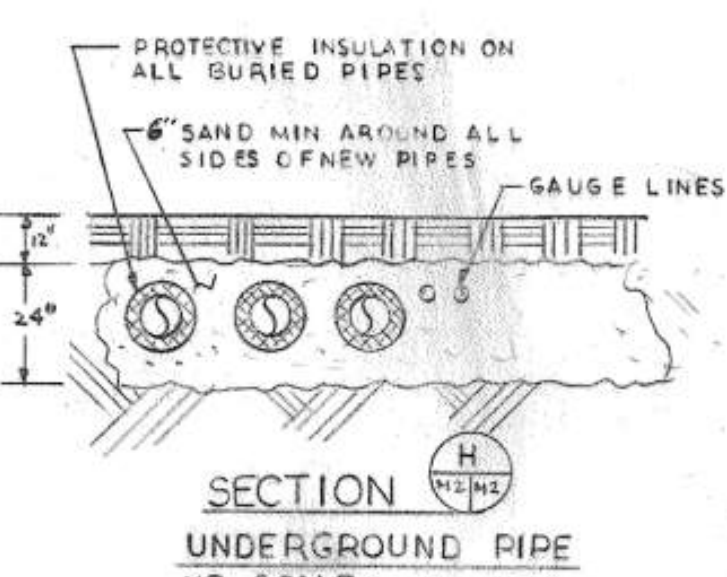
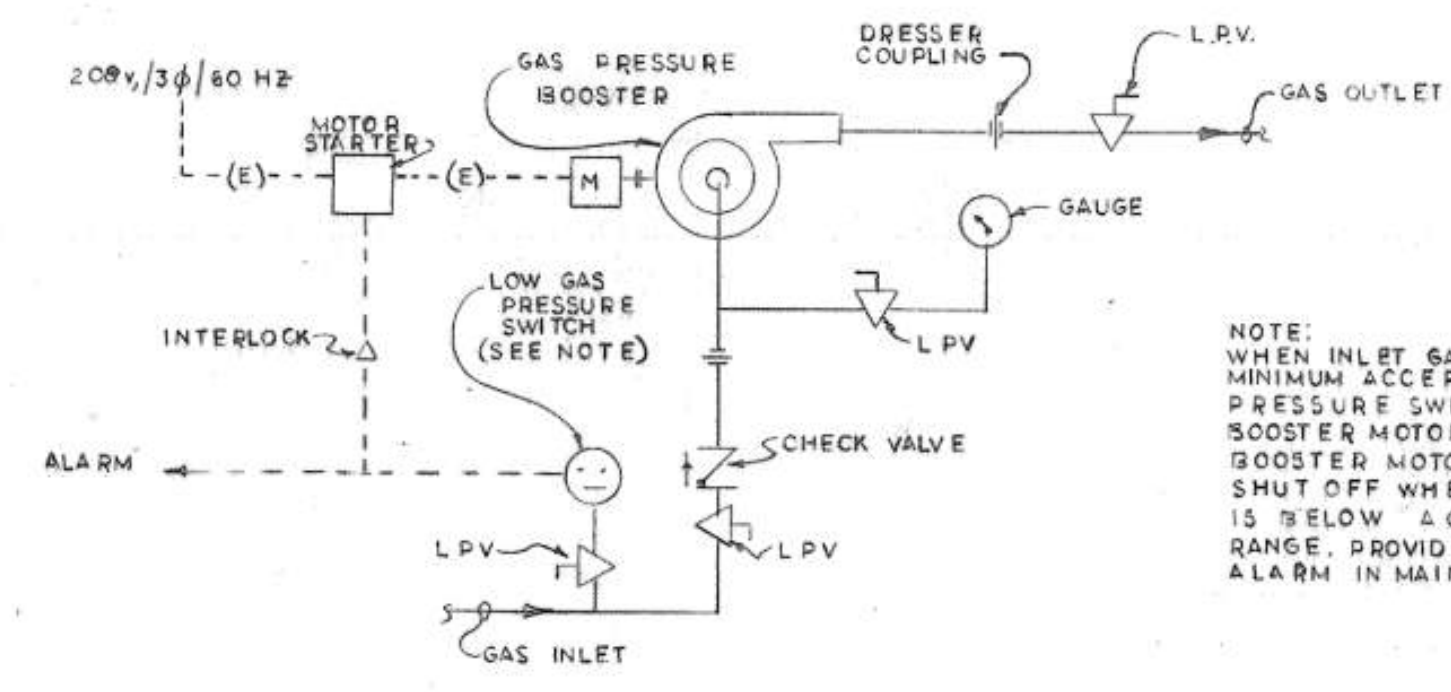
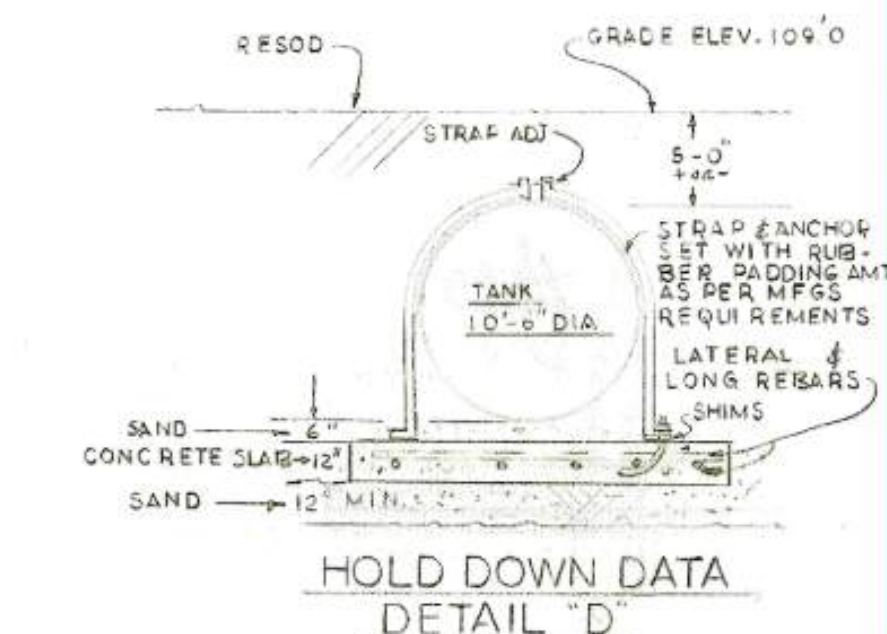
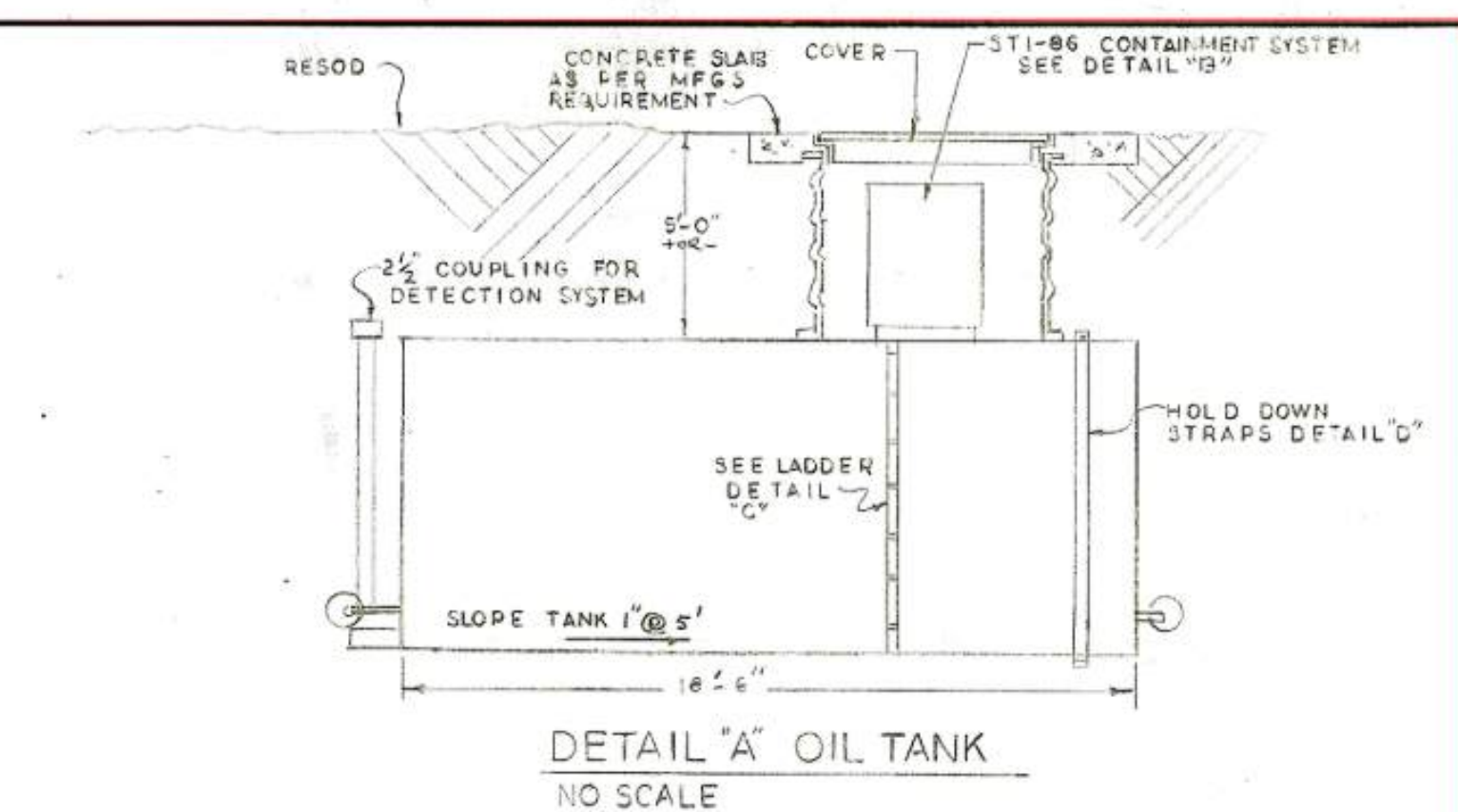
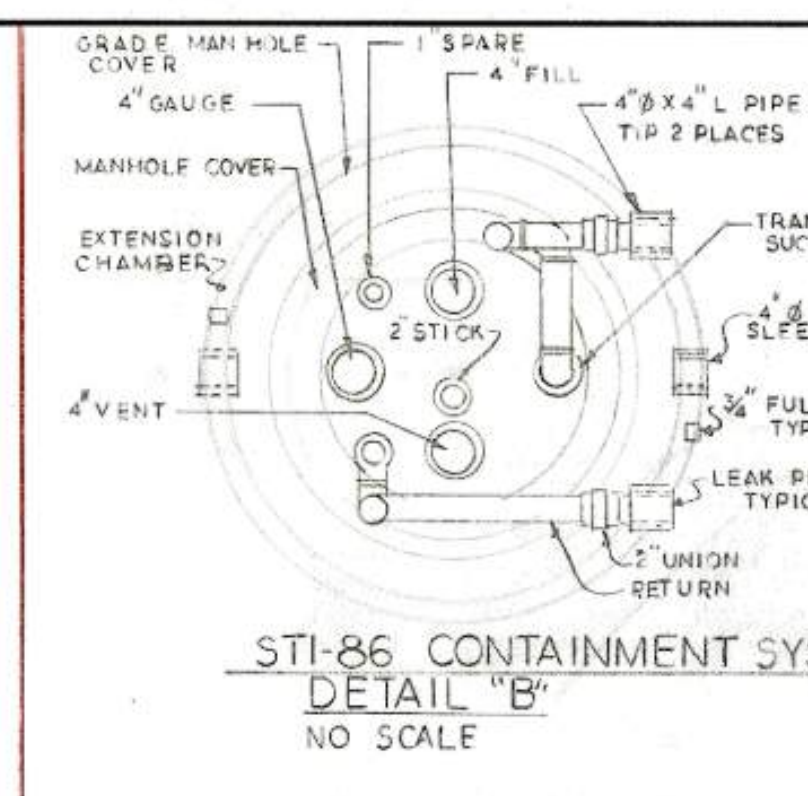
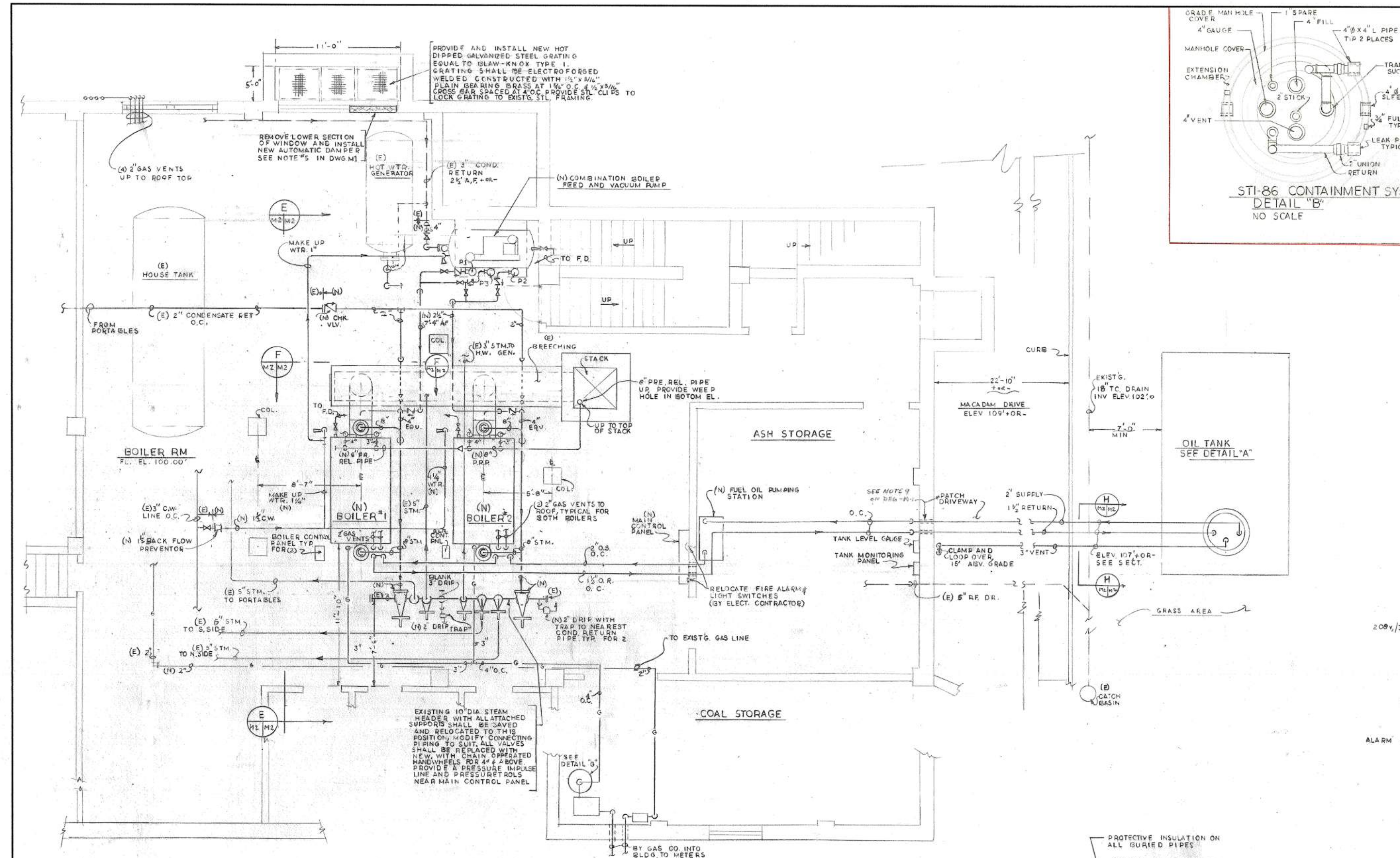
**EXISTING UNDERGROUND STORAGE TANK DRAWING**

LOCATION NO.	FILE NO.
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B-070	OF	2019 / 20
B-071	OF	2019 / 20
B-072	OF	2019 / 20
B-073	OF	2019 / 20

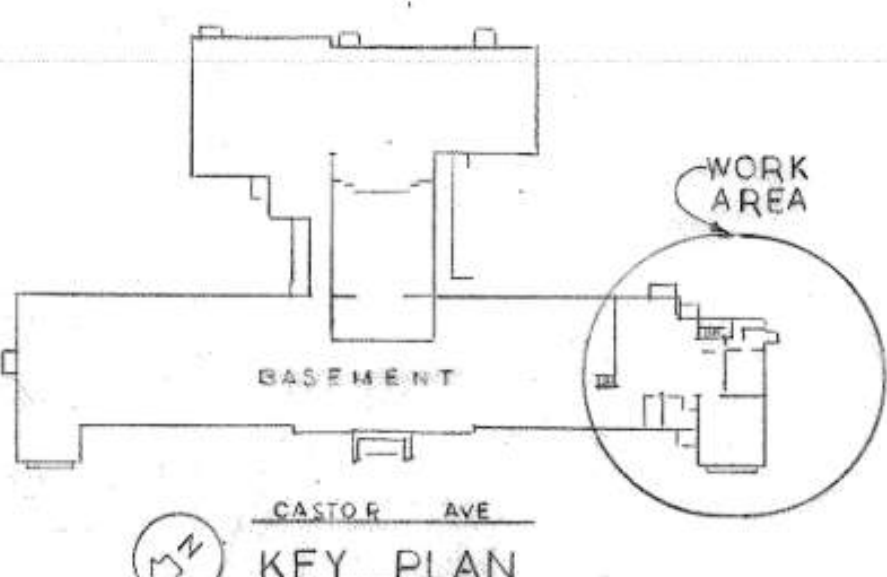
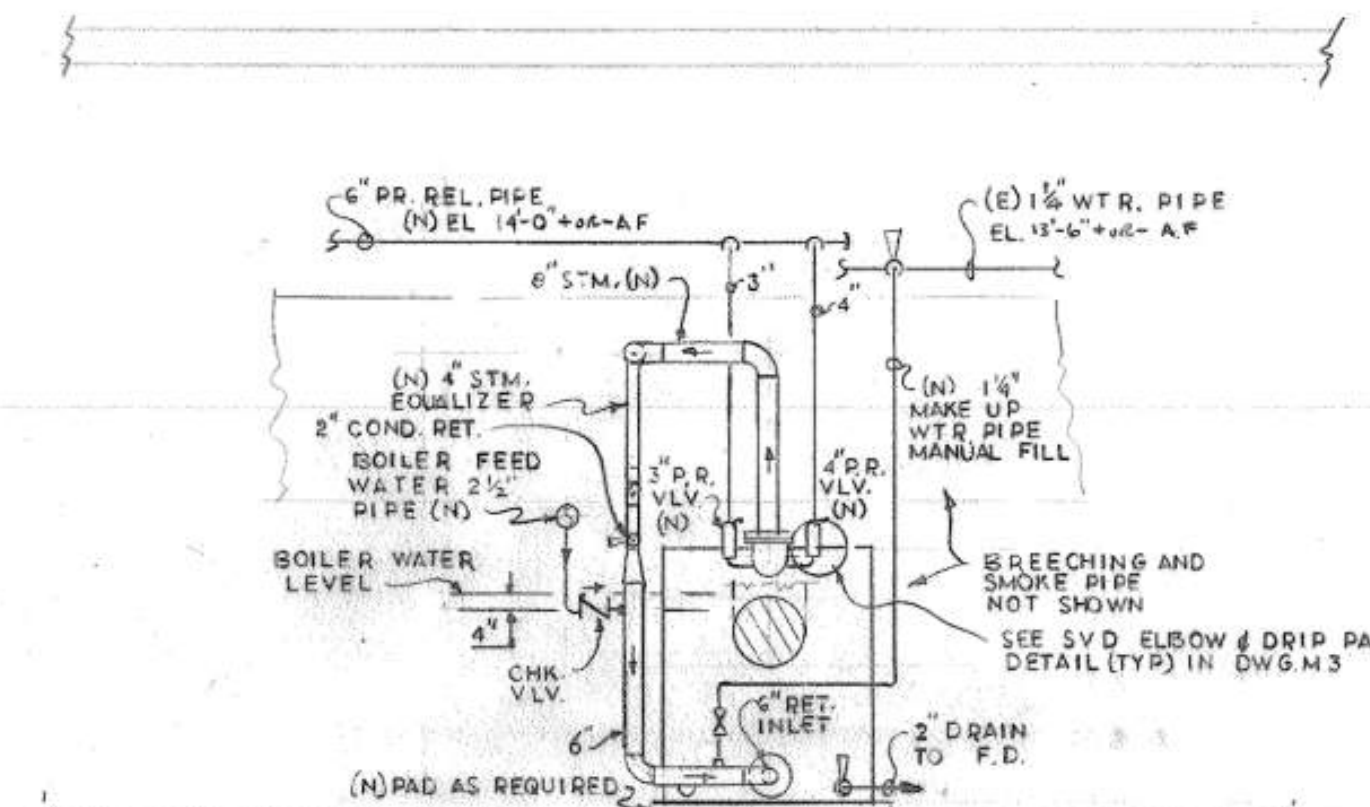
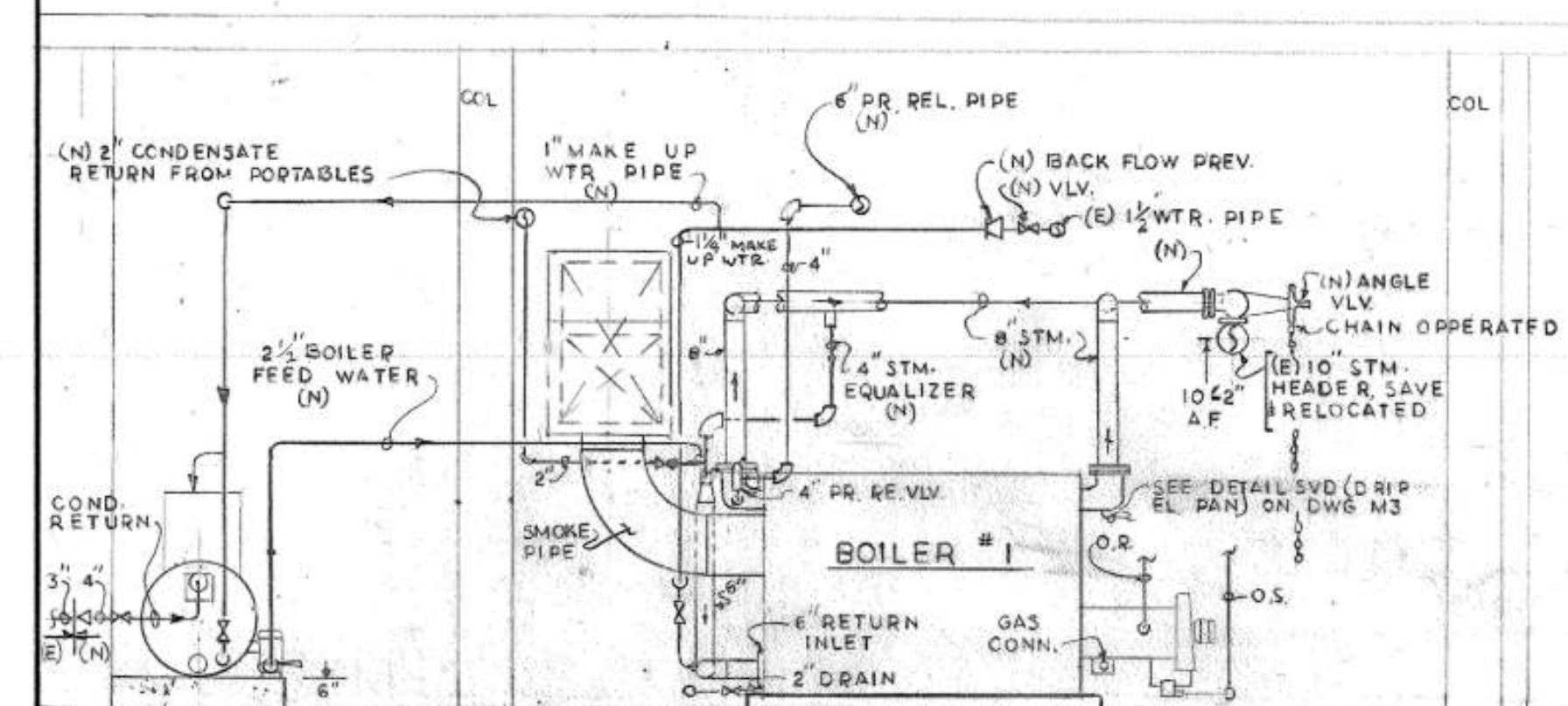
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**EX.M2**



**UNDERGROUND TANK SURVEILLANCE SYSTEM**

- Provide audio/visual alarm system to monitor the secondary containment tank. Monitor shall include one (1) vacuum venturi, one (1) vacuum gauge, one (1) leak detector transmitter assembly and a secure grade manhole with flush bolted cover to protect the transmitter assembly.
- Provide a remote digital display in both gallons and inches of product accurate to within 1/16" along with adjustable high and low level warning lights and alarm and water bottom indication light. All incorporated into a single system.
- All impulse piping shall be pitched back to the tank.
- Provide a 1/2" filling limiter valve with internal fill tube which provides high level filling shutoff.
- Insulate underground piping with 1 1/2" thick cellular insulation and pigtails jacketing, as manufactured by Pittsburgh Corning or equal. Provide insulation per manufacturer's recommendations.

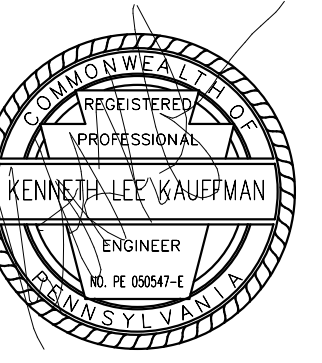


SPEC. NO. 87	<b>SCHOOL DISTRICT of PHILADELPHIA</b>
DATE 12/1/21	<b>BOARD of EDUCATION</b>
SCALE 1/4"=1'-0"	FACILITIES SERVICES DIVISION
DRAWN BY	<b>DEPARTMENT of DESIGN &amp; ENGINEERING</b>
CHECKED BY FGB/S/P	734 SCHUYLKILL AVENUE, PHILADELPHIA, PENNSYLVANIA 19146
BLDG. NO. 35-0	<b>SCHOOL &amp; LOCATION</b>
TYPE 175	<b>RHAWNURST SCHOOL</b>
FILE NO. 120	<b>CASTOR AVE &amp; BORBECK</b>
	DRAWING NO. <b>M2</b>
	TITLE <b>BOILER REPLACEMENT</b>
	APPROVED BY <i>William J. ...</i>
	CONTRACTOR TO VERIFY ALL CONDITIONS & DIMENSIONS AT THE SITE

8-75-c-892a



SEAL:



KENNETH LEE KAUFFMAN  
STATE AND LICENSE NO: PA 050547-E

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**03/02/2021**

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NO.	DATE	REVISION

**SCHOOL & LOCATION**  
**RHAWNURST ELEMENTARY SCHOOL**

7809 Castor Ave, Philadelphia, PA 19152

**PROJECT TITLE**

**ADDITIONS & RENOVATIONS**

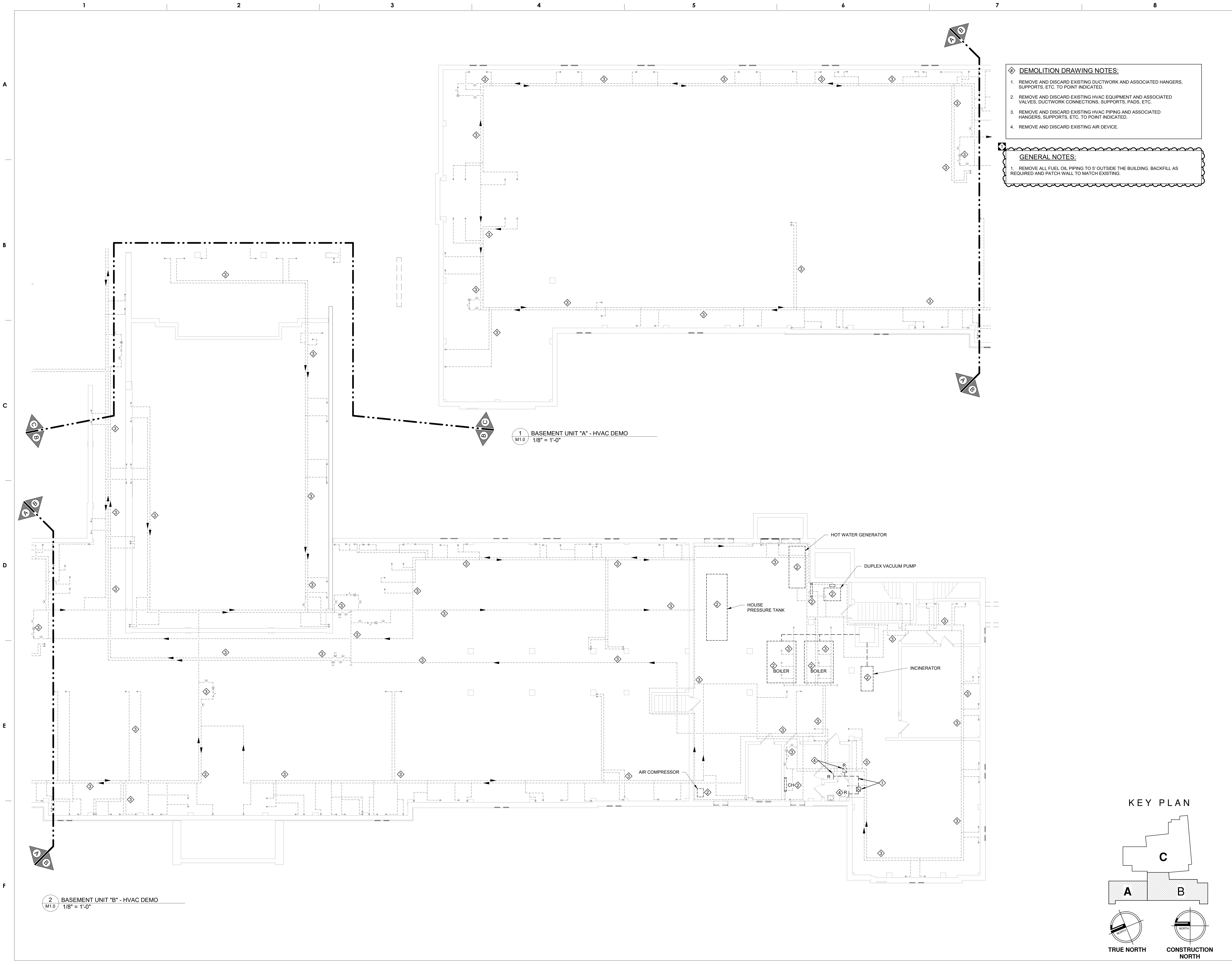
**DRAWING TITLE**

**BASEMENT UNIT "A" & "B" HVAC DEMOLITION**

LOCATION NO.	FILE NO.
DRAWN BY	CHECKED BY

B-070	OF	2019 / 20
B-071	OF	2019 / 20
B-072	OF	2019 / 20
B-073	OF	2019 / 20

DRAWING NO.  
**M1.0**



**DEMOLITION DRAWING NOTES:**

- REMOVE AND DISCARD EXISTING DUCTWORK AND ASSOCIATED HANGERS, SUPPORTS, ETC. TO POINT INDICATED.
- REMOVE AND DISCARD EXISTING HVAC EQUIPMENT AND ASSOCIATED VALVES, DUCTWORK CONNECTIONS, SUPPORTS, PADS, ETC.
- REMOVE AND DISCARD EXISTING HVAC PIPING AND ASSOCIATED HANGERS, SUPPORTS, ETC. TO POINT INDICATED.
- REMOVE AND DISCARD EXISTING AIR DEVICE.

**GENERAL NOTES:**

- REMOVE ALL FUEL OIL PIPING TO 5' OUTSIDE THE BUILDING, BACKFILL AS REQUIRED AND PATCH WALL TO MATCH EXISTING.

1 BASEMENT UNIT "A" - HVAC DEMO  
M1.0 1/8" = 1'-0"

2 BASEMENT UNIT "B" - HVAC DEMO  
M1.0 1/8" = 1'-0"

**KEY PLAN**

