PROJECT MANUAL - Volume 4 of 4

Wilmington Elementary School

320 Salem Street, Wilmington, Massachusetts, 01887

90% Construction Documents - September 25, 2026

Dore & Whittier Architects Inc. Project Number: 23-0847

Awarding Authority / Owner
Town of Wilmington

Architect
Dore & Whittier Architects Inc.

Geotechnical Consultant
Lahlaf Geotechnical Consulting

Civil Consultant
CDW Consultants, Inc.

Landscape Consultant
Terraink

Structural Consultant
Engineers Design Group

Plumbing and Fire Protection Consultant
Akal Engineering, Inc.

HVAC and Electrical Consultant
GGD Consulting Engineers, Inc.

Geoenvironmental Consultant
PEER Consultants, P.C.

Door Hardware Consultant
Allegion, PLC

Owner's Project Manager
LeftField Project Management

Construction Manager
Fontaine Brothers, Inc.

Sustainable Design Consultant
The Green Engineer

Environmental / HAZMAT Consultant
United Environmental Consultants

Technology Consultant
Edvance Technology Design

Acoustical Consultant
Acentech

Foodservice Consultant
Crabtree McGrath Associates, Inc.

Cost Estimating
PM&C

Traffic and Site Survey Consultant
Nitsch Engineering

DORE + WHITTIER

SECTION 00 01 07
SEALS PAGE

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Project Name: Wilmington Elementary School
Dore & Whittier Architects Inc. Project Number: 23-0847

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Donald M. Walter Date

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END OF SECTION

SECTION 31 00 00

EARTH MOVING

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

A. The General Documents, as listed in the Table of Contents, and applicable parts of Division 1, GENERAL REQUIREMENTS, shall be included in and made a part of this Section.

B. Examine all drawings and all other Sections of the Specifications for the requirements therein affecting the work of this trade. Plans, surveys, measurements, and dimensions, under which the work is to be performed are believed to be correct to the best of the Architect's knowledge, but the Earth Work Site Contractor shall have examined them for himself during the bidding period, as no compensation will be made for any errors or inaccuracies that may be found herein. The Earth Work Site Contractor shall reconcile all drawings.

C. Where there is a conflict between drawings, the stricter requirement and the interpretation that is most in favor of the Owner will be adopted at no additional cost to the Owner.

D. The Earth Work Site Contractor shall become thoroughly familiar with the site, consult records and drawings of adjacent structures and of existing utilities and their connections, and note all conditions which may influence the work of this Section.

E. By submitting a bid, the Earth Work Site Contractor affirms that he has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.

F. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure a steady progress of work under this Contract.

1.02 SCOPE OF WORK

A. Work described in Section 1.02 of these specifications shall be included in the base bid and will not be paid for separately.

B. The work of this section consists of all excavation, filling and grading and related items as indicated on the Drawings and/or as specified herein and includes, but is not limited to, the following:

1. All materials, equipment, labor and services required for all Earth Moving work, including all items incidental thereto, as specified herein and as shown on the Drawings.
2. Excavation of all types, including but not limited to excavations for footings, slabs, foundations, retaining walls, temporary support of excavations, dewatering systems, new pavements, ramps, equipment pads, curbs, sidewalks, and utilities, to the lines and grades shown in the Drawings or the limits specified herein, whichever is deeper. The excavation includes rock removal to allow the construction of foundations, slabs on-grade, and installations of utilities. Excavation shall include removal and legal offsite disposal of all materials that cannot be reused.
3. Excavating, filling, trenching, backfilling, compaction and concrete encasement of utility conduits, of all description, required for the construction of foundations, walls, building

structures, retaining walls, temporary support of excavations, dewatering systems, new pavements, ramps, equipment pads, curbs, sidewalks, utility structures, lawn areas, and site improvements. Provide all additional fill materials as specified herein. Refer to Sections on Heating, Plumbing, Fire Protection, Electrical and Structural for other excavation.

4. Entirely removing topsoil/surficial organic soil, tree stumps, root balls, swamp deposits, buried subsoil, buried organic soil, asphalt, concrete structures, cobbles, boulders, demolition debris, below ground structures, existing fill, existing bedrock, and other deleterious matter from within the proposed building footprint, or improving the existing soils by means of ground improvements.
5. Removing existing fill above the top of ground improvements and replacing it with Structural Fill.
6. Entirely removing topsoil, surficial organic material, tree stumps, root balls, asphalt, concrete structures, cobbles, boulders, existing bedrock, and other deleterious material from within the proposed paved areas.
7. Improving the existing fill and subsoil under the subbase of paved areas.
8. Screening and stockpiling the topsoil for reuse per Architect's instructions.
9. Performing test pits before start and during construction per Geotechnical Engineer's instructions.
10. Removing and disposing of spoiled material not suitable for fill from the site. No burning on the site shall be permitted.
11. Pre-trenching for possible cobbles, boulders, bricks, asphalt, abandoned foundations, concrete, wood, metal, or other obstructions before the installation of the ground improvements. The cost of pre-trenching and all necessary means to remove obstructions at the site shall be included in the base bid. After the obstructions are removed, the fill materials shall be compacted in one-foot lifts.
12. Rehandling, hauling and placing of stockpiled materials for use in refilling, filling, backfilling, grading and such other operations. Stockpiling shall include protection to maintain materials in a workable condition.
13. Furnishing, placing, and compacting fill materials, including subbase layer under paved areas, ramps, equipment pads, curbs, sidewalks, and other locations required in the drawings.
14. Removing, hauling, stockpiling, rehandling, and placement of materials.
15. Over-excavation to remove unsuitable materials.
16. Proofrolling/proofcompacting of exposed subgrade for fill, footings, foundations, slabs, walks, equipment pads, pavements, lawns and grasses, and exterior plants.
17. Backfilling of excavations for foundations, footings, walls, utilities, pavements, sidewalks, and landscaped areas with specified on-site and imported materials.
18. Installing seismographs and monitoring vibration at the nearby existing buildings during construction. The cost of vibration monitoring shall be included in the base bid.
19. Disposing off-site of excess or unsuitable materials.
20. Placing bedding, sub-base and base course layers.
21. Stabilizing/mitigating of saturated or otherwise disturbed materials.
22. Performing rough and final grading.
23. Filling slopes and site retaining walls.
24. Installing and removing excavation support, shoring or bracing to perform the excavations during the removal of the unsuitable materials
25. Protecting existing buildings, utilities, roads, pavements, lawns, planting and other improvements from damage due to construction.

26. Performing coordination of material testing shall be the responsibility of the Earth Work Site Contractor. All imported material tested shall be under ASTM D6913 and shall be paid for by the Earth Work Site Contractor.
27. Performing material testing, and field density testing.
28. Coordinating work and preparing the site for the ground improvements specialty contractor.
29. Placing the load transfer platform material on top of the ground improvements per the specialty contractor's design.
30. Repairing damaged ground improvements in accordance with procedure included in the specialty contractor's submittal.
31. Performing dust control and cleanup.
32. Groundwater Control, dewatering, pumping, bailing and control of groundwater and surface water for all work under this contract in accordance with item 1.13 of these specifications.
33. Installing temporary support of excavation in accordance with item 1.12 of these specifications.
34. Installing fencing and safety devices or controls as specified.
35. Notifying all affected utility companies and Dig Safe before the start of work.
36. Processing and improving onsite marginal soil, including by crushing and blending, to meet the specifications herein.

C. The Work of this Section shall include performance of pre and post construction Condition surveys.

1.03 CONTRACT REFERENCE

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

B. Related Sections

1. Section 00 31 00, Available Project Information
2. DIVISION 01 -- GENERAL REQUIREMENTS
3. Section 01 56 39, Temporary Tree and Plant Protection
4. Section 01 78 29, Final Site Survey
5. Section 02 41 00, Demolition.
6. Section 03 30 00, Cast-In-Place Concrete
7. DIVISION 22 -- PLUMBING
8. Section 31 10 00, Site Clearing
9. Section 31 25 00, Erosion and Sedimentation Controls
10. Section 31 60 00, Ground Improvements
11. Section 32 12 16, Asphalt Paving
12. Section 32 12 40, Granite Curb
13. Section 32 13 13.13, Concrete Paving (Site)
14. Section 32 17 23, Pavement Markings
15. Section 32 90 00, Underdrain System
16. Section 33 10 00, Site Water Utilities
17. Section 33 31 00, Sanitary Sewerage
18. Section 33 41 00, Storm Drainage Utilities

1.04 DESCRIPTION

A. The Earth Work Site Contractor shall furnish all labor, material, tools and equipment necessary to excavate materials; segregate, track, handle, sample, analyze, and test excavated materials, backfill, and re-grade as indicated on the Drawings.

B. The Earth Work Site Contractor shall use suitable on-site soils and fill, and soil from off-site sources. Please note that most of the on-site existing fill and natural soil will likely not be suitable for reuse. The Earth Work Site Contractor shall avoid mixing the reusable soils with fine-grained and/or organic soils. Imported materials or amending/blending of onsite materials with imported materials are anticipated for this project.

C. The Earth Work Site Contractor shall make excavations in such a manner and to such widths that will provide suitable room for performing the Work and shall furnish and place all sheeting, bracing, and supports. Excavation support is anticipated for this project.

D. The Earth Work Site Contractor shall provide labor and material for all pumping and draining; and shall render the bottom of excavation firm and dry and in all respects acceptable. The Earth Work Site Contractor shall collect and properly dispose of all discharge water from dewatering systems in accordance with local and State requirements and permits.

E. The Earth Work Site Contractor shall raise the Site to final grades and compact the subgrade and intermediate layers to the required criteria set forth within this Section of the Construction Specifications.

F. The Earth Work Site Contractor shall provide routine monitoring of in-place excavation support system.

G. The Earth Work Site Contractor shall protect and moisture condition all onsite and imported materials for proper installation, compaction and use. This includes covering, drying, and adding moisture in order to maintain suitable workability of the soil materials. Failure by the Earth Work Site Contractor to follow this requirement shall not be cause for additional cost to the Owner.

1.05 INFORMATION

A. Information on the Drawings, Reference Drawings, Geotechnical Reports, and in the Specifications relating to subsurface conditions, natural phenomena, and existing utilities and structures is from the best sources presently available. Such information is furnished only for information and is not guaranteed.

B. Site Information – Data on indicated subsurface conditions are not intended as representations or warrants of continuity of such conditions between soil borings and test pits. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn there by the Earth Work Site Contractor. Data is made available for the convenience of the Earth Work Site Contractor. The Owner, Architect and Engineer assume no responsibility for the accuracy of the data other than at the particular locations and at the time the explorations were made.

C. The Earth Work Site Contractor, at his/her own expense, may conduct additional subsurface testing for his/her own information after approval by the Owner. The Owner assumes no responsibility for the Earth Work Site Contractor's failure to make his own site investigation and makes no representation other than the soils reports regarding the character of the soil or subsurface conditions which may be encountered during the performance of the work. The Earth Work Site Contractor shall refer to the Geotechnical Report. Failure by the Earth Work Site Contractor to be aware of existing site conditions shall not be cause for additional cost to the Owner.

1.06 SUBSURFACE CONDITIONS AND SPECIAL SITE CONSIDERATIONS

A. Lahlaf Geotechnical Consulting, Inc. of 100 Chelmsford Road, Suite 2, Billerica, MA 01862 prepared a geotechnical report titled: “Geotechnical Report, Proposed Wildwood Early Childhood Center, North Intermediate School – 320 Salem Street Site, Wilmington, Massachusetts, dated January 14, 2026. The Owner, the Architect, and the Geotechnical Engineer assume no responsibility for the accuracy of the data and for the Earth Work Site Contractor's failure to make his own site investigation and make no representation other than the soils reports regarding the character of the soil or subsurface conditions which may be encountered during the performance of the work. Failure by the Earth Work Site Contractor to be aware of existing site conditions shall not be cause for additional cost to the Owner.

B. Information on subsurface conditions is made available for the convenience of the Bidders. The Owner does not represent to the Earth Work Site Contractor that the information is either an accurate or a comprehensive indication of subsurface conditions. Bidders are invited to review the information to apprise themselves of the information available, and also to make additional investigations at their own expense.

C. Interpretation of this data for purposes of construction is the responsibility of the Earth Work Site Contractor. It is the Earth Work Site Contractor’s responsibility to make interpretations and draw conclusions with respect to the character of materials to be encountered and groundwater conditions at the site and their impact upon Earth Work Site Contractor’s work based on his expert knowledge of the area, construction dewatering methods, and support of excavation methods. Earth Work Site Contractor may, at his own expense, conduct additional subsurface testing for his own information after approval by the Owner.

D. The Geotechnical Report indicates that the majority of the materials present at the site contain quantities of fines beyond the limit deemed acceptable for reuse by the specification. The Earth Work Site Contractor is made aware of this condition and will not be eligible to receive additional compensation exceeding the Earth Work Site Contractor’s initial bid for imported material.

E. The Earth Work Site Contractor shall visit the site prior to submitting a bid to become familiar with the extent of the work to be done under this Contract. The Earth Work Site Contractor shall be responsible for determining the quantities of earth materials necessary to complete the work under this Section. All earth materials shall be included in the Earth Work Site Contractor’s base bid.

F. Test boring locations as depicted on the Drawings are located by tape measurements from existing site features and structures and shall only be considered as accurate as the procedure utilized.

G. The Earth Work Site Contractor shall be aware that the ground surface elevation was interpolated to the nearest foot and are approximate.

H. No claim for extra cost or extension of time resulting from reliance by the Earth Work Site Contractor on information presented herein shall be allowed, except as provided in the Contract Documents.

1.07 QUALITY CONTROL

A. Costs related to retesting due to unacceptable quality of work and failures discovered by testing shall be paid for by the Earth Work Site Contractor at no additional expense to Owner, and the costs thereof will be deducted by the Owner from the Contract Sum.

1.08 COORDINATION

A. Prior to start of earthwork, the Earth Work Site Contractor shall arrange an onsite meeting with the Architect, Engineer, the Geotechnical Engineer, and the site testing agency for the purpose of establishing the Earth Work Site Contractor's schedule of operations, and scheduling observation and testing procedures and requirements.

B. As construction proceeds, the Earth Work Site Contractor shall be responsible for notifying the Geotechnical Engineer at least 48 hours and the site testing agency at least 24 hours prior to the start of earthwork operations requiring observation and/or testing. This section also applies to instances when the Earth Work Site Contractor resumes earthwork operations after a period of pause in earthwork operations that require observations by the Geotechnical Engineer.

C. The work of this Section shall be coordinated with that of other trades affecting, or affected by, this work, to ensure the steady progress of all work of the Contract.

1.09 PERMITS, CODES AND SAFETY REQUIREMENTS

A. This project is subject to the Safety and Health regulations of the U.S. Department of Labor set forth in 29 CFR, Part 1926. The General Contractor and Earth Work Site Contractor shall be familiar with the requirements of these regulations.

B. The Earth Work Site Contractor is responsible for the adequacy of the excavation support system and shall retain the services of a Professional Engineer registered in Massachusetts to design any required excavation support systems. The Earth Work Site Contractor’s Professional Engineer shall practice in a discipline applicable to excavation work, shall have experience in the design of excavation support systems and shall design in conformance with OSHA requirements. The Earthwork Site Contractor’s Professional Engineer shall provide sufficient on-site inspection and supervision to assure that the excavation support system is installed and functions in accordance with his design. Criteria listed herein defining the responsibilities of the Earth Work Site Contractor’s Professional Engineer are minimum requirements.

C. All work shall conform to the Drawings and Specifications and shall comply with applicable codes and regulations.

D. Comply with the rules, regulations, laws and ordinances of the Town of Wilmington, of the State of Massachusetts, appropriate agencies of the State of Massachusetts and all other authorities having jurisdiction. Coordinate all work done within Town and State rights of way with the appropriate agencies. Provide all required traffic control and safety measures, including uniformed police officers per Town and State requirements. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.

E. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration (OSHA), United States Department of Labor whichever is more stringent.

F. The Earth Work Site Contractor shall procure and pay for all permits and licenses required for the complete work specified herein and shown on the Drawings.

G. The Earth Work Site Contractor shall not close or obstruct any street, sidewalk, or passageway unless authorized in writing by the Architect. The Earth Work Site Contractor shall so conduct his operations as to interfere as little as possible with the use ordinarily made of roads, driveways, sidewalks or other facilities near enough to the work to be affected hereby. The Earth Work Site Contractor shall comply with the time limits established by the terms for trucking onto and off the site.

H. Any apparent conflict between the Drawings and Specifications and the applicable codes and regulations shall be referred to the Architect in writing, for resolution before the work is started.

I. The Earth Work Site Contractor shall comply with all excavation, trenching, and related sheeting and bracing requirements of Occupational Safety and Health Administration (OSHA) excavation safety standards, 29 CFR Part 1926.650 through 1926.652.

1.10 LAYOUTS AND GRADES

A. All line and grade work not presently established at the site shall be laid out by a survey team under the supervision of a Land Surveyor or Professional Engineer registered in the Commonwealth of Massachusetts and employed by the Earth Work Site Contractor in accordance with Drawings and Specifications. Basic layout for the project is shown on the drawings. The Earth Work Site Contractor shall supply all additional layout and grade control to properly implement and construct the work. The Earth Work Site Contractor shall establish permanent benchmarks and replace any which are destroyed or disturbed. The Earth Work Site Contractor shall employ and pay all costs for a registered Civil Engineer or Surveyor who is licensed within the jurisdiction of the project site to lay out all lines and grades in accordance with the Drawings and Specifications for the construction. The Earth Work Site Contractor shall submit building layout drawings for approval, stamped by a Registered Surveyor.

B. The words “finished grades” as used herein shall mean final grade elevations indicated on the Drawings. Spot elevations shall govern over proposed contours. Where not otherwise indicated, project site areas outside of the building shall be given uniform slopes between points for which finished grades are indicated or between such points and existing established grades.

C. The word “subgrade” as used herein, means the surface or elevation remaining after completing excavation or top surface of a fill, borrow fill or compacted fill. This surface is immediately beneath the site improvements, fill materials as dimensioned on the Drawings, or other proposed surface material.

D. The words “rough grading” shall mean excavating or filling to elevations indicated, and to the required depths herein. The permissible tolerance of rough grading within an area 100 sq. ft. shall not exceed plus or minus 2 in. The cost of placing fill material to refill areas having rough grades lower than designed shall be borne by the Earth Work Site Contractor.

1.11 DISPOSITION OF EXISTING UTILITIES

A. All work shall be executed in such a manner as to prevent any damage to existing buildings, streets, curbs, paving, service utility lines, structures and adjoining property. Existing streets, sidewalks and curbs damaged during the project work shall be repaired or replaced to their condition prior to commencement of Earth Moving operations.

B. Locate and mark underground utilities to remain in service before beginning the work. Active utilities existing on the site and work areas shall be carefully protected from damage and relocated or removed as necessitated by the work. When an active utility line is exposed during construction, its location and elevation shall be plotted on the record drawings as described in this Section and both Architect and Utility Owner notified in writing.

C. Inactive or abandoned utilities encountered during construction operations shall be removed and suitably backfilled if within the building area. Abandoned utilities outside the building area shall be removed, grouted, plugged or capped. The location of such utilities shall be noted on the record drawings and reported in writing to the Architect.

D. The Earth Work Site Contractor shall notify “Dig Safe” and local utility companies prior to the start of construction. The “Dig Safe” number shall be submitted by the Earth Work Site Contractor in writing to the Architect prior to construction.

E. Acceptance of any of the Earth Work Site Contractor’s plans, design calculations and methods of construction by the Designer and /or design team shall not relieve the Earth Work Site Contractor of the responsibility for the adequacy of the excavation lateral support system; preventing damage to existing or new structures, utilities and streets adjacent to excavations; the safety of persons working within excavated areas and the public at large; and excavation dewatering.

1.12 SUPPORT OF EXCAVATION

A. Provide support of excavation (SOE) system in order to meet the requirements of OSHA and to assure complete safety against collapse of earth at sides of excavations. The Earth Work Site Contractor shall design and submit for review and upon approval install a temporary support of excavation (SOE) to protect the existing structures and utilities during construction and to perform the excavations during utility excavations and during the removal of the unsuitable materials.

B. In selecting the type of SOE system, the Earth Work Site Contractor shall take into consideration the presence of rock and the presence of cobbles and boulders, and abandoned buried structures in the existing fill and in the natural soil.

C. If sufficient or proper supports have not been provided, additional supports shall be placed at the expense of the Earth Work Site Contractor. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

D. All components of SOE system not ordered left in place shall be carefully removed in such a manner as not to endanger the construction of other structures, utilities or property whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand and rammed with tools especially adapted to that purpose or otherwise compacted to achieve the required density.

E. The design and installation of SOE systems shall not constitute a condition for which an increase may be made in the contract price with the exception that if the Architect directs with writing that certain shoring or sheeting shall be left in place, the contract price will be adjusted in accordance with General Conditions.

F. SOE systems shall be designed to support the earth pressures, surcharge loads from stored material and construction equipment.

G. Shoring and bracing of trenches and other excavations shall, at a minimum, be in accordance with the latest requirements of the Department of Labor and Industries Bulletin No. 12, Section 10, and all subsequent amendments, and OSHA excavation safety standards.

H. SOE systems shall be designed by a Professional Engineer registered in the Commonwealth of Massachusetts and hired by and paid for by the Earth Work Site Contractor.

1.13 DRAINAGE AND GROUNDWATER CONTROL

A. The Earth Work Site Contractor shall control the grading in areas under construction at the site so that the surface of the ground will properly slope to prevent accumulation of groundwater and surface water in excavated areas and adjacent properties.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

C. The Earth Work Site Contractor shall provide, at his own expense, adequate pumping and drainage facilities to maintain the excavated area sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The flows of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent property.

D. Before excavation below groundwater level, place system into operation to lower groundwater level to specified levels and then operate it continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required. The groundwater level shall be maintained at 12 inches beneath the bottom of excavation or deeper until the excavation is backfilled to at least 2 feet above the groundwater level. The Earth Work Site Contractor shall be prepared to install multiple sump pumps to achieve the requirements of these specifications.

E. The Earth Work Site Contractor shall submit a groundwater control plan in accordance with the requirements of Section 1.19. The plan shall include locations of deep and shallow (moveable) sump pumps.

F. Sump pumps shall be installed in crushed stone wrapped a geotextile fabric for filtration and separation.

G. Deep stationary sump pumps shall be at least 7 feet beneath the bottom of the deepest excavation, and shallow, moveable sump pumps shall be at least 3 feet beneath the bottom of the excavation.

H. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

I. Damage resulting from the failure of the dewatering operations of the Earth Work Site Contractor, and damage resulting from the failure of the Earth Work Site Contractor to maintain all the areas of work in a suitable dry condition, shall be repaired by the Earth Work Site Contractor, at no additional expense to the Owner. The Earth Work Site Contractor's pumping and dewatering operations shall be carried out in such a manner as to prevent damage to the Contract work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous to protect the work and/or to maintain satisfactory progress.

J. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water from the trenches, excavations, and stormwater management operations shall be disposed of in such a manner as to avoid public nuisance, injury to public health or the environment, damage to public or private property, or damage to the work completed or in progress.

K. The Earth Work Site Contractor shall excavate interceptor swales and ditches prior to the start of major earthmoving operations to reduce the potential for erosion and to keep areas as free from surface and ponded water as possible.

L. All piping exposed above ground surface for this use shall be properly covered to allow foot traffic and vehicles to pass without obstruction.

M. Should surface, rain or groundwater be encountered during the operations, the Earth Work Site Contractor shall furnish and operate pumps or other equipment and provide all necessary piping to keep all excavations clear of water at all times and shall be responsible for any damage to work or adjacent properties for such water. Protect subgrades and foundation soils from softening and damage by rain or water accumulation. Install dewatering

system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

N. The presence of groundwater or stormwater in soil will not constitute a condition for which an increase in the contract price may be made. Under no circumstances place concrete fill, lay piping or install appurtenances in excavation containing free water. Keep utility trenches free of water until pipe joint material has hardened and backfilled to prevent flotation.

O. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on a continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense.

P. For further information refer to paragraphs on SPECIAL REQUIREMENTS FOR SEQUENCE OF CONSTRUCTION OPERATIONS AND DRAINAGE AND EROSION CONTROL as specified herein.

Q. Remove groundwater control components at end of dewatering operations. Backfill sump pump excavation and plug well hole as applicable using suitable materials as specified herein.

1.14 FROST PROTECTION/WORK IN FREEZING WEATHER

A. Protect excavation bottoms and sides against freezing. Provide protective insulating materials, including by means of heat blankets, and heating plant.

B. A layer of fill shall not be left in an uncompacted state at the close of a day's operation when there is the potential for that layer to freeze.

C. The Earth Work Site Contractor shall not place any material on snow, ice, frozen soil, or soil that was permitted to freeze prior to compaction. Removal of these unsatisfactory materials will be at the Earth Work Site Contractor's expense.

D. Do not excavate to full indicated depth when freezing temperatures may be expected, unless work can be completed to subgrade, the materials installed, and the excavation backfilled the same day. Protect the excavation from frost if placing of materials or backfilling is delayed.

E. The Earth Work Site Contractor shall keep the operations under this Contract clear and free of accumulation of snow within the limits of Contract Lines to carry out the work.

F. No materials shall be installed on frozen ground. Fill materials shall be free of frost.

G. The subgrade of footings and slabs shall be protected from frost before placing concrete. The subgrade on the sides of the footings shall be protected from frost after the footings are constructed until sufficient fill is placed to protect the bottom of footings from frost induced heave. Uninsulated slabs shall be covered with heat blankets until the slab areas are heated. The cover shall extend at least 4 feet beyond the limits of the slabs.

1.15 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION

A. The Earth Work Site Contractor shall take the necessary steps to avoid disturbance of subgrade and underlying natural soils/compacted fill during excavation and filling operations. Methods of excavation and filling operations shall be revised to avoid disturbance of the subgrade and underlying natural soils/compacted fill, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials. The Earth Work Site Contractor shall coordinate with the Architect or Soils Representative to modify his operations to minimize disturbance and protect bearing soils, based on the Architect's or Soils Representative's observations.

B. All excavated or filled areas disturbed during construction, all loose or saturated soil, and other areas that will not meet compaction requirements as specified herein shall be removed and replaced with compacted approved material in accordance with this Specifications. Fill that cannot be compacted within 48 hours because of its saturated or wet condition shall be removed and replaced with compacted approved material in accordance with this Specifications. Costs of removal of disturbed material and replacement with approved material shall be borne by the Earth Work Site Contractor.

C. The Earth Work Site Contractor shall place a six-inch layer of Crushed Stone or 6-inch layer of Granular Fill/Structural Fill over natural soil to stabilize areas disturbed during construction.

1. The placement of the Crushed Stone layer or Granular Fill/Structural Fill as well as material costs shall be borne by the Earth Work Site Contractor. A geotextile fabric shall be used to separate the crushed stone from the natural soil when the natural soil is below the groundwater table, and from the overlying fill when directed by the Geotechnical Engineer at no additional cost to the Owner.

1.16 SPECIAL REQUIREMENTS FOR SEQUENCE OF CONSTRUCTION OPERATIONS AND DRAINAGE AND EROSION CONTROL

A. The sequencing of construction operations as specified under Section 31 25 00, Erosion and Sedimentation Controls shall be extended through earthwork operations as follows:

1. Perform initial procedures as specified under Section 31 25 00, Erosion and Sedimentation Controls – Initial Sequence of Construction Activities and Preliminary Drainage Control.
2. Repair any broken or damaged Sections of the haybales or siltation fencing installed during site preparation and install any additional Sections necessary for proper erosion control.
3. Throughout earthwork operations, in addition to drainage swales, check dams, siltation sumps, and other items shown on the Drawings, the Earth Work Site Contractor shall take other necessary precautions, including installation of temporary drainage swales, siltation sumps, check dams, haybales, silt fencing and temporary pipe to direct and control drainage from disturbed areas on the site so that erosion and siltation is minimal. In addition, no erosion or discharge of silt or larger particles shall occur in water bodies or wetland areas to remain undisturbed or onto adjacent properties.
4. Damaged or loose haybales and siltation fence shall be replaced to maintain their function of controlled erosion and siltation. Damaged or broken down check dams and filtration dams shall be replaced immediately.
5. Throughout construction, remove accumulation of silt or soil build-up behind haybales, silt fences, check dams and filtration dams as it occurs. Remove accumulations of silt and build-up from the siltation pumps and silt traps when it is approximately 18 inches deep, or when it adversely affects the performance of the system. Remove silt sacks in catch basins when they have become clogged and replace to maintain their function.
6. Replace the crushed stone on the inside of all siltation sumps to permit adequate flow through the media and to maintain their function as a filter of silt and larger particles. Excavate silt and other material from the basins of all siltation sumps as it accumulates.
7. Remove temporary drainage swales, check dams, siltation sumps, haybales and other temporary drainage, erosion and siltation control measures when permanent drainage control measures have been installed, and grass is established in drainage areas and lawn areas. Do not remove the above items without approval of the Architect. If, in the Architect's opinion, these measures are still necessary, they shall stay in place.

1.17 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the grade and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill. Imported fill shall meet the gradation requirements set forth in PART 2 - PRODUCTS.

E. Building Area: The area defined by the projection of a line from two feet outside of the edge of the footing extending downward and outward at a slope of 1.5H: 1V. (If over-excavation is required below the footing the building area will be redefined from the bottom of over-excavation).

F. Compaction: The tamping and rolling of all backfill placed in uniform horizontal layers not exceeding a defined uncompacted lift thickness.

G. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

H. Deleterious Material: Trash, debris, clay, topsoil, roots, organic material friable material, glass, material that has become soft and saturated, even if previously compacted, material defined in section 1.17.X, or otherwise degradable materials that compromise the strength and properties of soils.

I. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions per Architect's instructions. Authorized additional excavation and replacement material will be paid for according to Contract provisions.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

J. Fill: Soil materials used to raise existing grades or meet proposed grades.

K. Frost Zone: The area within 4 feet of finished grade.

L. Influence Zone/Area: The area below a footing defined by the projection of a line from two feet outside of either edge of the footing extending downward and outward at a slope of 1V:1.5H.

M. "In-the-dry": In-situ soil moisture content of no more than two percentage points above the optimum moisture content for that soil.

N. Optimum Moisture Content: Determined by the ASTM standard specified to determine the maximum dry density for relative compaction.

O. Prepared Ground Surface: The ground surface after clearing, grubbing, stripping, excavation, and scarification and/or compaction.

P. Proof-rolling/proofcompacting: The tamping and rolling of all subgrades including running a loaded rubber tire truck over the subgrade when requested by the Geotechnical Engineer.

Q. Relative Density: As defined by ASTM D4253 or D4254.

R. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversized material shall be applied to maximum dry density.

S. State Standards: Massachusetts Highway Department Standard Specifications for Highways and Bridges.

T. Structures: Buildings, footings, foundations of any type, retaining walls, buildings and equipment slabs, ramps, stairs, tanks, curbs, sidewalks, mechanical and electrical appurtenances, retaining walls, or other man-made stationary features constructed above or below the ground surface.

U. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

V. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below structures, subbase, drainage fill, or topsoil materials.

W. Unclassified Excavation: The nature of materials to be encountered has not been identified or described herein.

X. Unsuitable material shall be material having at least one of the following properties:

1. Material with a maximum unit dry weight per cubic foot less than 110 lbs., as determined by ASTM D1557.
2. Material containing greater than 3 percent organic matter by weight, topsoil, organic silt, peat, construction debris, roots and stumps.
3. Material which has a Liquid Limit greater than 55 when tested in accordance with ASTM D 4318.
4. Materials that do not meet one of the gradation specifications in this section.
5. Wet material which cannot be compacted due to moisture contents outside of the limits of plus or minus 3 percentage points of optimum moisture content.
6. Material classified as unsuitable by the Geotechnical Engineer.
7. Unsuitable material shall be disposed of off-site per Architect’s instructions.
8. Material processed onsite that is not well graded or contains excess stones and exhibits honeycombing when placed in lifts.
9. Materials that are unstable as a result of inadequate construction dewatering, excessive subgrade disturbance, or other means and methods used by the Earth Work Site Contractor are not considered unsuitable materials This include materials that were stable and that have become unstable.

Y. Utilities: On-site underground and aboveground pipes, conduits, ducts, and cables, as well as underground services within buildings.

Z. Trench: An excavation of any length where the width is less than twice the depth and where the shortest distance between payment lines does not exceed ten feet. All other excavations shall be defined as open excavations.

AA. Architect: Where architect is referenced it shall mean the Architect or the Architect’s representative.

BB. Geotechnical Engineer: Where Geotechnical Engineer is referenced it shall mean the Geotechnical Engineer or its representative.

1.18 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements or requirements of other specification sections, the most restrictive requirements that are most favorable to the Owner will govern.

B. American Society for Testing and Materials (ASTM):

1. ASTM D1556, Density of Soil In Place by the Sand-Cone Method.
2. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
3. ASTM D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
4. ASTM D6913, Particle Size Analysis of Soils.

C. Commonwealth of Massachusetts:

1. Massachusetts Highway Department Standard Specifications for Highways and Bridges.
2. The Commonwealth of Massachusetts State Building Code 780 CMR, Tenth Edition (MSBC 10th Edition)

D. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO T-11, Standard Method of Test for Amount of Material Finer than 0.075 mm sieve in aggregate.
2. AASHTO T-27, Standard Method of test for sieve analysis of fine and coarse aggregates.

E. Occupational Safety and Health Act of 1970 (Public Law 91-596 of the United States, 29 USC Section 651 et seq.).

1.19 SUBMITTALS

A. Product Data: For the following:

1. Each type of plastic warning tape.
2. Geotextile – The Earth Work Site Contractor shall submit a 12-inch by 12-inch sample of geotextiles.
3. Controlled low-strength material, including design mixture.

B. Submit a detailed construction sequence plan for project excavation indicating temporary stockpile areas, side slopes of excavations, limits of required temporary excavation support and sequence and procedures for subgrade protection, excavation, concrete placement, moisture conditioning of on-site excavated soils used as fill, filling, backfill, and compaction.

C. The Earth Work Site Contractor shall submit the name of imported material suppliers. Change of source suppliers shall require approval from the Architect.

D. Grain-size distribution analysis test data shall be delivered with the samples. The analysis shall be performed in accordance with ASTM D6913 and shall at the minimum include the sieve sizes listed for the respective material in Part 2. The data shall include a plot of the gradation and the envelope of the specified material. A material shall be considered meeting the specifications when its gradation curve fits entirely within the specified envelope. Borrow

soil materials with grain-size distribution curves that do not fall entirely within the specified envelope shall be deemed unacceptable.

E. The Earth Work Site Contractor shall submit to the Architect, manufacturer's literature and data on proposed compaction equipment.

F. The Earth Work Site Contractor shall provide to the Architect, on a daily basis, copies of field records documenting the location of stockpiled material, and stockpile identification data.

G. The Earth Work Site Contractor shall submit a scale plan daily that defines the location, limits, and depths of the area excavated.

H. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Classification according to ASTM D 2487 of each onsite and borrow soil material proposed for fill and backfill.
2. Recent (less than one month old) Gradation Curve (ASTM D6913) and Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.

I. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

J. Excavation and Excavation Support Plan: Submit at least 10 calendar days prior to the start of the work a detailed plan for the sequence of excavation, and methods to be used for excavation support and dewatering of excavations. Submit engineering calculation stamped by a Massachusetts Registered Professional Engineer and shop drawings for earth support systems to be used.

K. Dewatering plan shall be submitted at least 10 days before the start of construction. Dewatering and groundwater control systems shall be designed to keep excavations free of water and to avoid disturbance of the subgrade in accordance with Section 1.13 of these Specifications. The dewatering submittal shall include a plan clearly showing locations, depth, and size of deep stationary sump pumps.

L. Rock blasting plan shall be submitted at least 10 days before the start of blasting operations. This submittal shall include description of blasting operations, handling procedure and storage of explosives, blasting limits and depths, blasting sequence, measures to limit vibrations, and measures to limit overblast and rock heave to less than 2 feet.

1.20 SAMPLING AND TESTING

A. The Earth Work Site Contractor shall submit two 50-lbs samples of each type of fill material, in air-tight containers, proposed for use on-site in accordance with PART 2 - PRODUCTS, to the Owner's Geotechnical Engineer (Geotechnical Consultant) for preliminary compliance testing at least two weeks prior to use. No fill material shall be delivered to the site or placed until the material has been preliminarily approved. The final review of the material will be based on a sample tested by the Owner's testing agency upon delivery of the material to the site. The gradation curves shall fit entirely within the envelopes defined by the limits specified herein for the material to be approved for use at the site.

1. Samples shall be delivered to the office of the Architect.
2. Samples required in connection with compaction tests will be taken and transported by the Soils Representative.
3. Additional tests, including grain-size analyses and laboratory compaction tests shall be performed on the material after it is delivered to the site.

4. For on-site materials, submit representative samples, collected from each stockpile of excavated on-site material to be used, directly to the Owner's Geotechnical Consultant's office at least two weeks in advance of use of these materials.

B. Product Data: Submit location of pits for borrow material. Samples shall include name of source, name of material, sampling date, and intended use.

C. Samples shall be representative of the source pit. If materials are found to vary once construction begins, the Earth Work Site Contractor shall be required to submit additional representative samples, for compliance testing, at his own cost.

D. Compaction tests:

1. Compaction tests shall be performed at all bench and other site fixture pads.
2. Compaction tests shall be performed on each lift of placed and compacted material. Accordingly, it is the responsibility of the Earth Work Site Contractor to provide ample notice to the testing agency to provide a field representative to perform field density tests.

E. Materials imported to the site by the Earth Work Site Contractor for on-site use shall not contain oil, hazardous waste, or deleterious materials.

1. The Earth Work Site Contractor shall be responsible for all costs incurred by the Owner as a result of the Earth Work Site Contractor's action to import materials containing concentrations of oil and/or hazardous materials to the site, including the cost of removing the contaminated soil, the cost of remediation of onsite soils affected by the contamination, and the cost of replacement.
2. In the event that site characterization of off-site borrow sources indicates that soils are acceptable to the Architect or Engineer for use, then chemical testing will not be required. It is anticipated that chemical testing would not normally be required for material from customarily utilized commercial borrow sources.

   No fill material from "urban areas" will be accepted for fill at the site, even if chemical testing indicates no exceedances of "Reportable Concentrations".

   If requested by the Owner or Engineer, based on review of the borrow site characterization, the Earth Work Site Contractor shall conduct testing on proposed fill material and submit results prior to delivery to the site, at no additional cost to the Owner. Testing shall be conducted by a DEP-certified testing laboratory and shall include, at a minimum, the following analytical test data.

   a. Total Petroleum Hydrocarbons (EPA Method 418.1) every 100 yards
   b. Volatile Organic Compounds (EPA Method 8420) every 500 yards
   c. PCB and Pesticides (EPA Method 8080) every 500 yards
   d. Total RCRA Metals (EPA Method 6000-7000 series) every 500 yards
   e. Polynuclear Aromatic Hydrocarbons (EPA Method 8270) every 500 yards
   f. TCLP for those total parameters which exceed twenty times the TCP criteria every 500 yards.
   g. Total cyanide (EPA 9020)

3. All off-site material submitted for use on the project site shall conform to the S-1 Soils Standards contained in the Massachusetts Contingency Plan, dated October 1, 1993, Section 310 CMR 40.0975 or site soil background levels, whichever is lower. Samples will be chemically tested to determine their conformance with the S-1 Soils Standards and site soil background levels.

4. Testing parameters and testing frequencies may be reduced, per the Soils Representative's instructions.
5. All sieve analyses for conformance of on-site and off-site fill materials to be used in the work shall be done by means of a mechanical wet sieve analysis and in accordance with ASTM D6913.

1.21 QUALITY ASSURANCE

A. The Owner may retain and pay for the services of an independent testing agency (Soils Representative) to monitor and observe the backfill operations, perform laboratory tests on soil samples, and to perform field density tests; and a Geotechnical Engineer to periodically observe the earthwork operations, observe the preparation of the subgrade for footings, slabs, and if requested by the Owner paved areas, and to review laboratory and field test data. The Geotechnical Engineer may from time to time request that the Earth Work Site Contractor excavate tests pits ahead of excavation to confirm subsurface conditions. Test pits shall be performed at no additional cost to the Owner.

B. The Geotechnical Engineer's duties do not include the supervision or direction of the actual work by the Earth Work Site Contractor, his employees or agents. Neither the presence of the Geotechnical Engineer nor any observation and testing by the Engineer shall excuse the Earth Work Site Contractor from defects discovered in his Work at that time or subsequent to the testing.

C. The services of the Soils representative may include but are not limited to monitoring and performing observations of the backfill operations and testing during placement of fills and backfills within the proposed building, parking area, underneath structures in general, and controlled fill areas.

D. Neither the presence of the Soils Representative and/or the Geotechnical Engineer, nor any observations and testing performed by them, nor failure to give notice of defects shall excuse the Earth Work Site Contractor from defects discovered in his work.

E. Subgrades of footings and slabs, and if requested by the Owner subgrades of paved areas, shall be observed by the Geotechnical Engineer before placing fill. The compaction and material composition shall be approved by the geotechnical engineer before placement. If inspections indicate subgrade does not meet specified requirements, the unsuitable subgrade shall be excavated, the unsuitable material shall be removed, and replaced with approved backfill material and compacted at no additional cost to the Owner or architect. The work shall be done in accordance with this specification.

1. Testing frequency shall be as follows:

Material	Responsible Party	Situation	Test	Minimum Frequency
Structural Fill/ Ordinary Fill/ Processed	Earth Work Site Contractor	Source Investigation	Grain Size Moisture Density Relationship	1 per source 1 per source
Gravel for Sub-base/ Common Borrow/ Bedding Material/ Crushed Stone / Pea Gravel	Owner	During Placement	Grain Size t Moisture Density Relationship	1 per source 1 per 100 tons
	Owner	As-Placed	Dry Density and As-Placed Moisture	2 per lift per location or activity and no less than 1 every 500 sf

Loam Borrow	Earth Work Site Contractor	During Placement	PH, Nitrogen, Phosphorous, Potassium, and USDA Classification	2 per Acre
Riprap	Earth Work Site Contractor	Source Investigation	Source Material Certification Specific Gravity	1 per source 1 per source
	Earth Work Site Contractor	During Placement	Source Material Certification Specific Gravity	1 per 500 tons 1 per 500 tons

a. The Owner reserves the right to modify the services of the Soils Representative or Geotechnical engineer.

F. The Earth Work Site Contractor shall make provisions for allowing safe and timely observations and testing of Earth Work Site Contractor's Work by the Geotechnical Engineer and by the Soils Representative.

G. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, Engineer, consultants, Soils Representative, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least 3 working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

H. Testing: Compaction tests will be required by the Owner and will be paid for by the Owner. No specific testing schedule has been established at this time. If tests indicate that density requirement have not been achieved, the Earth Work Site Contractor shall continue compacting the tested material. All retesting is these areas shall be paid for by the Earth Work Site Contractor.

I. The Owner's Testing Agency will perform water content, gradation tests on onsite and processed materials, and compaction tests. The results of these tests will be submitted to the Architect, and a copy submitted to the Earth Work Site Contractor, on a timely basis so that the Earth Work Site Contractor can take such action to remedy the indicated deficiencies.

J. Earth Work Site Contractor shall notify Architect when excavations have reached required subgrade and provide a minimum notice of 24 hours prior to placement of backfill on exposed subgrade. Density and Compaction Testing: The Earth Work Site Contractor is responsible to schedule compaction tests and to allow adequate time for the proper execution of said tests. This section also applies to instances when the Earth Work Site Contractor resumes earthwork operations after a period of pause in earthwork operations that require observations by the Geotechnical Engineer.

K. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:

1. Prepare plan report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
2. Seismographic monitoring services during blasting operations.
3. Prepare a preblast survey of all adjacent properties, including a structural inspection of the buildings and properties and shall include a written and photographic record of existing conditions.

4. Blast operations shall not commence until all reports and plans are received and approved by the Owner and the Architect.

1.22 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact a utility-locator service for the area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies and Town of Wilmington to shut off services if lines are active.

C. Subsurface investigations indicated the presence of fill material which contains organic matter. This material has limited reuse applications at the site.

D. Subsurface investigations indicated the presence of sand and gravel materials which will likely be easily disturbed due to construction activities. This material is also likely to require regular moisture conditioning to obtain required compaction requirements.

1.23 MEASUREMENT

A. Measurement of Unsuitable Soil Excavation:

1. Strip vegetation, topsoil, buried organic material and fill to a minimum depth of 1 foot below the existing grades in accordance with the Contract Documents or in accordance with drawings. Remove existing asphalt, curbing, cobbles, boulders, concrete, metal, woods, and above and below ground structures.

2. Remove unsuitable soils to top of natural soil as shown on the Contract Documents or in the field per the Owner’s Geotechnical Consultant’s instructions in accordance with the Section 3.1-B, 3.3, 3.6, 3.7, 3.9,and 3.10 of these Specifications in areas where ground improvements are not installed.

3. Employ a Registered Land Surveyor to survey to bottom of the excavation for unsuitable soils throughout the building footprint. Excavations shall be surveyed at the corners, high and low points, and a maximum spacing for survey points of 20 feet in each direction on a grid.

4. Quantities shall be measured in their original position to the limits of clearly defined vertical construction lines and to the depth required for the defined construction. Payment will be at the Contract Unit Rates.

PART 2 - PRODUCTS

2.01 GENERAL

A. Segregate excavated material based upon material type to enable reuse in appropriate locations based upon material type as described in Section 3.5.

B. Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

2.02 SOIL MATERIALS

A. Use of materials shall be as described below and as shown in the Drawings.

B. Fill material will not be accepted from off-site borrow sources that are Massachusetts DEP MCP disposal sites. Common borrow material obtained from off-site borrow sources that have no known releases or disposal of oil and/or hazardous material shall be acceptable for use only when accompanied by documentation stating there has been no known releases or disposal of oil and/or hazardous materials at the off-site borrow site.

C. Fill material shall be free from frost/ice and snow, rocks with a diameter greater than 2/3 of the loose lift thickness as specified herein, and foreign matter, such as construction debris, asphalt, trash, wood, roots, leaves, sod, and organic matter. All fill material shall be maintained by the Earth Work Site Contractor at suitable moisture contents for proper placement and compaction as specified herein

D. Offsite pulverized pavement and crushed concrete are not acceptable for fill material except as specified herein.

2.03 STRUCTURAL FILL

A. Structural Fill shall have a plasticity index of less than 6 and shall meet the gradation requirements shown below. Structural Fill shall be compacted in maximum 9-inch loose lifts to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture contents within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
3 inches	100
1 ½ inch	80 – 100
½ inch	50 – 100
No. 4	30 – 85
No. 20	15 – 60
No. 60	5 – 35
No. 200*	0 - 10

*0 – 5 In top 12 inches under sidewalks, walkways, rubber surface in play areas, equipment pads, and unheated and exterior slabs (Select Fill).

Use structural fill within building areas beneath floor footings and slabs, retaining wall foundations, and in other soil-bearing situations.
Crushed concrete can be used as Structural Fill provided it meet the requirements of these specifications. If used, the crushed concrete shall be used up to 6 inches below the bottom of footings and 12 inches below the bottom of slabs. Crushed concrete shall be free of debris, wood, and organic material, and shall meet the environmental requirements set forth in these specifications.

Use Structural Fill with less than 5 percent fines in top 12 inches under exterior slabs-on-grade including under sidewalks, walkways, rubber surface in play areas, equipment pads, and unheated and exterior slabs.

2.04 ORDINARY FILL

A. Ordinary Fill shall have a plasticity index of less than 6 and shall meet the gradation requirements shown below. Ordinary Fill shall be compacted in maximum 9-inch loose lifts

to at least 95 percent of the Modified Proctor maximum dry density (ASTM D1557), with moisture content s within ±2 percentage points of optimum moisture content.

Sieve Size	Percent Passing by Weight
6 inches	100
1 inch	50 – 100
No. 4	20 - 100
No. 20	10 - 70
No. 60	5 – 45
No. 200	0 - 20

Use Ordinary Fill for general grading; as backfill for embankments, behind the free draining backfill behind retaining walls, beneath the base layer of landscape areas; and beneath the subbase layer in paved areas outside the building footprint.

Crushed concrete can be used as Ordinary Fill provided it meet the requirements set forth by this specification.

2.05 COMMON BORROW

A. Common Borrow material shall be soil containing no stone larger than 8 inches and shall be substantially free of organic loam, wood, trash, or other objectionable materials which may be decomposable, compressible or which cannot be properly compacted. Onsite and offsite Common Borrow materials shall not contain more than 30 and 20 percent by weight of silt and clay, respectively.

1. No Common Borrow shall be imported until available onsite Ordinary Fill has been utilized or with prior written approval from the Architect.
2. Common Borrow material from off-site borrow sources shall contain no detectable concentrations of asbestos.
3. Crushed concrete can be used as Common Borrow provided it meet the requirements of these specifications.

2.06 PROCESSED GRAVEL FOR SUBBASE

A. Processed Gravel for Subbase shall be onsite or imported material conforming to Item M1.03.1 of the State Standards. This material can be used as subbase in the top 12 inches beneath paved areas.

B. Processed Gravel for Subbase may be anticipated to be onsite in limited quantities.

C. Crushed concrete cannot be used as Processed Gravel for Subbase.

2.07 BEDDING MATERIAL

A. Crushed Stone Bedding Material shall be imported material conforming to Item M2.01.3 of the State Standards.

B. Coarse Sand Bedding Material shall be imported material conforming to Item M1.04.0 type A of the State Standards.

2.08 SAND FILL

A. Sand Fill: To be used as utility bedding and backfill. It shall be hard, durable sand free from ice, snow, roots, sod and other deleterious matter conforming to the material and gradation requirements for Type B Sand Borrow, MassDOT Item M1.04.0. The Sand Fill shall be used as backfilling material around banks of pipes. The Sand Fill shall be graded within the following limits:

Sieve Size	Percent Passing by Weight
3/8-inch	100
No.200	0-10

2.09 DENSE GRADED CRUSHED STONE FOR SUBBASE

A. Dense graded Crushed Stone for subbase shall be imported material conforming to Item M2.01.7 of the State Standards. This material shall be used as an alternate to Processed Gravel for Subbase in the top 12 inches immediately beneath paved areas.

B. Crushed concrete cannot be used as Dense Graded Crushed Stone for Subbase.

C. Dense graded Crushed Stone for subbase are not anticipated to be present onsite.

2.10 CRUSHED STONE

A. Crushed Stone shall be impacted durable material with maximum of 1-½-inch or 2-inch as specified in the Drawings. Stone used for drainage components shall be double washed. For all other applications fines shall be less than 1 percent unless otherwise noted. Crushed stone shall meet the following gradation:

Size (inches)	Percent Finer
1 ½ – 2	100
1 ¼	85 - 100
¾	10 - 40
½	0 - 8
#200	Less than 1

B. ¾-inch Crushed Stone shall comply with State Standards M2.01.4.

C. ¼-inch to 3/8-inch Crushed Stone shall comply with State Standards M2.01.6.

2.11 PEA GRAVEL

A. Clean naturally rounded aggregate with particle sizes no larger than 3/4 of an inch with no more than 5 percent passing the #8 sieve. The dry density shall be a minimum of 95 pounds per cubic foot.

2.12 WASHED STONE

A. Washed stone shall be free from shale, clay, organic materials, and debris with stone sizes conforming to No. 4 stone as specified by ASTM D448. Not more than 0.5 percent of satisfactory material passing a No. 200 sieve shall be allowed to adhere to the stone. Laboratory testing shall be completed in compliance with ASTM D6913, and results shall be submitted to the Civil Engineer for approval.

2.13 FILTER FABRIC

A. Filter fabric shall be nonwoven, needle-punched geotextile, manufactured for subsurface drainage applications, made from polypropylene fibers with elongation greater than 50 percent and complying with AASHTO M288. Filter fabric shall consist of Mirafi 140N, US120NW, GeoTex 401, or approved equal.

B. High Visibility Filter Fabric shall consist of US 160NW-HVO non-woven orange filter fabric, GeoTex 601OR, or Mirafi 160N/O, or approved equal.

2.14 GEOTEXTILE FABRIC

A. Geotextile No. 1: Geotextile Fabric for erosion control/slope protection/separation/filtration shall conform to Item M9.50.0 type IV of the State Standards. Geotextile No. 1 is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that fibers retain their relative position. The product is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Grab Tensile Strength	ASTM D 4632-91	lbs	120
Grab Tensile Elongation	ASTM D 4632-91	percent	50
Trapezoid Tear Strength	ASTM D 4533-91	lbs	50
Mullen Burst Strength	ASTM D 3786-87	psi	225
Puncture Strength	ASTM D 4833-00	lbs	65
Apparent Opening Size (AOS)	ASTM D 4751-99A	U.S. Sieve	70
Permittivity	ASTM D 4491-99A	sec^{-1}	1.8
Permeability	ASTM D 4491-99A	sec	0.21
Flow Rate	ASTM D 4491-99A	gal/min/ft	135
UV Resistance (at 500 hours)	ASTM D 4355-02	percent strength retained	70
Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261-92	oz/yd	4.8
Thickness	ASTM D 5199-01	mils	55
Roll Dimensions (width x length)	--	ft	12.5 x 360 / 15 x 360
Roll Area	--	yd	500 / 600
Estimated Roll Weight	--	lb	164 / 197

B. Geotextile No. 2: Geotextile No. 2 is a nonwoven geotextile composed of polypropylene fibers, which are formed into a stable network such that fibers retain their relative position. The product is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

Geotextile No. 2 shall be used where the project Civil Engineer required it.

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Grab Tensile Strength	ASTM D 4632	lbs	160
Grab Tensile Elongation	ASTM D 4632	percent	50
Trapezoid Tear Strength	ASTM D 4533	lbs	60
Mullen Burst Strength	ASTM D 3786	psi	305
Puncture Strength	ASTM D 4833	lbs	95
Apparent Opening Size (AOS)	ASTM D 4751	U.S. Sieve	70
Permittivity	ASTM D 4491	sec^{-1}	1.4
Permeability	ASTM D 4491	sec	0.22
Flow Rate	ASTM D 4491	gal/min/ft	110
UV Resistance (at 500 hours)	ASTM D 4355	percent strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	oz/yd	6.4
Thickness	ASTM D 5199	mils	75
Roll Dimensions (width x length)	--	ft	15 x 300
Roll Area	--	yd	500
Estimated Roll Weight	--	lb	217

C. Geotextile No. 3: Geotextile for the installation of underground tank
   1. Woven geotextile fabric with a minimum grab tensile strength of 120 lbs/inch and a maximum apparent opening size of #50 US sieve (0.300 mm)

D. A geotextile fabric shall not be used between crushed stone and soil fill material at the base of retaining walls. Where separation between crushed stone and soil fill material is required, the crushed stone shall be choked by means of a soil filter.

E. A geotextile fabric shall be used to separate crushed stone used as a drain within or behind MSE and modular retaining walls and the backfill/natural soil.

2.15 OTHER SOIL MATERIAL

A. Drainage Aggregate: Narrowly graded mixture of washed crushed stone or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

B. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural soil; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.

C. Fine Aggregate: ASTM C 33; fine aggregate, natural, or manufactured sand.

D. River Stone: River stone shall be 1-½-inch to 3-inch rounded and 3-inch to 6-inch rounded and oval, smooth stone, color range shall be warm tones of buff, beige, tan and gray. Color range shall be consistent throughout. Stone shall be clean and washed free of deleterious material. Earth Work Site Contractor to submit 5-gallon container sample for each size range with source indicated.

E. Rip-rap: rip-rap shall be sound, durable rock which is angular in shape in accordance with M2.02.0 of the State Specifications.

F. Gravel for Synthetic Turf Dynamic Base shall consist of durable crushed rock or crushed gravel stone, free of ice, snow, sand, silt, clay, loam, shale, or other deleterious or organic matter; washed, and graded. Fragmentation shall be at least 100 percent. No round stone or sand shall be accepted. It shall be graded within the following limits:

Base Stone:

U.S. Sieve Size	Percent Finer by Weight
1 inch	100
3/4 inch	85-100
1/2 inch	55-85
3/8 inch	40-75
1/4 inch	25-65
No. 4	5-35
No. 8	0-20
No. 16	0-10
No. 200	0-2

Finishing Stone:

U.S. Sieve Size	Percent Finer by Weight
1/2 inch	100
3/8 inch	85-100
1/4 inch	75-100
No. 4	60-90
No. 8	35-75
No. 16	10-55
No. 30	0-40
No. 50/60	0-15
No. 100	0-8
No. 200	0-2

SCHEDULE 1 - ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

B. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility,

with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer Systems.

PART 3 – EXECUTION

3.01 GENERAL

A. Prior to commencing work, the Earth Work Site Contractor shall establish property line locations and place construction control markers clearly visible and understandable to workers in the field. The Earth Work Site Contractor shall exercise due care so as not to disturb adjacent structures and shall leave the Site in clean and orderly condition upon completion of the work.

B. Unanticipated Soil Conditions:

1. Removal of unsuitable materials up to the depths shown in the drawings and/or specified herein shall be part of the base bid and shall not be considered an unanticipated soil condition. The depth to the bottom of unsuitable material shall be estimated by interpolating between the depths to unsuitable material in the nearest borings and/or test pit.
2. If unsuitable bearing materials are encountered at the specified subgrade depths, i.e., deeper than the elevations shown in the Geotechnical Report, the Earth Work Site Contractor shall notify the Architect. The Earth Work Site Contractor shall carry excavation deeper and replace the excavated material with suitable/approved compacted fill or lean concrete per the Architect's or geotechnical engineer's instructions.
3. Removal of such material and its replacement per the Architect's instructions will be paid as extra compensation in quantity approved by the Architect and calculated using survey points of the excavated area. Only changes in the work authorized in advance by the Architect in writing shall constitute an adjustment in the Contract Price.
4. Material that is above or below optimum moisture for compaction of the particular material in place as determined by the Architect or the Soils Representative and is disturbed by the Earth Work Site Contractor during construction operations so that proper compaction cannot be reached shall not be considered as unsuitable bearing materials. This material shall be removed and replaced with lean concrete or with approved material per the Architect's or Geotechnical Engineer's or Soils Representative's instructions at no additional cost to the Owner.
5. The Earth Work Site Contractor shall follow a construction procedure which permits visual identification of firm natural ground.

C. Excessive Excavation: If any part of the general or trench excavation is carried, through error, beyond the depth and dimensions indicated on the Drawings or called for in the Specifications, the Earth Work Site Contractor at his own expense, shall furnish and install compacted fill, concrete, or take other remedial measures per the Architect's instructions to bring fill material up to the required level or dimension.

D. The Earth Work Site Contractor shall reuse onsite excavated soils that meet the gradation requirements of materials specified herein. Solid waste consisting of brick, concrete, asphalt, cobbles, boulders, excavated or blasted rock, and all unsuitable excavated materials shall become the property of the Earth Work Site Contractor and be legally disposed of off-site at no additional cost to the Owner.

Samples and Testing:

1. Excavated material taken directly from onsite cuts that will meet the Specifications may be used as fill provided the Earth Work Site Contractor obtains written approval from the Architect. No such fill material shall be placed until approved for use by the Architect in writing and until test results, including gradation and compaction tests are approved by the Geotechnical Engineer.
2. Testing of materials as delivered may be made from time to time. Materials in question may not be used, pending test results. Tests of compacted materials will be made regularly. Remove rejected materials and replace with approved backfill material, whether in stockpiles or in place.
3. The existing fill and the natural soil contain high fines contents. Such soils are very susceptible to disturbance when exposed to moisture. Care shall be exercised during construction to maintain a dry working subgrade. Provide working mats, e. g., crushed stone or concrete mud mats, to reduce the potential for disturbance of the foundation subgrade and to improve working conditions. The use of crushed stone to stabilize soft subgrade shall be at no additional cost to the Owner.

E. Deficiency of Fill Material: Provide required additional fill material to complete the work if a sufficient quantity of suitable material is not available from the required excavation on the project site at no additional cost to the Owner.

F. Surplus Fill Material: Surplus fill that is not required to fulfill the requirements of the Contract shall be removed from the site and legally disposed of at no additional cost to the Owner.

G. Protect all benchmarks, monuments, and property boundary pins. Replace if destroyed by Earth Work Site Contractor's operation.

3.02 PREPARATION

A. The Earth Work Site Contractor shall be deemed to have inspected the Site and satisfied himself/herself as to actual grades and levels and true conditions under which the Work will be performed.

B. Areas required for execution of Work shall be cleared. The work area shall be free of standing water and shall be dry.

C. All site health and safety controls shall be fully established and in operation prior to beginning any demolition, soil, and fill excavation. Site controls shall include but not be limited to work zones properly barricaded, wheel wash and decontamination facilities, and all support equipment and supplies including personal protective equipment. All site controls shall be reviewed by the Architect in the field.

D. The Earth Work Site Contractor shall provide all layout field data, including ties, to the Architect. The Earth Work Site Contractor shall maintain all required field controls throughout the performance of the Work.

E. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

F. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, cobbles, boulders, rock, obstructions, and deleterious materials from ground surface is specified in Section 31 10 00 "Site Clearing."

G. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section 31 25 00 – Erosion and Sedimentation Controls.

H. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

I. Provide excavation support, shoring or bracing to perform the excavations and to support the bank of the stream during the removal of the unsuitable materials.

J. Provide groundwater Control, dewatering, pumping, bailing and control of all groundwater and surface water for all work under this contract.

3.03 SUBGRADE PREPARATION

A. Topsoil, existing fill, buried organic soil, buried subsoil, swamp deposits, tree stumps, roots balls, cobbles, boulders, abandoned utilities, existing and abandoned foundations, asphalt, demolition debris, and other below-ground structures shall be entirely removed from within the footprint of the proposed building before the start of foundation work in areas where ground improvements are not installed. The removal shall extend vertically to the top of the natural soil or to rock, and laterally beyond the limits of the influence zone of 5 feet beyond the limits of the proposed building, whichever is greater.

B. The ground improvements shall be installed in existing fill that is pre-trenched and free of obstructions. Material placed above the top of the ground improvements shall consist of Structural Fill or Crushed Stone. The ground improvements shall be exposed, and the subgrade compacted before lacing Structural Fill or Crushed Stone.

C. Cobbles and boulders shall be removed at least 12 inches from beneath footings, 24 inches beneath the bottom of slabs and paved areas, and 24 inches beneath the topsoil or the base material for the synthetic turf in athletic fields. The resulting excavations shall be backfilled with compacted Structural Fill under the building, and with Ordinary Fill under the subbase of paved areas and under the base material in athletic fields.

D. Excavations in the silt and clay shall be performed with a smooth bladed bucket and the subgrade shall be compacted statically with no vibration.

E. Tree stumps, root balls, and roots larger than ½ inch in diameter shall be removed and the cavities filled with approved backfill material and compacted in accordance with this Specification.

F. After the subsoil, existing fill, surficial and buried organic material, and unsuitable material are removed from within the proposed building, the exposed subgrade in the natural soil shall be compacted using at least four passes of a vibratory roller compactor imparting a minimum dynamic effort of 40 kips.

G. The base of the footing excavations in the natural soil shall be compacted with a dynamic vibratory compactor weighing at least 200 pounds and imparting a minimum of 4 kips of force to the subgrade, before placing the backfill or concrete.

H. The base material of athletic fields shall conform to the gradation and placement requirements of the landscape architect or the manufacturer/installer of synthetic turf.

I. The grades within the proposed building shall be restored using Structural Fill up to the bottom of the proposed slabs or bottom of the under-slab drainage system when required, in accordance with drawings and details.

J. Due to the susceptibility of the natural soil to disturbance under foot and vehicular traffic, a minimum of 12 inches of Structural Fill or 3/4-inch crushed stone shall be placed under the footings to provide a firm working surface during placement of formwork and rebar.

K. The topsoil, and surficial organic material, tree stumps, rootballs, asphalt, and concrete structures and other deleterious material shall be entirely removed from within the proposed driveways and parking lots (paved areas). The existing fill and subsoil shall be removed from within paved areas to a depth of 18 inches beneath the bottom of the proposed pavement. Abandoned/buried foundations, if any, shall be removed within the proposed paved areas and athletic fields at least 3 feet beneath the bottom of the subbase layer of the proposed paved areas, and 3 feet beneath the topsoil or the subbase of synthetic turf in athletic fields.

L. To improve the subsoil or existing fill under the proposed paved areas, the exposed subgrade in the subsoil or existing fill material (i.e., after removing the surficial topsoil, organic material) shall be compacted with at least six passes of a heavy vibratory roller compactor imparting a dynamic effort of at least 40 kips. Where soft zones of soil are observed, the soft soil shall be removed, and the grade shall be restored using Ordinary Fill to the bottom of the proposed subbase layer. Where buried organic material is present beneath the proposed paved areas, it shall be removed. The exposed surface shall be proofrolled before placing backfill. If pumping of the existing fill or subsoil deeper than 18 inches beneath the bottom of the proposed pavement is observed, the soft and/or pumping material shall be removed and replaced.

M. After the surficial organic topsoil is removed from within the proposed athletic fields, the subsoil, existing fill, or natural soil shall be proofrolled with a loaded rubber tire truck or with a large vibratory roller compactor imparting a minimum dynamic effort of 40 kips. Where soft zones are indicated by the proofrolling, the soft zones shall be removed and the grades shall be restored using Ordinary Fill to the bottom of the base material of the proposed turf designed by the landscape architect or the manufacturer/installer of synthetic turf, if any.

N. In areas requiring rock excavations, disturbed rock material or rock that has heaved as a result of blasting shall be removed and replaced with Structural Fill or crushed stone within the footprint of the proposed building, and with Ordinary Fill beneath the pavement subbase of the proposed parking lots and driveways.

O. The bottom of footings bearing in bedrock shall be prepared as level as possible and shall not be sloped steeper than 12H:1V.

P. Rock surfaces that heave due to blasting shall be compacted with a vibratory roller compactor that imparts a minimum of 40 kips to the rock surface, prior to placing fill. Where the thickness of heaved rock is more than 2 feet, the heaved rock shall be removed and replaced with approved backfill material.

Q. Granular fill shall not be placed directly on rock surfaces containing voids. Suitably sized crushed stone or a geotextile for separation shall be placed on the fractured surface prior to placing the fill to limit migration of smaller particles into the voids.

R. Under utility pipes, manholes, and catch basins, rock shall be cut a minimum of 12 inches beneath the pipe or structure.

S. Laterally, the rock shall be removed at least 1 foot beyond the limits of footings and 3 feet beyond the limits of walls. Rock shall be cut a minimum of 12 inches outside utility structures and a minimum of 18 inches on each side of utility pipes.

T. To reduce overblasting and the potential for heaved rock, drill holes for blasting shall not extend more than 2 feet beneath the minimum depths shown above.

U. Rock blasting, if needed, shall be controlled to reduce vibrations and airblast overpressure to below thresholds established in the contract documents. The peak particle velocity shall be maintained at less than 2 inches per second (ips) for concrete foundations, 1 ips for stone foundations, and 0.5 ips for rubble foundations at the nearest structure.

V. Earth Work Site Contractor shall excavate from within the Building Area/Zone of Influence all unsuitable soils to a depth sufficient to reach the native soils, or to the top of ground improvements as specified herein, within the geotechnical report, and within the contract plans.

W. All excavated materials shall be segregated such that reusable material meeting the gradations provided for above are separated from organics and all other deleterious material.

X. Once the final subgrade has been reached, and upon acceptance by the Architect and Soils Representative, Earth Work Site Contractor shall backfill the excavated area with Structural Fill in the influence zone of building areas and Ordinary Fill in paved areas. Limits of excavation shall be determined in the field based upon observed conditions.

3.04 PROOF COMPACTING

A. Areas requiring excavation shall be excavated to subgrade and then proof compacted as specified in Section 1.2 of this Specification Section.

B. Where soft zones are revealed by compaction efforts and where organic soil is exposed, the soft material or organic soil shall be removed and replaced with Structural Fill in the influence zone of building areas and utility trenches and Ordinary Fill in paved areas.

3.05 REUSE OF ONSITE MATERIALS AND PROCESSING OF ONSITE MATERIALS

A. Based on the borings the buried subsoil, buried organic soil, and swamp deposits contain up to 45 percent fines, the existing fill contains up to 30 percent fines and the natural sand and gravel layer contains up to 35 percent fines. Subgrade support capacities may deteriorate when such soils become wet and/or disturbed. The Earth Work Site Contractor shall keep exposed subgrades properly drained and free of ponded water. Subgrades shall be protected from machine and foot traffic to reduce disturbance. Placed onsite material that become soft and unsuitable to support additional lifts of fill shall be removed and replaced at no additional cost to the Owner. The Earth Work Site Contractor shall not make claims due to difficulty handling the onsite material.

B. Organic soils cannot be reused for backfill except per the landscape architect’s instructions.

C. Should onsite materials be encountered that are suitable for reuse in accordance with the requirements for these specifications, the Owner will receive a credit from the Earth Work Site Contractor for the quantity of reused onsite material. The credit shall be based on the difference in unit rates between imported and onsite material for the particular soil designation. The Earth Work Site Contractor shall provide Unit Rates for these materials in his base bid.

D. Solid waste consisting of brick, concrete, asphalt, cobbles and boulders that measure less than 3 cubic yards in volume shall become the property of the Earth Work Site Contractor and be legally disposed of off-site at no additional cost to the Owner.

E. Excavated onsite soils which are suitable for re-use at the time of excavation but become frozen or too wet for re-use due to poor material handling practices shall be disposed of off-site and replaced at no additional cost to the Owner.

F. The processing of the existing building concrete and brick materials into Ordinary Fill shall be allowed.

G. The Earth Work Site Contractor must inspect all existing stockpiles on site including soil testing for each stockpiled material.

H. The Earth Work Site Contractor must amend the existing stockpiles if testing determines that the stockpiles do not meet the specifications for their intended use. The Earth Work Site Contractor shall provide third party sampling and testing for all soils amended on-site.

I. The Earth Work Site Contractor shall be allowed to mobilize a rock crusher to the site to process cobbles, boulders, blasted rock, and imported rock by blending these materials with the existing fill and natural soil and crushing them to produce a well graded materials, provided that these materials are maintained at suitable moisture contents for proper compaction processed material obtained by crushing blasted rock, boulders, and soil shall meet the gradation requirements of Ordinary Fill and Structural Fill. Material produced by the crushing operation shall be well graded so as to reduce the potential for formation of honeycombs during its placement and compaction.

J. The Earth Work Site Contractor shall protect stockpiled unprocessed materials from exposure to moisture using tarps. The tarps shall be secured so as not to be moved by wind or other action. No claim shall be made, by the Earth Work Site Contractor, due to failure to comply with this requirement.

K. When processing the blasted rock, the Earth Work Site Contractor shall mix the blasted rock with onsite soil free of organic soil to produce a well graded processed material meeting the specification of the material for which it is intended for use.

L. Before blasted rock, cobbles, and boulders that are crushed and processed onsite is reused, they shall be observed and approved by the geotechnical engineer. At the start of the crushing operations, the soil to rock proportions placed into the crusher shall be varied until the processed material meets the appropriate gradation requirements. The soil to rock proportion thus achieved shall be maintained throughout the duration of the project.

M. The material placed into the crusher shall be free of organics, wood, and other deleterious matter.

N. The jaws of the crusher shall be adjusted periodically to maintain the crushing gradation.

O. Excess blasted rock, processed or unprocessed, not used on site shall be the property of the Earth Work Site Contractor and shall be removed offsite at no additional cost to the Owner.

3.06 EXCAVATION, GENERAL

A. The Earth Work Site Contractor shall remain responsible for adequacy and safety of construction means, methods and techniques.

B. The Earth Work Site Contractor shall complete all excavations regardless of the type, nature or condition of the material encountered. The Earth Work Site Contractor shall be solely responsible for making all excavations in a safe manner.

C. The Architect shall be notified of unexpected subsurface conditions. Work shall be discontinued in affected areas until notified in writing to resume work by the Architect. No

claim shall be made, by the Earth Work Site Contractor, due to failure to comply with this requirement.

D. Displaced or loose soil shall be prevented from falling into any excavation. The stability of soil slopes shall be maintained in accordance with applicable local, state and federal regulations and guidelines.

E. All loose material shall be removed from the bottom of the excavation so that the bottom shall be in an undisturbed condition. If removal of the loose material results in excavation beyond the work limits and over excavation has not been approved by the Architect; the restoration of the excavation to grade shall be done at no additional cost to the Owner.

F. When the bottom of the excavation shall, by error of the Earth Work Site Contractor, have been taken to a depth greater than the depth specified, or directed by the Architect, said condition shall be corrected by refilling to the proper grade with approved backfill material or the design shall be altered in a fashion acceptable to the Architect to compensate for said error. All measures taken to rectify conditions caused by over excavation shall have the Architect's approval, and any increase in cost resulting from such measures shall be borne by the Earth Work Site Contractor.

G. Excavation shall not be performed when weather conditions or the conditions of the materials are such that, in the opinion of the Architect, work cannot be performed satisfactorily.

H. Appropriate measures shall be provided to retain excavation sidewalls and to ensure that persons working in or near the excavation are protected. Sheeting shoring or bracing may be used to support the walls of excavations. Method, design, construction and adequacy of any required bracing shall meet the OSHA requirements of 29 CFR Part 1926 and are the responsibility of the Earth Work Site Contractor.

I. All damage related to or caused by the excavation shall be repaired at the expense of the Earth Work Site Contractor.

1. Unclassified Excavation - For the purposes of payment, materials shall be unclassified except for those materials beyond the limits specified in Section item 3.6.I.2 as described in item 3.1-B of these specifications. Excavation shall comprise and include the satisfactory excavation, removal, and disposal of all materials encountered within the lines and grades shown in the Drawings or limits specified herein, whichever is deeper, regardless of the nature of the materials, and shall be understood to include, but not be limited to, earth, topsoil, subsoil, hardpan, fill, foundations, pavements, curbs, piping, railroad track and ties, cobblestones, footings, bricks, concrete, abandoned drainage and utility structures, debris, and materials classified as unsuitable materials. All excavation and replacement, if applicable, with suitable material within the lines and grades shown in the Drawings or the limits specified herein, whichever is deeper, will be considered and bid as unclassified and shall be included in the Earth Work Site Contractor's lump sum (i.e., shall not be paid for using Unit Rates).

2. For bidding purposes, the limits of unclassified excavation (i.e., excavations included as part of the base bid and for which there will be no payment using Contract Unit Rates) to remove the subsoil, existing fill and organic soil within the building, paved areas, and athletic fields shall be as defined in section 3.3 of these specifications. For rock excavations, the limits of unclassified excavation are defined in Section 3.7H. Rock excavation beyond the lines defined in Section 3.7H will be paid using unit prices.

3. All excavation and replacement, if applicable, with suitable material within the lines and grades shown in item 3.6.I.2 shall be considered and bid as unclassified and shall be included in the Earth Work Site Contractor's lump sum (i.e., shall not be paid for using Contract Unit Rates). Excavations beyond these lines described in the item shall be measured and paid for after approval of the measurements by the Architects as Classified Excavation using the Contract Unit Rates for respective classification in accordance with Section 00 43 22 Unit Prices Form included in the contract documents.

J. The Contract Unit Rates shall represent the exact net amount, per unit, to be paid to the Earth Work Site Contractor in the case of increases in the quantities, and the exact amount to be refunded to the Owner in the case of decreases in the quantities. No additional adjustment shall be allowed for overhead, profit, insurance, or other direct or indirect expenses by the Earth Work Site Contractor. Contract Unit Rates of materials shall include hauling, storing, stockpiling, moving, importing, spreading, and compacting. Increases or decreases in the quantities shall be approved by the Owner. Should quantities of certain materials or classes of work be increased or decreased from what is shown in the drawings and specified herein, the Contract Unit Rates listed below (see Section 3.6.M) shall be the basis of payment to the Earth Work Site Contractor, or credit to the Owner, for such increase or decrease in the work. The Contract Unit Rates shall represent the exact net amount, per unit, to be paid to the Earth Work Site Contractor in the case of increases in the quantities, and the exact amount to be refunded to the Owner in the case of decreases in the quantities. No additional adjustment shall be allowed for overhead, profit, insurance, or other direct or indirect expenses by the Earth Work Site Contractor. Contract Unit Rates of materials shall include hauling, storing, stockpiling, moving, importing, spreading, and compacting. Increases or decreases in the quantities shall be approved by the Owner.

1. The Earth Work Site Contractor shall excavate soil and fill to the limits necessary to achieve the required grades determined by the Architect. The limits of excavation may not coincide with those areas indicated on the Drawings. The excavation areas shown on the Drawings are estimated areas only.

K. Provide unit process as follows:

1. For each type of material listed in PART 2 - PRODUCTS, separate unit rates shall be provided for imported material and material processed onsite. The unit rates shall include furnishing/processing, stockpiling, placing, and compacting the material)
2. Provide unit rate for rock excavation in trenches and pits, removed from the site, and any placement of fill required to bring excavated surface to specified subgrade.
3. Provide unit rate for rock excavation as open excavation, removed from the site, and any placement of fill required to bring excavated surface to specified subgrade.

L. Unsuitable Soil Submitted Base Bid Quantity: The Earth Work Site Contractor shall carry in the Base Bid a quantity of XXX cubic yards for excavation and placement/replacement of materials beyond the limits specified item 3.6.I.2. Submitted base bid quantity shall cover removal and disposal of unsuitable soil and furnishing imported suitable backfill materials compacted in place.

1. The Owner will pay the excess excavation and replacement at the Unit Rate submitted in the Bid attachment 00 43 22 Unit Prices Form.
2. Final excavated surfaces shall be surveyed by the Earth Work Site Contractor and shall be measured from specified subgrade to bottom of excavation. Payment shall be based upon actual volumes with no bulking or swell factors applied. Earth Work Site Contractor shall submit all survey data and quantity calculations to Architect for approval.

M. Petroleum Contaminated Soil Submitted Base Bid Quantity: The Earth Work Site Contractor shall carry in the Base Bid a quantity of XXX cubic yards for removal of unanticipated, per Section 00 43 22 Unit Prices Form, petroleum contaminated soil materials. Submitted base bid quantity shall cover removal and disposal of petroleum contaminated soil and furnishing imported suitable backfill materials compacted in place. The submitted base bid shall cover all costs related to such excavation, removal off site, disposal, and replacement with compacted fill of approved material, overhead, and profit. No amount other than that herein specified will be paid by the Owner for the work defined herein.

1. If the total void volume of unanticipated petroleum contaminated material excavation, and its replacement with compacted fill exceeds the amount included in the Contract as listed above, the Owner will pay the excess excavation and replacement at the Unit Rate submitted in the Bid Attachment 00 43 22 Unit Prices Form.

2. If the total quantity of unanticipated petroleum contaminated materials, and its replacement with compacted fill is less than the amount included in the Contract as listed above, the contract sum will be decreased by the difference in excavation and its replacement multiplied by the Unit Rate submitted in the Bid Attachment – Unit Rates Schedule.
3. Final excavated surfaces shall be surveyed by the Earth Work Site Contractor and shall be measured from specified subgrade to bottom of excavation. Payment shall be based upon actual volumes with no bulking or swell factors applied. Earth Work Site Contractor shall submit all survey data and quantity calculations to Architect for approval.

3.07 ROCK EXCAVATION

A. Definitions and Classifications: The following classifications of excavation will be made only when rock excavation is required.

1. "Earth Excavation" consists of removal and disposal of pavement and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on subsurface conditions, and other materials encountered that are not classified as rock excavation.
2. "Rock Excavation" consists of removal and disposal of materials encountered that cannot be excavated without continuous and systematic drilling and blasting or continuous use of a ripper or other special equipment, except such materials that are classed as earth excavation. Typical of materials classified as rock excavation are as follows:
   a. Rock or stone in original ledge.
   b. Hard shale in original ledge.
   c. Boulders on site, outside trench limits, exceeding three cubic yards in volume.
   d. Boulders within trench limits, exceeding one cubic yard in volume.
   e. Rock that is blasted and excavated in large pieces shall not be paid for boulders.
3. Should highly fractured or weathered bedrock be encountered during excavation, the following shall apply:
4. When the material is encountered in trenching operations or under footings, it shall be excavated or ripped with a hydraulic backhoe equal to or larger than Caterpillar 336 excavator and will be classified as Earth Excavation. When it is demonstrated to the Architect and the Soils Representative that this material can no longer be removed with a hydraulic backhoe and requires drilling and blasting, this material shall be classified as Rock Excavation. For excavation procedures when this material is encountered under footings, refer to paragraph below. Boulders larger than 1 cubic yard in trenches, and boulders larger than 3 cubic yards in open excavations shall be paid for as rock.
5. When this material is encountered in open excavation, it shall be classified as earth excavation until drilling and blasting or continuous ripping is necessary as defined hereinabove.
6. Intermittent drilling and ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
7. Submitted Base Bid Quantity for Rock Excavation: The Earth Work Site Contractor shall carry in the Base Bid a quantity of XXX cubic yards for rock encountered in trench excavation removed from the site per Section 00 43 22 Unit Prices Form. The Earth Work Site Contractor shall also carry in the Base Bid a quantity of XXX cubic yards for open rock excavation removed from the site per Section 00 43 22 Unit Prices Form. The submitted Base Bid shall cover all costs relating to such rock excavation, including blasting, removal and placement of the excavated material, overhead and profit. No amount other than that herein specified will be paid by the Owner for excavation herein defined.

8. Quantities shall be measured by the volume of void created using survey points of the excavated area. The fixed Unit Rate shall be applicable to variations in excess of the submitted base bid quantity up to 100 percent of the submitted base bid quantity.

9. If the total quantity of Rock Excavation, open and/or trench, is less than the amount of Rock Excavation included in the Contract as listed above, the Contract sum will be decreased by the difference in Rock Excavation multiplied at the fixed Unit Rate. Quantities shall be measured by the volume of void created using survey points of the excavated area. The fixed Unit Rate shall be applicable to variations of the submitted base bid quantity by decreases of 100 percent of the submitted base bid quantity.

10. Hoe ramming rock shall be paid for as rock excavation and shall not be paid for as time and material (T and M).

B. Measurements:

1. When, during the process of excavation, rock is encountered, such material shall be uncovered and exposed in such a manner that the unbroken ledge surface is clearly visible, and the Architect shall be notified by the Earth Work Site Contractor, before proceeding further. The areas in question shall then be cross-sectioned as hereinafter specified.
2. Failure on the part of the Earth Work Site Contractor to uncover such material and to notify the Architect and proceeding by the Earth Work Site Contractor with the rock excavation before cross-sections are taken, will forfeit the Earth Work Site Contractor's right of claim towards the stated submitted base bid quantity or additional payment over and above the stated submitted base bid quantity at the quoted Unit Rate.
3. The Earth Work Site Contractor shall employ and pay for a Professional Civil Engineer or Land Surveyor registered in the Commonwealth of Massachusetts to take cross-sections of rock before removal and to make computations of volume of rock encountered within the Payment Lines. Cross-sections shall be taken in the presence of the Soils Representative and the computations approved by the Architect. The Owner has the option to perform independent cross-sections and computation of rock quantities.
4. Where removal of boulder or ledge is required outside the established payment lines, the extent of this removal and basis of payment shall be determined by the Architect.

C. If ledge is encountered within the limits of the Proposed Building Area, the Earth Work Site Contractor shall excavate this material 12 inches below subgrade of footings and 18 inches below subgrade of slabs and pavement unless otherwise directed by the Architect or Soils Representative. All loose or shaken rock shall be removed and replaced with compacted gravel fill, crushed stone or lean concrete per the Soils Representative's instructions.

D. Rock excavation for foundations outside of the Building Area: Remove rock to 6 inches below foundation or footing subgrade. All rock bottoms for foundations shall be carefully examined. Loose or shaken rock shall be removed to solid bearing, and the rock surface leveled, or shelved to a slope not exceeding one inch per two feet.

E. Prepared rock subgrades shall be compacted with at least four passes of a self-propelled vibratory roller such as Dyna Pac CA-30D (44,000 lbs. Centrifugal force) or equivalent. Rock subgrades in utility trenches shall be recompacted with at least four passes a walk-behind vibratory drum roller or other equivalent equipment having at least 10,000 pounds centrifugal force and sufficient to provide a firm, stable subgrade.

F. If any part of the rock excavation at footings to be carried beyond the depth and the dimensions indicated on the Drawings or called for in the Specifications, the Earth Work Site Contractor shall, at his own expense, furnish and install concrete of same strength as footings

to the required subgrade level of the footings as shown on the Drawings. Dowelling or other corrective structural measures per the Architect's instructions may also be required to properly anchor or reinforce the concrete. If rock excavation is carried beyond the depth and dimensions to subgrade in other areas, the Earth Work Site Contractor shall, at his own expense, furnish and install compacted gravel fill to subgrade per the Architect's instructions.

G. Basis of Payment: The total amount of rock excavation will be based upon the in-situ volume of rock excavated within and/or above the lines referred to in the next paragraph as "Payment Lines". The payment lines are only to be used as a basis of payment and are not to be used as limits of excavation. Limits of excavation area as shown on the Drawings and as specified herein.

H. Payment Lines for Rock Excavation:

1. Payment lines for columns footings shall be a vertical line 12 inches (laterally) from the edge of the footings. Payment lines for walls shall be a vertical line three feet (laterally) outside the walls or 12 inches (laterally) from the edge of the wall footing, whichever is greater. The depth of rock removal under footings shall be 12 inches below the bottom elevations shown on the Drawings.
2. Payment lines for manholes and catch basins shall be one foot outside of the outer wall and 12 inches beneath the structure.
3. Payment lines for rock excavation under slabs on grade shall be 18 inches below the bottom of the slab. Payment lines for rock excavation at plant beds shall be 12 inches at edge and full depth of required elevation for loam.
4. Payment lines for rock excavation at paved areas and lawns shall be 18 inches below bottom of asphalts.
5. Payment lines for rock excavation under pipes within the building and for utility trenches outside the building lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus two feet for pipes up to 18 inches. For pipes 18 inches and larger payment lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus three feet. Payment lines at bottom of all pipe and utility trenches shall be 12 inches below the bottom of the pipe.

3.08 STORAGE OF SOIL MATERIALS - STOCKPILING

A. The Earth Work Site Contractor shall be responsible for managing and tracking any and all materials excavated and placed in stockpiles for testing.

B. Materials shall be stockpiled on site at locations proposed by the Earth Work Site Contractor and approved by the Architect. Stockpiled materials shall be of sufficient quantities to meet project schedule and requirements.

C. The temporary stockpiled fill must be removed from the Site in accordance with applicable regulatory deadlines however no later than the completion date of this contract or 90 days from the date the stockpile was created, whichever is encountered first.

D. Stockpiles shall be securely barricaded and clearly labeled. Differing materials shall be separated with dividers or stockpiled apart to prevent mixing.

E. The Earth Work Site Contractor shall direct surface water away from stockpile site to prevent erosion or deterioration of materials. Soils shall be suitably dewatered prior to their relocation on Site or disposal off site.

F. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.09 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.10 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   a. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Trenches shall be excavated to the necessary width and depth for proper laying of pipe or other utility and excavation side slopes shall conform to OSHA requirements. Minimum width of trenches shall provide clearance between the sides of the trench and the outside face of the utility. Maximum trench sizes are as shown on the Drawings or as specified herein. The depth of the trench shall be twelve inches below the bottom of the pipe barrel or respective utility. If the existing soil at the final subgrade excavation is found not suitable, the Architect or Soils Representative may approve removal and replacement of material.
   1. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
   2. Clearance: As indicated on plans.
   3. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
   4. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

C. The Earth Work Site Contractor shall provide, at his own expense, suitable bridges over trenches where required for accommodation and safety of the traveling public to satisfy the required permits and codes.

3.11 SUBGRADE INSPECTION, COMPACTION AND PROOF ROLLING

A. Notify Architect when excavations have reached required subgrade.

B. Proof compact all subgrades in accordance with Sections 1.2 and 3.3 of these Specifications and the Geotechnical Report to identify soft pockets and areas of excess yielding. Do not proof compact wet or saturated subgrades.
   1. Completely proof compact subgrade in one direction repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
   2. Revise minimum weight or type of vehicle in first subparagraph below if required.
   3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect and/or Soil Representative, and replace with compacted fill.
   4. Proof compacting shall be completed utilizing a 20-Ton vibratory drum roller for granular soils. Should clay or other cohesive soils be encountered, sheep's foot roller shall be utilized. A total of 6 passes shall be considered complete.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, per the Architect's and/or soil representative's instructions, without additional compensation.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage,
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing and sheeting.

B. If, through failure or neglect of the Earth Work Site Contractor to conduct the excavation work in a proper manner, the surface of the subgrade is in an unsuitable condition for proceeding with construction, the Earth Work Site Contractor shall, at his own expense, remove the unsuitable material and replace it. Failure of the Earth Work Site Contractor to control surface or ground water adequately, premature excavation at the work site, or other manifestations of the Earth Work Site Contractor's neglect or improper conduct of the work, as determined by the Architect, shall be grounds for requiring removal and replacement of unsuitable subgrade without additional compensation.

C. Grading in the vicinity of backfilling shall be properly pitched to prevent water from running into the backfilled area. Work areas shall be kept free from water during performance of the work under this Contract at no expense to the Architect. The Earth Work Site Contractor shall build diversion berms and other devices necessary for this purpose.

D. The Earth Work Site Contractor shall not commence backfilling operations until the Architect gives approval.

E. After the subgrade has been prepared, fill material shall be placed and built-up in successive layers until the required elevations are reached. No fill shall be placed on a frozen surface, nor shall snow, ice, or other frozen material be included in fill. Wet materials containing moisture in excess of the amount necessary for satisfactory placement or compaction shall not be used.

F. All fill shall be brought up in essentially level lifts and shall be placed in levels by standard methods. The method of placement shall not disturb or damage other work. Layers of fill shall not exceed twelve inches of uncompacted thickness before compaction, unless otherwise specified, for proper subgrade stabilization.

G. Place backfill on subgrades free of mud, frost, snow, or ice.

H. Filling operations shall continue until the fill has been brought up to the finished slopes, lines, and grades for thickness of surface treatment.

I. The entire surface of the work shall be maintained free from ruts and in a condition that will permit construction equipment to travel readily over any Section. The top surface of each layer shall be made level or slightly sloped away from the center of the filled area. Fills shall be graded to drain and compacted/sealed whenever precipitation is expected.

J. Backfilling shall not be performed when weather conditions or the conditions of the material are such that, in the opinion of the Architect, work cannot be performed satisfactorily.

3.13 ACCEPTABLE BACKFILL MATERIALS

A. Backfill materials shall be placed in the areas as indicated in the table below:

Fill below footings, including site retaining walls, below slabs, and below the under-slab drainage system within the Building Area	Structural Fill

Fill for under-slab drainage system	3/4-inch Crushed Stone over geotextile fabric
Fill around footings for building and structures within the Influence zone	Structural Fill
Fill below pavement subbase	Ordinary Fill
Fill below sidewalk subbase	Ordinary Fill
Fill placed in top 1 foot below sidewalks, walkways, rubber play areas, exterior stairs, unheated and exterior slabs and pads	Select Fill, i.e., Structural Fill with less than 5 percent fines
Fill within utility trenches below pavement and sidewalk subbase	Ordinary Fill
Fill below utility bedding	Ordinary Fill
Fill placed in landscaped areas outside of the Influence Area of footings, retaining walls, and slopes, and at depths greater than 3 feet in paved areas	Common Borrow
Fill placed around banks of pipes	Sand Fill
Under site retaining walls and hardscape features	Structural Fill

3.14 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Place and compact initial backfill material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

D. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

E. Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Backfill voids with approved backfill material while installing and removing shoring and bracing. Where voids cannot be backfilled with compacted backfill, the voids shall be filled with flowable fill.

G. Backfilling around banks of pipes shall be performed by chinking the Sand Fill with hand shovel and pouring water on the backfill material (Sand Fill) to fill the voids.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.15 BELOW GRADE TANK BACKFILL

A. Backfill with Pea Gravel as specified herein. The use of the proper material is critical to the long-term tank performance.

B. Do not mix approved backfill material with sand or native materials. Do not backfill tank with sand or native materials.

C. Replace all excavated native materials with approved Pea Gravel which meets ASTM C 33 for quality and soundness.

3.16 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 (vertical) to 4 (horizontal) so fill material will bond with existing material.
1. Sequentially place and compact fill material in layers to required elevations.

B. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.17 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by plus or minus 3 percent and is too wet to compact to specified dry unit weight.
   3. If in the opinion of the Architect or Geotechnical Engineer, additional moisture is required, water shall be applied by sprinkler tanks or other uniform distribution devises. If excessive amounts of water or if rain should cause excessive wetness, the area shall be allowed to dry as provided above.

3.18 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross Sections, lines, and elevations indicated. Grading shall be done by standard methods. Areas adjacent to structures and other areas inaccessible to heavy grading equipment shall be graded by manual methods. Embankments shall be graded at all times to ensure runoff of water.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
   3. Provide proper drainage from the site, no grading shall be done to direct water to damage or potentially damage adjacent property or work executed under this contract.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: Plus or minus [1 inch]
   2. Walks: Plus or minus [1 inch]
   3. Pavements: Plus or minus [1/2 inch]

3.19 FIELD QUALITY CONTROL

A. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

B. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed in accordance with Section 1.7 and 1.20 of this Specification Section and:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 500 sq. ft. or less of paved area, but in no case fewer than 3 tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.

C. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.20 COMPACTION REQUIREMENTS

A. The following table lists minimum compactive efforts, which are required for all fill materials. Compaction of each lift shall be completed before placement and compaction of the next lift is started. The compaction equipment shall make an equal number of transverse and longitudinal coverages of each lift. The degree of compaction for fill placed in various areas shall be as follows:

1.	Under concrete slabs and footings	95 percent
2.	In paved areas	
	Within aggregate base course	95 percent
	Within aggregate subbase course	95 percent
	Below subbase course	95 percent
3.	In landscaped areas (To be checked/approved by RLA)	90 percent
4.	Around and Above Utilities below	
	Below Pavement subbase in paved areas	95 percent

*Percentage of maximum dry density of the materials at optimum moisture content as determined by methods or tests for ASTM designation D1551 Method D.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Backfill shall not be placed against walls until they are braced or have cured sufficiently to develop strength necessary to withstand, without damage, pressure from backfilling and compacting operations.

D. Before backfilling against walls, the permanent structures must be completed and sufficiently aged to attain strength required to resist backfill pressures without damage. Temporary bracing will not be permitted except by written permission from the Architect. Correct any damage to the structure caused by backfilling operations at no cost to the Owner.

E. During backfilling, the difference in elevation of backfill on opposite sides of the structure shall not exceed 24 inches, except as noted. Where backfill of wall is only on one side, only hand-operated roller or plate compactors shall be used within a lateral distance of 5 feet of back of wall for walls less than 15 feet high and within 10 feet of back of wall for walls more than 15

feet high. The backfill material shall be compacted with a dynamic vibratory compactor weighing no more than 1000 pounds and imparting a minimum of no more than 8 kips of force to the subgrade.

F. The Earth Work Site Contractor shall compact all fills made during the day of work prior to leaving the project for the evening. The upper layer shall be pitched to provide positive drainage towards swales or interceptor ditches to minimize ponding and erosion should it rain.

3.21 COMPACTION TESTING

A. The Earth Work Site Contractor shall make all necessary excavations and preparations for testing. Excavations for density tests shall be backfilled with material similar to that excavated, and compacted to the specified density by the Earth Work Site Contractor. Failure of the backfill material to achieve the specified density will be just cause for rejection of any or all portions of the excavation Section tested. The Earth Work Site Contractor will not be granted an extension of time or additional compensation for testing or repair of backfill ordered by the Architect.

B. Field density tests will be made by the Owner's Inspection Agency in accordance with the Method of Test for ASTM Designation D1556 or D6938, to determine adequacy of compaction; the location and frequency of such field tests shall be at the Architect's Inspection Agency's discretion.

C. All field density tests results shall be reviewed by the Architect prior to the placement of concrete.

D. The Earth Work Site Contractor shall notify the Inspection Agency when an area is ready for compaction testing. This notification shall be 48 hours in advance of placing or final compaction so that the Architect Inspection Agency has adequate time to take compaction tests.

E. Cooperate with the Architect in obtaining field samples of in-place materials after compaction. Furnish incidental field labor in connection with these tests. The Earth Work Site Contractor shall be informed by the Architect of areas of unsatisfactory density which may require improvements by removal and replacement, or by scarifying, aerating, sprinkling, and recompaction prior to the placement of the new lift. No additional compensation shall be paid for work required to achieve proper compaction.

F. The Owner or Architect's Inspection Agency's presence does not include supervision or direction of the actual work by the Earth Work Site Contractor, his employees, or agents. Neither the presence of the Inspection Agency nor any observations and testing performed by him shall excuse the Earth Work Site Contractor from defects discovered in his work.

3.22 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

1. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

B. Scarify or remove and replace soil material to depth per the Architect's instructions; reshape and recompact.

1. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

2. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Project property.

3.24 REMOVAL OF EROSION CONTROL MEASURES

A. Remove temporary drainage swales, check dams, siltation sumps, hay bales, siltation fencing and other temporary drainage, erosion and siltation control measures when permanent drainage control measures have been installed and grass is established in drainage areas leading to siltation sumps. Earth Work Site Contractor shall excavate and remove all sediments from siltation sumps prior to backfilling the sumps. Remove erosion control measures when approved by the Architect.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Protecting existing vegetation to remain.
   2. Removing existing vegetation.
   3. Clearing and grubbing.
   4. Existing Native Soil-Testing Prior to Disturbance and Removal of the Existing Topsoils.
   5. Removing above- and below-grade site improvements.
   6. Stockpiling of existing site elements.
   7. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
   8. Temporary erosion- and sedimentation-control measures.

B. Related Sections:
   1. Section 01 50 00 "TEMPORARY FACILITIES AND CONTROLS" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
   2. Section 01 56 39 “TEMPORARY TREE AND PLANT PROTECTION” for general protection of existing trees and shrubs.
   3. Section 31 13 00 “SELECTIVE REMOVAL, TRIMMING, AND ROOT PRUNING” for removal and pruning of existing trees and shrubs, including roots.
   4. Section 31 00 00 "EARTH MOVING" for site preparation.
   5. Section 31 25 00 "EROSION AND SEDIMENTATION CONTROLS" for temporary erosion and sedimentation control measures.

1.03 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than two inches (50 millimeters) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings defined by a circle concentric with each tree with a radius one and a half times the diameter of the drip line unless otherwise indicated.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

H. Caliper: Diameter of a trunk measured by a diameter tape at 4'-6" above the ground or DBH (diameter at breast height). (Standard as defined by the ISA – International Society for Arboriculture).

I. Arborist or Certified Arborist: As referenced here in all "arborists" or "certified arborists" shall be at minimum an ISA Certified Arborist or and ASCA Registered Consulting Arborist unless other specified.

1.04 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become General Contractor's property and shall be removed from Project site.

1.05 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed photographs or videotape.
   2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.
   1. Prior to any existing soil being disturbed and removed from the site, soil testing of the existing native soil present on site shall be performed and shared with the Landscape Architecture for review.

1.06 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; buffer pH, soluble salts, and mineral and plant-nutrient content of the soil.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Owner's Representative. A minimum of twelve representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for plant growth.
      a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.07 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
1. Do not proceed with work on adjoining property until required by Owner's Representative.

C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify Dig Safe System for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 PRODUCTS

2.01 EXISTING SOIL TESTING

A. Existing Native Soil shall be tested prior to the disturbance and removal of the existing topsoils from the site.

2.02 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 00 00 "EARTH MOVING".
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
2. Material Test Reports: For sampling and testing of Loam Borrow from Off-Site Sources and reference of On-Site Existing Soils Sources shall be as specified in QUALITY ASSURANCE paragraph of this Section.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
1. Use coating with a VOC content of 420 grams per liter (3.5 pounds per gallon) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag or wrap a one-inch (25-millimeters) blue vinyl tie tape flag around each tree trunk at 54 inches (1372 millimeters) above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Satisfactory Temporary Erosion and Sedimentation Control: Requirements for satisfactory soil material are specified in Section 31 25 00 "EROSION AND SEDIMENTATION CONTROLS."

B. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "TEMPORARY TREE AND PLANT PROTECTION."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner accepted by Owner's Representative.

3.04 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by General Contractor.
   1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.
   2. Owner will arrange to shut off indicated utilities when requested by General Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Owner's Representative not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Owner's Representative's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section Section 31 00 00 "EARTH MOVING" and Section 02 41 00 "DEMOLITION."

3.05 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 millimeters) below exposed subgrade.
   3. Use only hand methods for grubbing within protection zones.
   4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of eight inches (200 millimeters) and compact each layer to a density equal to adjacent original ground.

3.06 EXISTING SOIL TESTING

A. Prior to existing soils being disturbed and removed from the site, twelve samples from different locations across the site shall be packaged and sent to the soil testing laboratory.
B. Existing soil test results shall be shared with the Landscape Architecture for review.

3.07 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that remain exposed.
C. Stockpile all existing site elements and furnishings as indicated on the Drawings. Transport reusable elements to a location indicated by the Owner’s Representative within the project site and neatly stack or arrange in a stockpile for reuse or off-site storage.

3.08 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 13 00
SELECTIVE TREE AND SHRUB REMOVAL, TRIMMING, AND ROOT PRUNING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Pruning existing tree vegetation.
   2. Coordinating and scheduling of pruning inspections.
   3. Inspection of trees by Certified Arborist.

B. Related Sections:
   1. Section 01 50 00 "TEMPORARY FACILITIES AND CONTROLS" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
   2. Section 01 56 39 “TEMPORARY TREE AND PLANT PROTECTION” for general protection of existing trees and shrubs.
   3. Section 31 10 00 "SITE CLEARING" for protecting and removal of vegetation, topsoil stockpiling, management of above and below-grade utilities, and erosion and sedimentation control measures.
   4. Section 31 00 00 "EARTH MOVING" for site preparation.
   5. Section 31 25 00 "EROSION AND SEDIMENTATION CONTROLS" for temporary erosion and sedimentation control measures.

1.03 DEFINITIONS

A. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

B. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings defined by a circle concentric with each tree with a radius one and one half times the diameter of the drip line unless otherwise indicated.

C. Vegetation: Trees, shrubs, groundcovers, grass, and other plants

D. Caliper: Diameter of a trunk measured by a diameter tape at 4’-6” above the ground or DBH (diameter at breast height). (Standard as defined by the ISA – International Society for Arboriculture).

E. Critical Root Zone: Portion of the root system that is the minimum necessary to maintain vitality or stability of the tree. Encroachment or damage to the Critical Root Zone (CRZ) will put the tree at risk of failure. (Standard as defined by the ASCA - American Society of Consulting Arborists). The ISA – International Society for Arboriculture defines the measure of the Critical Root Zone as an area equal to a one-foot radius from the base of the tree’s trunk for each one-inch of the tree’s diameter at 4’-6” above grade or DBH (diameter at breast height).

F. Arborist or Certified Arborist: As referenced here in all “arborists” or “certified arborists” shall be at minimum an ISA Certified Arborist or and ASCA Registered Consulting Arborist unless other specified.

G. Airspading: The use of a compressed air-powered tool, or AirSpade, facilitates excavation, soil management, and tree healthcare within a tree’s critical root zone (CRZ). Unlike mechanical excavation techniques, air-spading efficiently removes or loosens soil without damaging a tree’s delicate root system.

1.04 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain the Owner's property, all removed or pruned materials shall become General Contractor's property and shall be removed from Project site.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning or airspading to be performed.
5. Description of maintenance following pruning.

1.06 INFORMATIONAL SUBMITTALS

A. General Contractor shall provide a written Tree Pruning Schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

B. General Contractor shall provide certification from an arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that those trees were promptly and properly treated and repaired when damaged.

C. General Contractor shall provide maintenance recommendations from an arborist, for care and protection of trees affected by construction during and after completing the Work.

D. General Contractor shall provide documentation of existing trees and plantings indicated to remain, which shall establish preconstruction conditions that might be misconstrued as damage caused by construction activities.

1.07 QUALITY ASSURANCE

A. Tree Pruning Standard: Comply with ANSI A300 Pruning Standards.

B. Arborist Qualifications: An experienced arborist certified by ISA, be licensed in the jurisdiction where Project is located, and be a current member of ASCA, or registered Consulting Arborist as designated by ASCA.

C. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to selective removal and trimming including, but not limited to, the following:
    a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
    b. Enforcing tree protection zones protection.
    c. Arborist's responsibilities.
    d. Field quality control.

1.08 PROJECT CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. No Contractor shall not direct vehicle or equipment exhaust towards protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 PRODUCTS

2.01 MATERIALS

A. Tree Protection Fencing and Signage Materials: Requirements for satisfactory soil material are specified in Section 01 56 39 “TEMPORARY TREE PROTECTION AND PLANT PROTECTION"

PART 3 EXECUTION

3.01 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag or wrap a one-inch (25-millimeters) blue vinyl tie tape flag around each tree trunk at 54 inches (1372 millimeters) above the ground.

C. Protect existing site improvements to remain from damage during construction.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. General: Protect trees and plants remaining on-site according to requirements in Section 31 25 00 "EROSION CONTROL."

B. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

E. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 PROTECTION ZONES

A. General: Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "TEMPORARY TREE AND PLANT PROTECTION".

B. General Contractor shall install protection-zone fencing along edges of protection zones in a manner that will prevent people from easily entering protected area.

C. General Contractor shall install protection-zone signage in visibly prominent locations in a manner approved by the Utility.

D. General Contractor shall repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Utility.

E. General Contractor shall maintain protection-zone fencing and signage in good condition as acceptable to the Utility and remove when construction operations are complete and equipment has been removed from the site.

3.04 EXCAVATION

A. General: Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "TEMPORARY TREE AND PLANT PROTECTION".

B. General Contractor shall backfill holes and depressions with approved site soil or imported topsoil. Compact dampened soil to 85-percent. Water to settle. Add soil and grade to conform continuously to adjacent existing grades.

C. Where utility trenches are required within protection zones, the General Contractor shall hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. General Contractor shall not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities.

D. General Contractor shall not allow exposed roots to dry out before placing permanent backfill.

3.05 FELLING

A. Fell trees to prevent damage to adjacent structures and to those trees and shrubs designated to remain.

B. Remove stumps and roots to a clear depth of 36-inches (0.9 meters) below existing grades in areas of lawn, and to full-depth in areas of paving, building footings, or utility structures.

3.06 PRUNING

A. Pruning shall be performed by a certified arborist. Prune trees over winter, between the months of November and March. Trees may be pruned at other times of the year, provided that the General Contractor submits to the owner for acceptance a scheduled time, and a description of pruning methods and materials.

B. Prune trees according to ANSI A300 Pruning Standards.

C. Where necessary, repairs to damaged wood shall be performed under the direction of the Owner, or a certified arborist.

D. Evergreens shall only be pruned to remove dead, broken or damaged branches.

E. Perform pruning using scissors-style cutting devices, and not anvil-style hand pruners, pole pruners or loppers

3.07 ROOT PRUNING

A. Prune roots that are affected by temporary and permanent construction. Prune roots under the supervision of a Certified Arborist as shown on Drawings and as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Coat cut ends of roots more than 1-1/2-inches (38 millimeters) in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Section 31 00 00 "EARTH MOVING".

B. Root Pruning/Airspade Adjacent to and Outside Protection Zone:

1. Any work, excavation or grading required within the protected root zone areas should be limited and will require the approval of the Owner’s Representative. An ISA Certified Arborist shall be hired at the contractors expense to perform any Airspade root pruning.
2. Work in root zone areas where roots exceed 3/4 inch diameter should be done by Airspade, including grading, landscaping and irrigation installation. An air spade should be used in areas where a trench is required across or through CRZ. Should a trench or similar be required within the CRZ, the ideal distance for excavation and continued tree health would be two foot of distance from trunk of tree for each inch diameter of tree at breast height.

Absolute minimum would be one foot distance from the tree trunk for each inch diameter at breast height.

a. Proof and schedule of any such services (Airspade) provided by an ISA Certified Arborist shall have input from Owner's Representative.
b. Tree removals within a fenced or protected area shall be done in a manner that has no negative effect on remaining trees.

C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

3.08 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches and as follows:
1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
2. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
a. Type of Pruning: Cleaning, Thinning, Raising and Reduction.
b. Specialty Pruning: Restoration.
3. Cut branches with sharp pruning instruments; do not break or chop.
4. Do not apply pruning paint to wounds.

B. Chip removed branches and spread over areas identified by Owner's Representative.

3.09 REGRADING

A. Where the new grade is indicated below existing grade around trees, General Contractor shall slope grade beyond the protection zone. General Contractor shall maintain existing grades within the protection zone.

B. Where the new grade is indicated above existing grades around trees, General Contractor shall slope grade beyond the protection zone. General Contractor shall maintain existing grades within the protection zone.

C. Where the existing grade within the Protection Zone is two inches or less below elevation of finish grade, General Contractor shall fill with topsoil. General Contractor shall place topsoil in a single uncompacted layer and hand grade to required finish grade elevations.

3.10 FIELD QUALITY CONTROL

A. General Contractor shall engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.11 REPAIR AND REPLACEMENT

A. General Contractor shall repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner accepted by the Owner's Representative.
1. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
2. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
3. Perform repairs within 24 hours.
4. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by the Owner's Representative.

END OF SECTION

SECTION 31 21 13
SUB-SLAB VENTILATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
   1. Prepare lowest floor subgrade as shown on Drawings.
   2. Coordinate installation of the sub-slab ventilation system with other under slab utilities, such as sub-slab plumbing.
   3. Coordinate installation of the vertical pipes with Architect.
   4. Install low profile sub-slab ventilation composite, details, vent pipes, and control systems (collectively referred to as "sub-slab ventilation system"), as shown on Drawings.

1.02 ABBREVIATIONS AND ACRONYMS

A. ASTM. ASTM International; www.astm.org.

B. MHD. Massachusetts Highway Department; www.mass.gov/orgs/highway-division

1.03 REFERENCE STANDARDS

A. Editions of listed standards as referenced by applicable codes, or most current edition if not referenced:

B. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

C. MHD - Commonwealth of Massachusetts Highway Department: Standard Specifications for Highways and Bridges.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: A meeting shall be held prior to application of the sub-slab ventilation system and vapor barrier to assure proper substrate preparation, confirm installation conditions, and any additional project specific requirements.

1.05 SUBMITTALS

A. Refer to Section 01 30 00 - Administrative Requirements for submittal procedures.

B. Construction Submittals
   1. Product Data: manufacturer's printed technical data, tested physical and performance properties, instructions for evaluating, preparing, and treating substrates, and manufacturer's specifications for all products to be used with the sub-slab ventilation system.
   2. Shop Drawings: product-specific and project-specific details for overlaps, penetrations, transitions and termination conditions.

C. Sustainability Submittals
   1. The proposed project is intended to be certified as a LEED "Silver" building per the LEED for Schools v4/v4.1 rating system. Sections 01 81 14 - LEED for Schools v4/v4.1 Project Scorecard and 01 81 13 - Sustainable Design Requirements apply to this Section. Additional prerequisite and credit compliance requirement information is available from the USGBC LEED for Schools v4/v4.1 credit library.
   2. The Construction Manager shall provide all documentation indicating applicability of products of this Section to potential LEED credits to the Project LEED Administrator using the 01 81 15 - LEED v4 Product Data - Sustainable Attributes Reporting Form.

D. Closeout Submittals
   1. Submit in accordance with Section 01 70 00 - Execution and Closeout Requirements, and Section 01 78 00 - Closeout Submittals.

2. Project Record Documents: As-built plan of the sub-slab ventilation system, for review by Architect.

1.06 FIELD CONDITIONS

A. It is hereby understood that the Construction Manager has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation at the site.

B. Plans, surveys, measurements, and dimensions under which he work is to be performed are believed to be correct, but the Construction Manager shall have examined them for themselves during the bidding period, as no allowances will be made for any errors or inaccuracies that may be found, except as otherwise provided herein.

PART 2 PRODUCTS

2.01 MATERIALS

A. Vapor Barrier: as specified in Section 03 30 00 - Cast-in-Place Concrete.

B. Sub-Slab Ventilation Pipe:

1. Six inch solid and perforated (as indicated on Drawings) PVC pipe conforming to ASTM D1785, Schedule 40.
2. Only mechanical type couplings are allowed. The use of solvents to weld PVC pipes is not allowed.
3. Auxiliary material products specified by the manufacturer, such as fittings, pipe reducers, and reinforcement tape.
4. Flexible connections shall be used at elbow joints and at penetrations through exterior walls and grade beams.

C. Sub-Slab Ventilation Vertical Riser Pipe:

1. Vertical riser pipe shall consist of six inch diameter solid PVC pipe.
2. Cap: 4-inch stainless steel VacuStack with screen, or approved equal.

D. Crushed Stone: consisting of inert angular material, derived from a stone quarry, that is hard, durable, washed, and free of deleterious materials. Gradation shall conform to MHD Specification Designation M2.01.4, and the following:

U.S. Sieve No.	**Percent Passing by Weight**
1 inch	100
3/4 inch	90-100
1/2 inch	10-50
3/8 inch	0-20
#4	0-5

E. Filter Fabric: Mirafi 140 N, or approved equal.

F. In-Line Ventilation Fan:

1. Ventilation fan shall consist of a low pressure / high flow in-line fan that can induce 50 to 300 cubic feet per minute of air flow between 0 to 2 inches of static pressure water column.
   a. Products: RN4 by Fantech, or approved equal.

G. Roof-top support system.

1. 1-5/8 inch slotted or perforated carbon steel framing and support system, including square tube shapes, bracing members, and piping clamp ring. All framing, bracing, clamp members, and fasteners shall be hot dipped galvanized.
   a. Products: Unistrut systems by Unistrut Service Company, or approved equal.

H. Pressure Treated Wood Sleepers: As specified in 06 20 00 - Finish Carpentry.

PART 3 EXECUTION

3.01 PREPARATION

A. Lay out sub-slab ventilation pipe according to Drawings.

B. Prior to beginning of installation, conduct a pre-installation and coordination meeting with all sub-contractors installing below-grade utilities, including plumbing and electrical sub-contractors.

3.02 INSTALLATION

A. Where sub-slab ventilation pipe or low-profile vent composite crosses over footings or grade beams, a solid pipe sleeve shall be installed to ensure the vapor collection system is continuous. The solid pipe sleeve shall be placed on top of, or through, the subject transition area. Utilize the manufacturer's recommended auxiliary fitting and sealant to connect solid piping to the low-profile venting composite. Consult with engineer of record and structural engineer for appropriate use and placement of solid pipe sleeve.

B. Install vertical riser pipes for ventilation of the sub-slab ventilation system, as indicated on Drawings. Coordinate locations of the vertical riser pipes with all other trades to prevent conflicts. Utilize the manufacturer's recommended auxiliary fittings and sealant to connect riser piping to the sub-slab ventilation piping or low-profile venting composite.

C. Vertical riser piping shall extend not less than 12 inches above a pitched roof or 18 inches above a flat roof, and shall not be located within 10 feet of windows / openings and air in-take units into conditioned spaces of the building.

D. Install roof-top ventilation termination support frames at each roof penetration and vent termination as indicated on Drawings. Provide support fame and pressure treated sleepers. Install roof membrane slip sheets, furnished by SC-ROOF, under pressure treated sleepers.

E. Install in-line ventilation fans as indicated on Drawings. Refer to Electrical Drawings for power supply locations for the vent fans.

F. Label all vertical riser pipes as "Sub-Slab Ventilation System Vent".

G. Prepare and submit an as-built plan of the sub-slab ventilation system.

3.03 CLOSEOUT ACTIVITIES

A. Submit in accordance with Sections 01 70 00 - Execution and Closeout Requirements and 01 78 00 - Closeout Submittals.

B. See Section 01 79 00 - Demonstration and Training, for additional requirements.

C. Demonstrate proper operation of system fans to Owner's designated representative.

D. Training: Train Owner's personnel on operation and maintenance of system fans.

3.04 PROTECTION

A. Protect installed sub-slab ventilation system and vapor barrier during placement of reinforcement steel and overburden.

B. Prior to the placement of concrete, perform a visual inspection of the sheeting to confirm no damage has occurred during the placement of reinforcement steel.

END OF SECTION

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. The Construction Manager will prepare and implement a Stormwater Pollution Prevention Plan (hereinafter called the SWPPP) to prevent storm water, soil erosion, and air pollution due to project construction activities. The SWPPP will implement erosion and sedimentation control prevention and treatment procedures such that stormwater runoff discharged from the site will meet the following general requirements:
    a. The erosion control shown on the plans is a minimum requirement. Additional erosion control measures may be required based on the SWPPP prepared for this project (if applicable), a Conservation Commission Order of Conditions (if applicable), or as changing site conditions warrant. The information shown on the plans is to supplement the developer or Construction Manager's expertise and is not meant to circumvent logical decisions required by a variety of field conditions including weather and the type of equipment available to the Construction Manager.
    b. Best management practices (BMPs) will be used to address storm water pollution prevention in accordance with the Town of Wilmington, MA DEP Stormwater Management Guidelines, and EPA NPDES Regulations.
    c. The SWPPP will be implemented and installed prior to commencement of earthwork activities.
    d. The SWPPP will be kept on-site at all times and review / project inspections will take place as specified therein. Control measures to prevent all erosion, siltation and sedimentation of wetlands, waterways, construction areas, adjacent areas, and off-site areas.
2. Control measures will be accomplished adjacent to or in the following work areas:
    a. Soil stockpiles and on-site storage and staging areas.
    b. Cut and fill slopes and other stripped and graded areas.
    c. Constructed and existing swales and ditches.
    d. Retention ponds.
    e. At edge of wetlands areas, if applicable, as shown on Drawings.
3. The Construction Manager shall implement additional erosion and sedimentation control measures when site inspections identify erosion, sediment transport, or failure of installed controls, to maintain compliance with the Massachusetts Erosion and Sediment Control Guidelines, the approved SWPPP, and all applicable permit requirements. All such measures shall be provided at no additional cost to the Town of Wilmington.
4. Periodic maintenance of all sediment control structures will be provided to ensure intended purpose is accomplished. Sediment control measures will be in working condition at the end of each day.
5. After any significant rainfall, sediment control structures will be inspected for integrity. Any damaged device will be corrected immediately.

B. Alternates: Not Applicable.

C. Items to Be Installed Only: Not Applicable.

D. Items to Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 31 10 00 - Site Clearing for protection of existing trees and other vegetation to remain.
2. Section 31 20 00 - Earth Moving for soil materials, excavating, backfilling, and grading for the building, structures, slabs on grade, walls, foundations, site grading, and removal of site utilities.
3. Provision of waste management: Section 01 74 19, Construction of Waste Management Plan.

1.03 QUALITY ASSURANCE

A. When applicable, comply with the requirements of the Stormwater Pollution Prevention Plan (SWPPP) prepared for the NPDES permit, which are incorporated herein by reference, and all other applicable requirements of governing authorities having jurisdiction. The specifications and drawings are not represented as being comprehensive, but rather convey the intent to provide complete slope protection and erosion control for both the project site and adjacent property.

1. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to a sediment and erosion control plan specific to the site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
2. Regulatory Order of Conditions

B. Erosion control measures will be established at the beginning of construction and maintained during the entire period of construction. On-site areas which are subject to severe erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.

C. All land-disturbing activities are to be planned and conducted to minimize the size of the area to be exposed at any one time, and the length of time of exposure.

D. Surface water runoff originating upgrade of exposed areas should be controlled to reduce erosion and sediment loss during the period of exposure.

E. When the increase in the peak rates and velocity of storm water runoff resulting from a land-disturbing activity is sufficient to cause accelerated erosion of the receiving stream bed, provide measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream.

F. All land-disturbing activities are to be planned and conducted to minimize off-site sedimentation damage.

G. The Construction Manager is responsible for cleaning out and disposing of all sediment once the storage capacity of the sediment facility is reduced by one-half.

H. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

I. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Straw Bales: Wire or nylon bound bales of straw, oriented around sides, rather than over and under.

B. Straw wattles will be made of straw of oats, wheat, barley, rye, or natural straw inside a flexible and durable tubular netting with metal clips or knotted ends and will be utilized to control

sediment runoff during construction activities. The minimum size for the straw wattles is 12-inch diameter. Furnish oak wood stakes 2-inch by 2-inch by 4 feet long or 1/2-inch by 4 feet long rebar with safety caps.

C. Stakes: Stakes for bales will be one of the following materials: Wood stakes of sound hardwood 2 by 2 inches in size or steel reinforcing bars of at least No. 4 size. Lengths will be approximately three feet.

D. Siltation Fence: Fabricated or prefabricated unit consisting of the following filter fabric properties:

1.	Grab Tensile Strength	124	ASTM D4632
2.	Elongation (%)	15	ASTM D4632
3.	Mullen Burst Strength (psi)	280	ASTM D3786
4.	Puncture Strength (lbs)	65	ASTM D4833
5.	Trapezoidal Tear (lbs)	60	ASTM D4833
6.	Flow Rate (gal/min/sf)	8	ASTM D4491
7.	Equivalent Opening Size (US Sieve)	30-80	ASTM D4751
8.	Ultraviolet Radiation Stability (%)	80	ASTM D4355
9.	Permittivity (sec-1)	0.05	ASTM D4491

E. Fencing: Steel posts will be standard 6-foot-long metal stamped drive stakes commonly used to support snow fences. Fencing will be new four-foot height wood lath snow fencing. Provide suitable steel staples or heavy nylon cord for securing filter cloth to support system.

F. Protective Measures: As temporary coverings on ground areas subject to erosion, provide one of the following protective measures, and as directed by the Architect with concurrence of the Town of Wilmington:

1. Hay or straw temporary mulch, 100 pounds per 1,000 square feet
2. Wood fiber cellulose temporary mulch, 35 pounds per 1,000 square feet.
3. Tackafier for anchoring mulch or straw will be a non-petroleum based liquid bonding agent specifically made for anchoring hay or straw.
4. Provide natural (jute, wood excelsior) or man-made (glass fiber) covering with suitable staples or anchors to secure to ground surface. Note that wire stapes and non-biodegradable coverings will not be used for any area that will be mown turf.
5. Temporary vegetative cover for graded areas will be undamaged, air dry threshed straw or hay free of undesirable weed seed.

PART 3 - EXECUTION

3.01 STRAW BALE BARRIERS

A. Excavation will be to the width of the bale and the length of the proposed barrier to a minimum depth of 4 inches.

B. Bales will be placed in a single row, lengthwise on proposed line, with ends of adjacent bales tightly abutting one another. In swales and ditches the barrier will extend to such a length that the bottoms of the end bales are higher in elevation than the top of the lowest middle bale.

C. Staking will be accomplished to securely anchor bales by driving at least two stakes or re-bars through each bale to a minimum depth of 18 inches.

D. The gaps between bales will be filled by wedging straw in the gaps to prevent water from escaping between the bales.

E. The excavated soil will be backfilled against the barrier. Backfill will conform to ground level on the downhill side and will be built up to 4 inches on the uphill side. Loose straw will then be scattered over the area immediately uphill from a straw barrier.

F. Inspection will be frequent, and repair or replacement will be made promptly as needed.

3.02 STABILIZED CONSTRUCTION ENTRANCE AND STONE BERMS

A. Stone size: Use ASTM designation C-33, size No. 2 (1-1/2" to 2-1/2"). Use crushed stone.

B. Length: As effective, but not less than 50 feet.

C. Thickness: Not less than eight inches.

D. Width: Not less than full width of all points on ingress or egress, but not less than 25 feet.

E. Washing: When necessary, wheels will be cleaned to remove sediment prior to entrance onto public right-of-way. When washing is required, it will be done on an area stabilized with crushed stone which drains into an accepted sediment trap or sediment basin. All sediment will be prevented from entering any storm drain, ditch, or watercourse with sandbags, gravel boards or other accepted methods.

F. Maintenance: The entrance will be maintained in a condition which will prevent tracking or flowing of sediment onto public rights-or-way. This may require periodic top dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spoiled, dropped, washed, or tracked onto public rights-of-way will be removed immediately.

G. Place crushed stone berms in locations required and as directed. Berms will have side slopes of 1:3 or less.

H. Inspect stone berms periodically and replace and/or regrade crushed stone when site inspections indicate displacement, sediment accumulation, clogging, or loss of design grade that reduces the effectiveness of the berm.

3.03 SILT FENCING

A. Excavate a six-inch trench along the upstream side of the desired fence location.

B. Drive fence posts a minimum of 1'-6" into the ground. Install fence, well-staked at maximum eight-foot intervals in locations as shown on Drawings. Secure fabric to fence and bury fabric end within the six-inch-deep trench cut.

C. Lay lower 12 inches of silt fence into the trench, six-inches deep and six-inches wide. Backfill trench and compact.

D. Overlap joints in fabric at post to prevent leakage of silt at seam.

3.04 EROSION CONTROL GRASSING

A. Grassing will be applied according to State of Massachusetts Highway Department Standard Specifications.

3.05 INLET PROTECTION

A. Install silt fence or straw bales around inlet as specified

3.06 DUST CONTROL

A. Throughout the construction period the Construction Manager will carry on an active program for the control of fugitive dust within all site construction zones, or areas disturbed due to construction. Control methods will include the following: Apply calcium chloride at a uniform rate of one and one-half pounds per square yard in areas subject to blowing. For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the Construction Manager.

B. The frequency and methods of application for fugitive dust control will be as directed by the Architect with concurrence by the Town of Wilmington.

3.07 TEMPORARY PROTECTIVE COVERINGS (AFTER GROWING SEASON)

A. Place temporary covering for erosion and sedimentation control on all areas that have been graded and left exposed after October 30. Construction Manager will have the choice to use either or both of the methods described herein.

B. Hay or straw will be anchored in-place by one of the following methods and as accepted by the Architect with concurrence by the Town of Wilmington. Mechanical "crimping" with a tractor drawn device specifically devised to cut mulch into top two inches of soil surface or appli-

cation of non-petroleum based liquid tackifier, applied at a rate and in accordance with manufacturer's instructions for specific mulch material utilized.

C. Placement of mesh or blanket matting and anchoring in place will be in accordance with manufacturer's printed instructions.

D. Inspect temporary protective coverings periodically and reset or replace materials when site inspections indicate displacement, deterioration, inadequate anchorage, or exposed soil conditions that compromise their effectiveness in preventing erosion.

END OF SECTION

SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

A. Attention is directed to the Contract and General Conditions and all Sections within Division 01 - General Requirements which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Temporary excavation support and protection systems.

B. Alternates: Not Applicable.

C. Items To Be Installed Only: Not Applicable.

D. Items To Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 31 20 00 - Earth Moving for dewatering system for excavations and soil materials, excavating, backfilling, and grading for the building, structures, slabs on grade, walls, foundations, site grading, and removal of site utilities.
2. Provision of waste management: Section 01 74 19, Construction of Waste Management Plan.

1.03 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Provide professional engineering services needed to assume engineering responsibility, including preparation of Shop Drawings and a comprehensive engineering analysis by a qualified professional engineer registered in the Commonwealth of Massachusetts.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, pavements, and other improvements adjacent to excavation.
4. Provide vibration monitoring to prevent impacts on adjacent structures and utilities.

1.04 SUBMITTALS

A. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer for excavation support and protection systems.

1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: For Installer and professional engineer.

C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems.

1.05 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:
   a. Geotechnical report.
   b. Existing utilities and subsurface conditions.

c. Proposed excavations.
d. Proposed equipment.
e. Monitoring of excavation support and protection system.
f. Working area location and stability.
g. Coordination with waterproofing.
h. Abandonment or removal of excavation support and protection system.

1.06 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
   1. Notify the Town of Wilmington Project Manager no fewer than two days in advance of proposed interruption of utility.
   2. Do not proceed with interruption of utility without the Town of Wilmington Project Manager's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. The Town of Wilmington will not be responsible for interpretations or conclusions drawn from the data.
   1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
   2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
   1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Designer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.
B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
D. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
F. Timber Piling: ASTM D 25, species listed in AWPA C3, pressure-treated in accordance with AWPA C3.
G. Seven Wire Strand: ASTM A 416, Grade 250 or 270., uncoated seven-wire, low-relaxation strand.
H. Grout: Suitable for service, minimum 4,000 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Town of Wilmington Project Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.02 SOLDIER BEAMS AND LAGGING

A. Install steel soldier beams before starting excavation. Space soldier beams at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wales horizontally at spacings indicated on the accepted shop drawings and secure to soldier beams.

3.03 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

3.04 TIEBACKS

A. Tiebacks: Drill for, install, grout, and tension tiebacks into position. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Test loading will be observed by a qualified professional engineer responsible for design of excavation support and protection system.
2. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.
3. Inspect tiebacks periodically to confirm anchors exhibit no movement.

3.05 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary, to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise accepted by Engineer.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.06 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
2. Fill voids immediately with accepted backfill compacted to density specified in Section 31 20 00 Earth Moving, as applicable.

3. Repair or replace, as accepted by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END SECTION

SECTION 31 60 00

GROUND IMPROVEMENTS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. The work consists of improving the existing ground by means of Aggregate Pier soil reinforcement or by means of Rigid Inclusions as specified herein. Aggregate Piers and/or Rigid Inclusions shall be installed below building foundations and slabs, retaining walls, stairs, access ramps, and sidewalk attached/connected to the proposed building.

B. Work shall consist of designing, furnishing, and installing Aggregate Pier and/or Rigid Inclusion ground improvements to the lines and grades designated on the project foundation plan and civil drawings as specified herein.

C. The installation of the ground improvements shall also include the removal and disposal of excavation spoils as a result of the installation process. The excavated material is all assumed to be unsuitable and shall either be wasted or used in accordance with the Earth Moving Specifications. The cost of installation of the ground improvements shall include the cost of hauling, stockpiling and disposal, of the excavated material.

D. The Aggregate Piers and/or Rigid Inclusions shall be in a columnar-type configuration and shall be used for support of building foundations, floor slabs, retaining walls, stairs, access ramps, and sidewalk attached/connected to the proposed building.

1.02 WORK INCLUDED

A. Provision of all equipment, material, labor, and supervision to design, furnish, and install Aggregate Piers and/or Rigid Inclusions for support of building foundations, floor slabs, retaining walls, stairs, access ramps, and sidewalk attached/connected to the proposed building and pre-trenching as described on item 1.1.

B. The Aggregate Pier and/or Rigid Inclusion design and installation shall adhere to all methods and standards described in this Specification.

C. These ground improvements are installed by driving a mandrel and hammer to the design depth, feeding the backfill material through the hollow mandrel, and compacting the backfill in one-foot lifts using the hammer; thus, generating no spoils. If the Aggregate Piers or Rigid Inclusions are installed in augered holes, the testing, if needed, and disposal of the spoils shall be included in the contractor's bid price.

D. The design of the ground improvement shall be verified with a modulus load test.

E. The subsurface conditions at the site included topsoil, asphalt, existing fill, buried organic soil, buried subsoil, and swamp deposits overlying sand and gravel, weathered rock, and rock. Based on the SPT data, the fill and some of the natural sand and gravel were loose to dense.

F. The existing fill contained organic soil and roots and may contain construction debris and other obstructions that need to be pre-trenched. The pre-trenching, if required, shall be performed by the Site Contractor. The cost of pre-trenching, including groundwater control during pre-trenching, shall be part of the ground improvements and no additional cost shall be paid to the Contractor for performing pre-trenching. After the obstructions are removed, the excavated material free of

obstructions shall be placed back and compacted to match the existing fill density. Material that becomes too wet during the pre-trenching operations shall not be placed back until it dries, or shall be replaced with dry material.

G. The ground improvement contractor shall monitor vibration through installation of seismographs at the nearby buildings during installation of Aggregate Piers and/or Rigid Inclusions.

1.03 APPROVED INSTALLERS

A. The Aggregate Pier and/or Rigid Inclusion installer (the Installer) shall be approved by the Engineer. Prior to approval, Installers and their Designers are required to submit to the Owner a qualification statement to demonstrate 5 years of experience on at least 10 projects of a similar scope and nature. Additionally, prior to approval, Installers and their Designers are required to submit to the Owner a preliminary design document. Without exception, no alternate installer will be accepted unless approved by the Owner.

B. Installers of Aggregate Pier and/or Rigid Inclusion foundation systems shall have a minimum of 5 years of experience with the installation of Aggregate Pier systems and shall have completed at least 10 projects in New England.

C. Local installer of Aggregate Piers and/or Rigid Inclusions include:

1. Vibro Stone Columns (VSC) (Aggregate Piers)) or Controlled Modulus Column (CMC) (Rigid Inclusions) by Menard (Phone: (781) 281-0371 or (908) 603-8224).

2. Vibro Piers (VP) (Aggregate Piers) or Vibro Concrete Columns (VCC) (Rigid Inclusions) by Hayward Baker/Keller (Phone: (401) 334-2565).

3. Aggregate Piers (AP) (Aggregate Piers) or GeoConcrete Columns (GCC) (Rigid Inclusion) by Geopier (Phone: 860-531-9137). The Local installer for Geopier Is HDI – (781) 848-2110.

4. Vibro Stone Columns (VSC) (Aggregate Piers) Subsurface Constructors (Phone: (866) 421-2460).

5. Aggregate Piers by H. B. Fleming (207) 799-8514.

1.04 REFERENCE STANDARDS

A. Design

1. “Ground Modification Methods Reference Manual – Volume I,” U.S. Department of Transportation, Federal Highway Administration, FHWA-NHI-16-027, FHWA GEC 013, April 2017.

2. “Control of Settlement and Uplift of Structures Using Short Aggregate Piers,” by Evert C. Lawton (Assoc. Prof., Dept. of Civil Eng., Univ. of Utah), Nathaniel S. Fox (President, Geopier Foundation Co., Inc.), and Richard L. Handy (Distinguished Prof. Emeritus, Iowa State Univ., Dept. of Civil Eng.), reprinted from *IN-SITU DEEP SOIL IMPROVEMENT, Proceedings of sessions sponsored by the Geotechnical Engineering Division/ASCE in conjunction with the ASCE National Convention held October 9-13, 1994, Atlanta, Georgia*.

3. “Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers,” by Evert C. Lawton and Nathaniel S. Fox. *Geotechnical Special*

Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments, ASCE, 2, 962-974.

4. "Behavior of Geopier®-Supported Foundation Systems during Seismic Events," by Kord Wissmann, Evert C. Lawton, and Tom Farrell. Geopier Foundation Company, Inc. Blacksburg, VA ©1999.

5. "The design of vibro replacement." H.J. Priebe. *Ground Engineering*, London. Dec 1995.

B. Modulus Testing

1. ASTM D 1143 - Pile Load Test Procedures
2. ASTM D 1194 - Spread Footing Load Test

C. Materials and Inspection

1. ASTM D 1241 - Aggregate Quality
2. ASTM D 422 - Gradation of Soils
3. ASTM C39/C39M-12a Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C-150-05 – Standard Specification for Portland Cement
5. ASTM D1557 – Moisture Density Relationship for Soils

D. Where specifications and reference documents conflict, the Owner shall make the final determination of the applicable document.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. DIVISION 02 – Existing Condition
2. DIVISION 03 – Concrete
3. DIVISION 31 – Earthwork
4. DIVISION 33 - Utilities

1.05 DEFINITIONS

1. Aggregate Piers: VSC, VP, or AP.

2. Rigid Inclusions: CMC, VCC, or GCC.

3. Test Element: Aggregate Pier and/or Rigid Inclusion element installed at as non-production element for the purpose of performing a modulus test. Test elements shall be installed prior to the start of production elements at a location representative of the subsurface conditions and loading. Where different subsurface conditions are encountered that warrant different types of improvements, a modulus test shall be performed for each type of improvement.

1.06 SUBSURFACE INFORMATION

A. Subsurface explorations have been performed at the site by the Geotechnical Engineer. The results of the explorations are included in the geotechnical report titled "Geotechnical Report, Proposed Wildwood Early Childhood Center, North Intermediate School – 320 Salem Street Site,

Wilmington, Massachusetts," prepared by Lahlaf Geotechnical Consulting, Inc. (LGCI) 100 Chelmsford Road, Suite 2, Billerica, MA 01862, dated January 14, 2026.

B. The subsurface explorations and geotechnical report were performed primarily for use in preparing the foundation design and are included for the convenience of the contractor. Use and interpretation of these data for purposes of the work shall be the responsibility of the Installer. Subsurface conditions and groundwater levels are not considered as accurate for any times or locations other than the specific time and location of each of the explorations.

C. The Owner assumes no responsibility for the Installer's failure to make his own site investigation and makes no representation other than the soils reports regarding the character of the soil or subsurface conditions which may be encountered during the performance of the work. The Installer shall refer to the Geotechnical Report. Failure by the Installer to be aware of existing site conditions shall not be cause for additional cost to the Owner.

D. Use and interpretation of these data for purposes of the work shall be the responsibility of the Installer. Subsurface conditions and groundwater levels are not considered as accurate for any times or locations other than the specific time and location of each of the explorations.

E. The Installer may, at his own expense, conduct additional subsurface testing for his own information after approval by the Owner.

F. No claim for extra cost or extension of time resulting from reliance by the Installer on information presented herein shall be allowed, except as provided in the Contract.

1.07 CERTIFICATIONS AND SUBMITTALS

A. Shop drawings that include spacing, diameter, length, installation procedure and sequence of construction with sufficient details, planned cut off and tip elevations, material, proposed equipment, aggregate gradation, and mix design. The design shall conform to the criteria in Subsection G.

B. Design Calculations - The Installer shall submit detailed design calculations and construction drawings prepared by the ground improvement designer (the Designer) for review and approval by the Owner in accordance with Section 3.2 of these specifications. All plans shall be sealed by a Professional Engineer in the State of Massachusetts.

C. Professional Liability Insurance - The Designer and Installer shall have Errors and Omissions design insurance for the work. The insurance policy should provide a minimum coverage of $3 million per occurrence.

D. Modulus/Load Test Reports – A modulus test/load test is performed on a non-production Aggregate Pier/Rigid Inclusion element to verify the design assumptions. The Installer shall furnish the Owner a description of the installation equipment, installation records, complete test data, analysis of the test data, and verification of the design parameter values based on the modulus test results. Test elements shall be installed prior to the start of production elements at a location representative of the subsurface conditions and loading. The report shall be prepared under direction of a Registered Professional Engineer in the State of Massachusetts.

E. Daily Aggregate Pier and Rigid Inclusion Progress Reports – The Installer shall furnish a complete and accurate record of Aggregate Pier and Rigid Inclusion installation to the Owner. The record shall indicate the Aggregate Pier/Rigid Inclusion location, length, volume of aggregate/concrete used or number of lifts, densification forces during installation of the aggregate, and final elevations or depths of the base and top of Aggregate Piers/Rigid Inclusions. The record shall also indicate the type and size of the installation equipment used, and the type of aggregate used. The Installer shall immediately report any unusual conditions encountered during installation to the Designer and to the Owner.

F. Submit calibration records for the load cells, the hydraulic jacks, the pumps, and the pressure gauges At least two weeks before performing the modulus and load tests.

G. The Ground Improvement is a contractor design. The contractor is fully responsible for the adequacy of the design and the performance of the system.

H. If required, the Installer/Designer shall include in its submittal an instrumentation plan as they own the design of the ground improvements and the performance of the proposed footings and slabs.

PART 2 - PRODUCTS

2.01 AGGREGATE

A. Aggregate used by the Installer for Aggregate Pier construction shall be pre-approved by the Designer and Owner and shall demonstrate suitable performance during modulus testing. Typical aggregate consists of Type 1 Grade B in accordance with ASTM D-1241-68, No. 57 stone, or other graded aggregate approved by the Designer.

B. Potable water or other suitable source shall be used to increase aggregate moisture content where required. The Owner shall provide such water to the Installer.

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2.02 PORTLAND CEMENT

A. Type I or Type II.

2.03 GROUT MIX

A. Minimum Compressive Strength:
- 4,000 psi at 28 days.
- 2,000 psi at 7 days.

2.04 CONCRETE

A. Minimum Compressive Strength:
- 4,000 psi at 28 days.
- 2,000 psi at 7 days.

PART 3 - EXECUTION

3.01 AGGREGATE PIER DESIGN AND RIGID INCLUSION DESGN

A. The design of the Aggregate Piers or Rigid Inclusions shall be based on the following:
1. A maximum allowable bearing pressure of 4,000 psf;
2. An allowable total settlement of 1 inch or less and an allowable differential settlement of 3/4 inch or less over a distance of 25 feet under static loads for footings;
3. A maximum of 0.5 inch settlement under slabs.

B. A load transfer platform (LTP) shall be installed on top of the Aggregate Piers and/or Rigid Inclusions, under the footings and slabs, stairs, access ramps, and sidewalk attached/connected to the proposed building, in accordance with the requirements of the specialty contractor designing the Aggregate Piers and/or Rigid Inclusions.

C. The Aggregate Piers and/or Rigid Inclusions shall be designed in accordance with generally accepted engineering practice. The design life of the structure shall be a minimum of 50 years.

D. The Aggregate Pier and Rigid Inclusion elements shall be designed using an Aggregate Pier or Rigid Inclusion stiffness modulus to be verified by the results of the modulus test/load test described in Section 3.7 of these specifications.

E. The specialty contractor shall be prepared to grout the Aggregate Piers if the modulus test reveals that the tested Aggregate Pier bulged during the modulus test.

F. The Aggregate Piers and/or Rigid Inclusions shall be designed for the full bearing capacity of footings regardless of what the actual footing loads are.

3.02 DESIGN SUBMITTAL

The Installer shall submit detailed design calculations, construction drawings, and shop drawings (the Design Submittal), for approval at least two week(s) prior to the beginning of construction. The installation shall not begin until final approval of all design and construction submittals. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. Additionally, the quality control test program for the Aggregate Piers and/or Rigid Inclusions, meeting these design requirements, shall be submitted. All computer-generated calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the State of Massachusetts.

A. The following shall be included in the design calculation submittal:

1. A written summary report that describes the overall ground improvement design.

2. Applicable code requirements and design references.

3. Design criteria including, soil shear strengths including friction angle and cohesion, unit weights, Aggregate Pier/Rigid Inclusion hole diameter, Aggregate Pier/Rigid Inclusion spacing, Aggregate Pier/Rigid Inclusion unit weight and friction angle/concrete compressive strength, composite shear strength parameters, and any other design assumptions.

4. A Structural Fill Footing Pad (or “Load Transfer Platform”) shall be required below all footings to transfer loads to the ground improvement elements. The system shall be designed to limit penetration (punching) of ground improvement elements into the Footing Pad.

5. Design calculation sheets with project number, foundation location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. An index page with the design calculations shall be provided.

6. Design notes including an explanation of any symbols and computer programs used in the design.

7. Detailed subgrade preparation notes and requirements.

8. A complete list of the equipment proposed for use, including a description of the characteristics of each piece of equipment.

9. Detailed description of the methods and equipment proposed for loading of the test element during the modulus test and load test. Any deviation from Section 3.7, of this specification shall be specifically noted with explanation for the requested deviation. Without exception, no deviations will be accepted unless approved by the Owner.

10. Calibration sheets less than 6 months old shall be submitted for dial gages and loading jacks.

B. Working Drawings. Utility locations, right of way, and other applicable information are available on the plans. Working drawings shall include, but not be limited to the following items:

1. A plan view of the Aggregate Pier/Rigid Inclusion ground improvement for identifying:

   a. Right of way, permanent or temporary construction easement limits, location of all known active or abandoned existing utilities, adjacent structures, or other potential interferences. Any drainage structure or drainage pipe centerline behind, passing through, or passing under the structure.

   b. Limits of the Aggregate Pier/Rigid Inclusion ground improvement and layout of the numbered individual Aggregate Piers/Rigid Inclusions.

   c. A schedule showing pier number, pier length, pier diameter, top and bottom design elevations.

2. Subsurface exploration locations shown on a plan view of the proposed structure alignment with appropriate reference base lines to fix the locations of the explorations relative to the structure.

3. Elevation view showing Aggregate Pier/Rigid Inclusion locations, elevations and depth of improvement; location of drainage elements and expansion/contraction joints when applicable.

3.03 APPROVED INSTALLATION PROCEDURES

A. The following sections provide general criteria for the construction of the Aggregate Piers and Rigid Inclusions. Unless otherwise approved by the Designer, the installation method used for Aggregate Pier or Rigid Inclusion construction shall be that as used in the construction of the successful modulus test.

B. Aggregate Piers installed using Rammed Aggregate Pier systems

1. Aggregate Pier (AP) systems shall be constructed by advancing a specially designed mandrel with a minimum 15-ton static force augmented by dynamic vertical ramming energy to the full design depth. The hollow-shaft mandrel, filled with aggregate, is incrementally raised, permitting the aggregate to be released into the shaft, and then lowered by vertically advancing and/or ramming to densify the aggregate and force it laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated to the top of pier elevation. The cycle distance shall be determined by the Designer. The mandrel shall be raised at a rate determined from the demonstration pier testing or no faster than 1 foot in 5 seconds. The crowd pressure shall be recorded to provide a measure of the vertical densification force as the mandrel is driven on its compaction stroke.

2. At AP element locations, water or compressed air shall be used if necessary, as determined from the flow test, to enhance free flow of aggregate through the mandrel as determined during the performance of a flow test. Water or air flow shall be discontinued when the mandrel reaches the 3-foot raise height.

3. At the completion of the pier installation, the hammer shall be turned off and the mandrel pushed downward applying full crowd pressure on the top of the pier to provide preloading.

4. At completion of the pier installation, the remaining stone in the mandrel may be emptied outside the pier location to allow for a measure of the remaining volume of aggregate.

5. Special high-energy impact densification apparatus shall be employed to densify the AP elements during installation. The apparatus shall apply direct vertical impact energy to each constructed lift of aggregate.

6. Densification shall be performed using a chained mandrel.

7. Downward crowd pressure shall be constantly applied to the mandrel shaft.

8. The Installer shall provide a full-time Quality Control Representative on-site during the installation process.

C. Aggregate Piers Installed using Vibrator

1. If a vibrator is used to construct the Aggregate Piers, the Installer shall use an electric down-hole vibrator capable of providing at least 80 HP of rated energy and a centrifugal force of 15 tons. The vibrator diameter must be at least 60 percent of the Aggregate Pier design diameter. An appropriate metering device should be provided at such a location that inspection of amperage increase may be verified during the operation of the equipment. The metering device may be an ammeter directly indicating the performance of the vibrator. The vibrator shall be a minimum of 16 inches in diameter. Complete equipment specifications should be submitted to the Engineer prior to commencement of the fieldwork.

2. The probe and follower tubes shall be of sufficient length to reach the elevations shown on the Installer's approved construction drawings. The probe, used in combination with the available pressure to the tip jet, shall be capable of penetration to the required tip elevation.

3. The probe shall penetrate into the foundation soil layer to the minimum depths required in the Installer's construction plans. After penetration to the required depth, the probe shall not be withdrawn more than 2 feet at any time unless the stone stops flowing to the bottom of the probe.

4. Redriving the probe into the treated depth shall be attempted at approximately 12 to 18-inch intervals to observe resistance to penetration and amperage build-up. During redriving, the probe tip shall penetrate to within 1 foot of the previous redriving depth.

5. Amperage build-up and backfill quantities will be contingent upon the type of probe used and procedures. Prior to commencement of work, the contractor shall discuss the equipment capabilities with the Owner to determine if trial probes will be necessary.

6. The Installer shall provide a full-time Quality Control Representative on-site during the installation process.

D. Aggregate Piers installed by other methods may be considered by the Owner upon review and approval by the Owner.

E. Rigid Inclusions

1. Install the Rigid Inclusions in accordance with the sequence detailed in the approved work plan. If adjacent Rigid Inclusions are observed to be influenced by the installation of a neighboring Rigid Inclusion, the installation sequence shall be modified to prevent disturbance of Rigid Inclusions. Modifications to the sequence, or replacement of Rigid Inclusions deemed unusable due to disturbance, shall be completed by the Contractor at no additional cost to the Owner.

2. Cutoff the Rigid Inclusions to the top elevation of the first layer of the load transfer pad, or slightly higher to allow any required trimming or removal of low strength material at the butt of the Rigid Inclusion. The cut-off elevation of each Rigid Inclusion shall be within +/- 0.1 feet. The cut-off shall be made before the concrete sets.

3. Protect the concrete at the top of Rigid Inclusions from mixing with surrounding soil.

3.04 PLAN LOCATION AND ELEVATION OF AGGREGATE PIERS AND/OR RIGID INCLUSIONS

A. The as-built center of each Aggregate Pier and/or Rigid Inclusion shall be within 6 inches of the locations indicated on the plans. Aggregate Piers and/or Rigid Inclusion installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

3.05 REJECTED AGGREGATE PIERS AND/OR RIGID INCLUSIONS

A. Aggregate Pier and/or Rigid Inclusion elements installed beyond the maximum allowable tolerances shall be abandoned and replaced with new Aggregate Piers/Rigid Inclusions unless the Designer approves the condition or provides other remedial measures. All material and labor required to replace rejected piers shall be provided at no additional cost to the Owner, unless the cause of rejection is due to an obstruction or mislocation.

3.06 LAYOUT

A. The Contractor shall provide layout (construction staking) of the ground improvement elements. The Contractor shall provide ground elevations in sufficient detail to estimate drilling depth elevations to within two-inches.

3.07 QUALITY CONTROL REPRESENTATIVE

A. The Installer shall have a full-time, on-site Quality Control Representative to verify and report all installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Designer and to the Owner. The quality control procedures shall include the preparation of Aggregate Pier and/or the Rigid Inclusion Progress Reports completed during each day of installation containing the following information:

1. Footing and Aggregate Pier and/or Rigid Inclusion location.
2. Pre-auger diameter and soil conditions encountered during drilling (if required).
3. Aggregate Pier and/or Rigid Inclusion length.
4. Planned and actual Aggregate Pier and/or Rigid Inclusion elevations at the top and bottom of the Aggregate Pier and/or Rigid Inclusion.
5. Average lift thickness of each Aggregate Pier and/or Rigid Inclusion.
6. Volume of aggregate used in each Aggregate Pier.
7. Volume of concrete used in each Rigid Inclusion
8. Documentation of any unusual conditions encountered.
9. Type and size of densification equipment used.
10. Compressive strength of concrete used for Rigid Inclusions,

3.08 AGGREGATE PIER MODULUS TEST AND/OR RIGID INCLUSION LOAD TEST

A. A minimum of one (1) Modulus/Load Test is required for this project. When authorized, an Aggregate Pier modulus test or Rigid Inclusion load test(s) shall be performed at locations agreed upon by the Designer and the Owner to verify or modify Aggregate Pier or Rigid Inclusions designs. Modulus Test Procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194, as outlined in the ground improvement design submittal. Aggregate Piers and/or Rigid Inclusions shall be tested to 150 percent of the maximum design stress as shown in the ground improvement design submittal. The modulus tests shall be of the type and installed in a manner specified herein.

B. A telltale shall be installed at the bottom of the test pier so that bottom-of-pier deflections may be determined. Acceptable performance is indicated when the bottom of the pier deflection is no more than 30 percent of the top of pier deflection at the design stress level, the total settlement is less than the design settlement, and the residual movement, i.e., movement after the unloading, is less than 0.5 inch.

C. ASTM D-1143 general test procedures shall be used as a guide to establishing load increments, load increment duration, and load decrements. As a minimum, the following loading increments, decrements and duration shall be used.

Increment	Approximate Load (percent design)	Minimum Duration (min)	Maximum Duration (min)
Seat	< 9	0	N/A
1	17	15	60
2	33	15	60
3	50	15	60
4	67	15	60
5	83	15	60
6	100	15	60
7	117	60	120
8	133	15	60
9	150	15	60
10	100	N/A	N/A
11	66	N/A	N/A
12	33	N/A	N/A
13	0	N/A	N/A

D. With the exception of the load increment representing approximately 117 percent of the design maximum top of ground improvement stress, all load increments shall be held for a minimum of 15 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for a maximum of 1 hour, whichever is occurs first.

E. The load increment that represents approximately 117 percent of the design maximum stress on the ground improvement shall be held for a minimum of 60 minutes. The load is then maintained until the rate of deflection reduces to 0.01 inch per hour or for a maximum of 4 hours, whichever is occurs first.

F. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.

G. At least one Rigid Inclusion load test shall be performed in accordance with ASTM D 1143 to maximum load test of 200 percent of the sign load at 25 percent of the design load increments, when applicable.

H. The location of the Aggregate Pier modulus test and the Rigid Inclusion load test shall be approved by the geotechnical engineer

I. Submit as-built plans showing layout, location and numbers of installed Aggregate Piers and/or Rigid Inclusions.

3.09 BOTTOM STABILIZATION TESTING (BSTS) / CROWD STABILIZATION TESTING (CSTs)

A. Bottom stabilization testing (BSTs) or Crowd stabilization testing (CSTs) shall be performed during the installation of the modulus/load test pier and be observed by the Quality Control Representative and the Owner's geotechnical engineer. The tests are performed by applying downward vertical energy to the tamper, mandrel or probe following lift construction and monitoring the amount of additional deflection from the applied energy. Additional testing by the Designer (typically 10 percent of the production Aggregate Piers and/or Rigid Inclusions) shall be performed on selected production Aggregate Pier and/or Rigid Inclusion elements to compare results with the modulus /load test pier.

3.10 QUALITY ASSURANCE

A. The Owner will retain the geotechnical engineer to provide full-time monitoring of Aggregate Pier and/or Rigid Inclusion construction activities, including observing the Aggregate Pier modulus test and/or the Rigid Inclusion load test.

3.11 SITE PREPARATION AND PROTECTION

A. The Site Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the Aggregate Piers and Rigid Inclusions.

B. Site grades for Aggregate Pier and/or Rigid Inclusion installation shall be a minimum of 2 feet below the finished grade elevation to minimize Aggregate Pier and/or Rigid Inclusion installation depths. Ground elevations and bottom of footing elevations shall be provided to the Aggregate Pier and/or Rigid Inclusion Installer in sufficient detail to estimate installation depth elevations to within 3 inches.

C. The Site Contractor will provide site access to the Installer, after earthwork in the area has been completed. A working surface shall be established and maintained by the Site Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the Aggregate Pier and/or Rigid Inclusion installation.

D. Prior to, during and following Aggregate Pier and/or Rigid Inclusion installation, the Site Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.

E. If spoils are generated by Aggregate Pier and/or Rigid Inclusion installation, spoil removal from the Aggregate Pier and/or Rigid Inclusion work area in a timely manner to reduce the potential for interruption of Aggregate Pier and/or Rigid Inclusion installation is required.

F. The installer shall coordinate with Site Contractor the installation of support of excavation (SOE) system if required. The purpose of this coordination is to plan the workflow and avoid down time during construction.

G. The Site Contractor will monitor vibration through installation of seismographs at the nearby building during installation of Aggregate Piers and/or Rigid Inclusions.

H. The Site Contractor shall perform test pits within the footprint of the proposed building to explore for the presence obstructions and remove them.

3.12 AGGREGATE AND/OR RIGID INCLUSION LAYOUT

A. The location of Aggregate Pier and/or Rigid Inclusion supported foundations and slabs for this project, including layout of individual Aggregate Pier and/or Rigid Inclusion shall be marked in the field using survey stakes or similar means at locations shown on the drawings.

3.13 EXCAVATIONS FOR OBSTRUCTIONS

A. The existing fill may contain below-ground structures and/or obstructions that need to be pre-trenched. Should any obstruction be encountered during Aggregate Pier and/or Rigid Inclusion installation, the Site contractor shall be responsible for promptly removing such obstruction, or the Aggregate Pier and/or Rigid Inclusion shall be relocated or abandoned. Obstructions include, but are not limited to, abandoned utilities, existing and abandoned foundations or concrete structures, asphalt, demolition debris, cobbles, boulders, wood, metals, and other below-ground structures, and underground tanks, which shall prevent placing the piers to the required depth or shall cause the pier to drift from the required location.

B. Dense natural rock or weathered rock layers shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials. Dense rock or weathered rock may be anticipated within the proposed depths of the Aggregate Piers and/or Rigid Inclusions.

3.14 UTILITY EXCAVATIONS

A. The Site Contractor shall coordinate all excavations made prior and subsequent to Aggregate Pier and/or Rigid Inclusion installations so that excavations do not encroach on the Aggregate Piers and/or Rigid Inclusions as shown in the Aggregate Pier and/or Rigid Inclusion construction drawings.

B. Protection of completed Aggregate Piers and/or Rigid Inclusions is the responsibility of the Site Contractor. If utility excavations are required in close proximity to the installed Aggregate Piers and/or Rigid Inclusions, the Site Contractor shall contact the Aggregate Pier and/or Rigid Inclusion Designer immediately to develop construction solutions to minimize impacts on the installed Aggregate Pier and/or Rigid Inclusion elements.

C. The Site Contractor will repair damaged Aggregate Piers and/or Rigid Inclusions in accordance with procedure included in specialty contractor's submittal.

3.15 FOOTING BOTTOMS

A. Excavation and surface compaction of all improved subgrades shall be the responsibility of the Site Contractor.

B. Foundation excavations to expose the tops of Aggregate Piers and/or Rigid Inclusions shall be performed with a smooth edge bucket in a workman-like manner, and shall be protected, until the LTP is built on top of the Aggregate Piers and/or Rigid Inclusions, with procedures and equipment best suited to (1) avoid exposure to water, (2) prevent softening of the matrix soil between and around the Aggregate Piers and/or Rigid Inclusions before building the LTP, and (3) achieve direct and firm contact between the dense, undisturbed Aggregate Piers/Rigid Inclusions and the LTP.

C. The proposed footings shall be supported on a minimum of 12 inches of Structural Fill or 3/4-inch crushed stone wrapped in a filter fabric placed directly over Aggregate Piers and/or Rigid Inclusions. The Structural Fill or crushed stone layer shall be thicker if required for the LTP installed in accordance with the requirements of the specialty contractor.

D. All excavations for footing bottoms supported by Aggregate Pier and/or Rigid Inclusion improved subgrades shall be prepared in the following manner by the Site Contractor. Recommended procedures for achieving these goals are to:

1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment).
2. Compaction of surface soil and top of Aggregate Piers and/or Rigid Inclusions shall be prepared using a large vibratory plate compactor. Motorized impact compactors ("Wacker Packer," "Jumping Jack," or similar) shall only be used in cohesive soils and when approved by the Designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the Aggregate Pier and/or Rigid Inclusion shall be recompacted prior to completing footing bottom preparation.
3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation. A lean concrete mud-mat may be used to accomplish this. Other methods must be pre-approved by the Designer.
4. The Aggregate Piers and/or Rigid Inclusions shall be visible before placing Structural Fill or crushed stone over the top of the Aggregate Piers and/or Rigid Inclusions. Such Structural Fill or crushed stone shall not be placed until the geotechnical engineer has observed the subgrade.

E. The following criteria shall apply, and a written inspection report sealed by the Engineer shall be furnished to the Installer to confirm:

1. That water has not been allowed to pond over the Aggregate Pier and/or Rigid Inclusion subgrade at any time. This statement shall be provided by the Site Contractor.
2. That all Aggregate Piers and/or Rigid Inclusions designed for each structure have been exposed in the footing excavation or prior to fill placement.
3. That immediately before footing construction or fill placement, the tops of Aggregate Piers and/or Rigid Inclusions have been inspected and the top of the Aggregate Piers recompacted with mechanical compaction equipment.
4. That no excavations have been made after installation of Aggregate Pier and/or Rigid Inclusion elements within the excavation limits described in the Aggregate Pier and/or Rigid Inclusion construction drawings, without the written approval of the Installer or Designer.

3.16 SLAB SUBGRADES

A. The proposed slab shall be supported on a minimum of 12 inches of Structural Fill placed directly over Aggregate Piers and/or Rigid Inclusions. The Structural Fill layer shall be thicker if required for the LTP installed in accordance with the requirements of the specialty contractor or in the drawings.

B. The Aggregate Piers and/or Rigid Inclusions shall be visible before placing Structural Fill or crushed stone over the top of the Aggregate Piers and/or Rigid Inclusions. Such Structural Fill or crushed stone shall not be placed until the geotechnical engineer has observed the subgrade.

3.17 VIBRATION MONITORING

A. The Site Contractor shall perform vibration monitoring during installation of Aggregate Piers and/or Rigid Inclusions. The peak particle velocity should be less than one (1) inch per second.

3.18 BASIS OF PAYMENT

A. Payment shall include all costs for design and installation of the Aggregate Piers and/or Rigid Inclusion and in accordance with requirements of the Contract Documents and Section 00 43 22 Unit Prices Form. Payment for the Work of this Section shall be made following approval by the Owner in accordance with requirements of the Contract Documents, Section 00 43 22 Unit Prices Form, and the following Schedule:

1. Preparation of design calculations and construction drawings and installation of Aggregate Pier and/or Rigid Inclusion elements:

   $____ Lump Sum

2. Unit Price for additional installed Aggregate Pier (w/o remobilization):

   $____ Lump Sum

3. Unit Price Credit for Aggregate Pier not installed:

   $____ Lump Sum

4. Unit Price for additional Modulus test (w/o remobilization)

   $____ Lump Sum

5. Unit Price for additional installed Rigid Inclusion (w/o remobilization):

   $____ Lump Sum

6. Unit Price Credit for Rigid Inclusion not installed:

   $____ Lump Sum

7. Unit Price for Load test (w/o remobilization)

   $____ Lump Sum

8. Alternate – Provide price for laying out Aggregate Piers and/or Rigid Inclusions):

   $____ Lump Sum

9. Unit Price for additional Mobilizations

   $____ Each

SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
   1. Hot-mix asphalt paving, including walkways, ramps, and curbs.
   2. Hot-mix asphalt patching.
   3. Pavement-marking paint.

B. Alternates: Not Applicable.

C. Items To Be Installed Only: Not Applicable.

D. Items To Be Furnished Only: Not Applicable.

E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
   1. Section 31 20 00 - Earth Moving for aggregate subbase and base courses and for aggregate pavement shoulders.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: Certification, by authorities having jurisdiction, of acceptance of each job mix proposed for the Work.

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

C. Material Certificates: For each paving material, from manufacturer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and accepted by the Massachusetts Highway Department (MHD).

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the Massachusetts Highway Department (MHD) for hot mix asphalt paving work.
   1. Comply with requirements of the Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, including supplemental specifications and special provisions.
   2. Comply with requirements of the Americans with Disabilities Act (ADA) and the Massachusetts Architectural Access Board (MAAB). If these requirements cannot be met with the grades and slopes indicated on the plans, notify the Designer immediately.
   3. Comply with requirements of the local authority having jurisdiction concerning the location and construction of accessible curb cuts.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.
   1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
      a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.

b. Review condition of subgrade and preparatory work.

c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.06 PROJECT CONDITIONS

A. Traffic Control: Maintain safe and continuous access for vehicular and pedestrian traffic throughout construction in accordance with the project phasing plan, approved traffic control plan, and applicable regulatory requirements, including coordination with ongoing construction activities.

B. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 degrees F.
2. Asphalt Base Course: Minimum surface temperature of 40 degrees F and rising at time of placement.
3. Asphalt Surface Course: Minimum surface temperature of 60 degrees F at time of placement.

C. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 degrees F for water-based materials, and not exceeding 95 degrees F.

PART 2 - PRODUCTS

2.01 AGGREGATES

A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

D. Reclaimed Asphalt Pavement (RAP): Provide material obtained from the highways or streets by crushing, milling, or planning existing hot mix asphalt pavements.

1. The proportion of RAP to virgin aggregate for base course mixtures and intermediate course mixtures will be limited to a maximum of 40 percent for drum mix plants and 20 percent for modified batch plants. The maximum amount of RAP for surface course mixtures will be 10 percent.

2.02 ASPHALT MATERIALS

A. Asphalt Binder Performance Graded: AASHTO M320 or AASHTO MP 1a, with performance grade as specified in the latest edition of the MassDOT Standard Specifications for Highways and Bridges.

B. Tack Coat: AASHTO M 140 emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.03 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Pavement-Marking Paint: Acrylic/latex type, low VOC, traffic marking paint.

1. Color: As indicated.

C. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.

1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.04 ASPHALT MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes accepted contracts by MHD Specifications, HMA Binder for binder courses, HMA Surface Standard Top for surface courses, and MHW 3/8” Top for sidewalks, designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types".

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.02 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

3.03 PATCHING

A. Existing Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a minimum rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.04 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.05 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at minimum temperature of 250 degree F.
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.06 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of six inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.07 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 degrees F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. Average Density: ASTM D 2041, per MHD Specifications.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.08 ASPHALT CURBS

A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 degrees F.

1. Asphalt Mix: Same as pavement surface-course mix.

B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.09 INSTALLATION TOLERANCES

A. Accessibility: Comply with requirements of Massachusetts Architectural Access Board and ADAAG requirements. Remove and replace paving that does not meet required tolerances, when measured with a two-foot straightedge.

B. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.

C. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within MHD Specification tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas.

3.10 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Designer.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.11 WHEEL STOPS

A. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.12 FIELD QUALITY CONTROL

A. Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by Town of Wilmington for field quality control activities for the Work of this Section. Refer also to Section 01 45 23 – Testing and Inspecting Services.

B. Test the plane of the finished surfaces of base, binder, and surface courses with a 16-foot straightedge, except use a 10-foot straightedge on vertical courses and on the top course of resurfaced streets which contain manhole covers, valve boxes, and the like.

C. Carefully apply the straightedge immediately after the first compaction by rolling, and from then on as may be necessary until and after the final compaction of the material in place. Hold the straightedge in successive positions parallel to the road centerline and in contact with the road surface; check the entire area from one side of the pavement to the other.

D. Correct irregularities which vary 3/8 inch from a true finished surface in base and binder courses, and 1/4 inch in top courses.

E. Irregularities that develop prior to completion of rolling, while the material remains workable, shall be corrected by loosening the surface mixture and adding or removing material where surface deviations, segregation, or non-uniform texture are observed. If irregularities or defects remain after final compaction, correct the defective work by removing and replacing the affected material to produce a true, even, and uniform surface.

3.13 OPENING TO TRAFFIC

A. No vehicular traffic or loads will be permitted on the newly completed pavement until adequate stability has been attained, and the material has cooled sufficiently to prevent distortion or loss of fines, and the pavement has achieved a maximum temperature of 140 degrees F.

B. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Architect.

3.14 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-accepted landfill.

END OF SECTION

SECTION 32 12 16.36
ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Sport Court Paving.

B. Hot-mix asphalt (HMA) | bituminous concrete sport court paving.
   1. Hot-mix asphalt | bituminous concrete shall be composed of mineral aggregate and asphalt | bituminous concrete binder, mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and conformance to the lines, grades, thickness and typical cross sections shown on the plans.
   2. Each course shall be constructed to the depth, typical section, or elevation required by the contract and/or plans and shall be rolled, finished, and accepted before the placement of the next course. Each course shall be placed to a smooth, dense, and uniform appearance.
      a. Sawcutting existing pavements.
      b. Asphalt Emulsion for Tack Coat.

C. Acceptance: The acceptance of plant produced material for gradation, asphalt content, and air voids shall be determined by the Designer in accordance with the requirements of the section on acceptance criteria, herein specified.

D. Related Work: The following items are not included in this Section and shall be performed under the designated Sections:
   1. Section 02 41 00 "DEMOLITION" for demolition and removal of existing asphalt | bituminous concrete pavement.
   2. Section 04 43 00 “STONE MASONRY” for granite curbing.
   3. Section 31 00 00 "EARTH MOVING" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
   4. Section 32 13 13.13 "CONCRETE PAVING (SITE)" for installation of cement concrete paving for plazas and walkways.
   5. Section 32 18 10 “COURT SURFACING” for multiuse sport court sealcoat surfacing.
   6. Section 32 18 23.43 “RECREATIONAL PAVEMENT MARKINGS” for play line stripe.

1.03 ACTION SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Proof of a State or local municipality Department of Transportation’s pre-approved Job Mix Formula (JMF).
   2. Tack Coat.

C. Material Certificates: For each paving material, from manufacturer.
   1. Submit certified test reports signed by the material producer certifying that materials comply with, or exceed, the specification requirements.

D. LEED
1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
   a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paver is 29 or greater.
4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.04 REFERENCES

A. The following Standards shall apply to the Work of this Section:
1. Commonwealth of Massachusetts Department of Transportation (MassDOT) Highway Division Specifications: Standard Specifications for Highways and Bridges; latest edition.
2. AASHTO: American Association of State Highway and Transportation Officials:
   Standard Size of Coarse Aggregate for Highway Construction: M43.
   Emulsified Asphalt: M140.
   Cationic Emulsified Asphalt: M208.
3. ANSI | ASTM: American Society for Testing and Materials:
   Specification of Concrete Aggregates: C33.
   Test method for Softening Point of Bitumen (Ring and Bell Apparatus): D36.
   Test method for Ductility of Bituminous Materials: D113.
   Penetration-Graded Asphalt Cement for Use in Pavement Construction: D946
   Test Method for laboratory Compaction Characteristics of Soil using Modified Effort [56,000 ft-lbf/ft3 (2,700 kN-m/m3)]: D1557.
   Specification for Viscosity-Graded Asphalt Cement for use in Pavement Construction: D3381.
4. ACI: American Concrete Institute.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by MassDOT, Highway Division.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MassDOT, Highway Division for hot mix asphalt | bituminous concrete paving work.
1. Comply with requirements of MassDOT, Highway Division, Standard Specifications for Highways and Bridges, including supplemental specifications and special provisions.
2. Comply with requirements of the Americans with Disabilities Act (ADA) and the Massachusetts Architectural Access Board (MAAB). If these requirements cannot be met with the grades and slopes indicated on the plans, notify the Designer immediately.
3. Comply with the requirements of the local authority having jurisdiction concerning the location and construction of accessible curb cuts.
4. Coordination. The General Contractor shall coordinate and schedule the Work under this specification with all other work, including underground utility improvement construction, to avoid covering up incomplete, unfinished, and/or uninspected work. Any repaving required

due to uncoordinated and/or improper scheduling shall be done by the General Contractor at no cost to Owner.

1.06 PROJECT CONDITIONS

A. Weather Limitations.

1. HMA | bituminous concrete shall only be placed on dry, unfrozen surfaces. The underlaying surface shall be accepted by the Owner's Representative and/or Designer prior to placement of any HMA | bituminous concrete. Underlaying surfaces shall be cleaned of any foreign materials.
2. The HMA | bituminous concrete shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture (film of water) or when the air and/or surface temperature is less than the temperature requirements contained in MassDOT Specifications Table 450.42-1. When the surface temperature of the underlying course is less than 50 degrees Fahrenheit the General Contractor shall determine the time available for compaction. The General Contractor shall also take extra precautions to control the temperature of the materials during placement. The time available for compaction shall be calculated based on the time, date, air temperature, average wind speed, sky conditions, latitude, mix type, PG grade, lift thickness, mix delivery temperature, existing surface type, existing moisture content of surface, existing state of moisture in surface, and surface temperature. The estimated time available for compaction can be calculated with computer programs, e.g., Pave Cool Tool. This program is available at the following web location: http://www.dot.state.mn.us/app/pavecool/
3. The information regarding the air temperature, average wind speed, sky conditions, mix delivery temperature, and existing moisture conditions shall be evaluated by the Designer and the General Contractor's representative located at the paving operation. The estimated time available for compaction shall be provided by the General Contractor to the Designer. The Designer and the General Contractor shall determine if there is an adequate amount of time available to compact the mixture. Options can be explored to extend the time available for compaction. If there is an adequate amount of time available to compact the mixture, the temperature requirements may be waived by the Designer; however, all other requirements including compaction shall be met. The General Contractor assumes responsibility for constructing the pavement to meet compaction and specification requirements.
4. The General Contractor shall not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown shall not be placed until the pavement surface shows no signs of free moisture, provided the mixture is within temperature limits as specified.
5. When the air temperature falls below 50 degrees Fahrenheit, extra precautions shall be taken in drying the aggregate, controlling the temperature of the materials, and placing and compacting the mixtures.
6. The construction of hot mix asphalt | bituminous concrete pavements shall terminate on November 15 and shall not be resumed prior to April 1 except as determined and directed in writing by the Designer.

1.07 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Installation Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs shall be allowed because of a lack of knowledge of existing conditions as indicated in the Construction Documents, or obvious from observation of the site.

B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the General Contractor shall have examined them for himself during

the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.08 ADA AND MAAB COMPLIANCE

A. Comply with American with Disabilities Act (ADA) and the requirements of the Massachusetts Architectural Access Board (MAAB).
   1. Slopes: Walkways as defined by Section 22.1 of 521 CMR, shall be graded to a maximum of 4.5 percent. The cross-pitch (perpendicular to travel) for walkways and paths shall be constructed at 1.5 percent.
   2. The requirements specified hereinabove shall supersede the grades indicated on the Drawings. If these requirements cannot be met with the grades indicated on the Drawings, the Designer shall be notified immediately for direction.

PART 2 PRODUCTS

2.01 HOT MIX ASPHALT | BITUMINOUS CONCRETE

A. General
   1. Hot Mix Asphalt (HMA) | bituminous concrete paving shall conform to MassDOT Standard Sections 450.10, 450.30, and M 3.06.00. All HMA | bituminous concrete mixtures shall meet the requirements of the Superpave volumetric mix design system.
   2. Within the public Right-Of-Way, the local municipality's HMA | bituminous concrete product requirements shall govern, if applicable.
   3. HMA | bituminous concrete designs shall meet the requirements of MassDOT Standard Specification Section 450.30
      a. Each HMA | bituminous concrete pavement course placed shall be comprised of one of the mixtures listed in MassDOT Standard Specifications Table 450.10-1: HMA | Bituminous Concrete Pavement Courses & Mixture Types
   4. Asphalt | bituminous concrete mixtures shall be composed of the following:
      a. Mineral aggregate
      b. Mineral filler (if required)
      c. Performance Graded Asphalt Binder (PGAB)
         1) All mixes shall be PG 64-28

2.02 ASPHALT EMULSION FOR TACK COAT

A. Asphalt emulsion materials shall be homogeneous and shall show no separation after mixing within 30 days after deliveries. They shall conform to the requirements of AASHTO M 140. Anionic emulsion used for tack coat shall be grade RS-1h.

2.03 SPORT COURT SURFACING

A. Refer to Section 32 18 10 "COURT SURFACING" for athletic sealcoat on athletic asphalt | bituminous concrete sport court paving.

2.04 RECREATIONAL PAVEMENT MARKINGS

A. Refer to Section 32 18 23.43 "RECREATIONAL PAVEMENT MARKINGS" for line striping on athletic asphalt | bituminous concrete sport court paving.

PART 3 EXECUTION

3.01 GENERAL

A. Subbase under paving shall be compacted as described in Section 31 00 00 "EARTH MOVING" Add material meeting the requirements of ordinary borrow to bring the subgrade to the required grade before placing base course.

B. Furnish, set, and maintain all line and grade stakes necessary to guide the automated grade control equipment. Where required these control stakes shall be maintained and used throughout the operations, from the grading of the subbase material up to and including the final layers of the pavement.

C. The gravel base course shall be spread in layers upon the prepared subgrade conforming to the required line and grade. Gravel shall be placed in compacted layers not more than four inches thick compacted to not less than 95 percent of the maximum dry density of the material. Any stone greater than three inches in size shall be removed. Compaction shall continue until the surface is even and true to line and grade.

D. Gravel base course shall be placed on backfilled and compacted trenches to proper grade before placement of pavement.

E. The edges of existing pavement that is to remain shall be sawcut to an even, straight edge using a power-driver rotary saw; use of a jackhammer is unacceptable.

1. The pavement shall be sawcut through its full depth at all joints between existing and proposed pavements to provide a uniform, smooth vertical surface.
2. Sawcut edges which become broken, ragged or undermined as a result of the operations shall be re-cut prior to the placement of abutting proposed pavement at no additional cost to the Owner.
3. Sawcut surfaces in asphalt | bituminous concrete pavements shall be sprayed or painted with a uniform, thin coat of asphalt emulsion tack coat immediately before placement of hot mix asphalt | bituminous concrete against the cut surface.

F. Asphalt | bituminous concrete courses shall be spread and compacted to the finished thicknesses as shown on the Contract Drawings. A smooth even surface shall be produced.

G. Any joints at junctions of old and new pavements shall be sealed with hot poured joint sealer and covered with sand.

3.02 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.03 QUALITY CONTROL OF HMA | BITUMINOUS CONCRETE PAVEMENT

A. General. Quality Control (QC) shall be in conformance with MassDOT Standard Specifications Section 450.60 through 450.68 and required as indicated. The General Contractor assumes responsibility of the quality for all materials and construction incorporated into the work and shall control all the processes leading to the final result through this function. The QC system addresses all elements which affect the quality of the pavement including, but not limited to:

1. Mix Design
2. Aggregate Grading
3. Quality of Materials
4. Stockpile Management
5. Proportioning
6. Mixing and Transportation
7. Placing and Finishing
8. Joints
9. Compaction
10. Surface smoothness and uniformity
11. Thickness and grade

B. The General Contractor shall be prepared to discuss and present, at the pre-paving conference, their understanding of quality control for this contract.

1. Surface Smoothness.
   a. The finished surfaces of the pavement shall be uniform in appearance, free from irregularities in contour and texture and shall present a smooth-riding surface.

Smoothness evaluation applies to all hot mix asphalt | bituminous concrete roadways and walkways receiving 1.5 inches or more in plan (compacted) thickness of HMA | bituminous concrete pavement.

b. Carefully apply the straight edge immediately after the first compaction by rolling, and from then on as may be necessary until and after the final compaction of the material in place. Hold the straightedge in successive positions parallel to the road centerline and in contact with the road surface; check the entire area from one side of the pavement to the other.
    1) Tests for conformity with the specified crown and grade shall be made immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.
    2) The finished surface of the pavement, when measured with a 10-foot straightedge, shall not vary more than 1/4 inch for the surface course and 3/8 inch for the intermediate course measured perpendicular and parallel to the centerline.
    3) After the completion of final rolling, the smoothness of the course shall again be tested.
c. Humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective work and replacing with new material. This shall be done at the General Contractor's expense.
d. Skin patching will not be permitted.
e. When profile corrections are required, use one or more of the following corrective methods:
    1) Removing and replacing the entire pavement thickness.
    2) Diamond grinding or micro milling.
    3) Overlaying (not patching) with the specified surface course.
    4) Removing the surface by milling and applying a lift(s) of the specified course(s).
    5) Use of other methods that will provide the desired results.
f. The corrective method(s) chosen shall be performed at the Installation Contractor’s expense, including all necessary equipment and traffic control.
    1) Areas of removal and replacement shall be removed the full width of the lane or paver pass. The removal areas shall begin and end with a transverse butt joint which shall be constructed with a transverse sawcut perpendicular to the centerline or paver pass.
    2) Replacement materials shall be placed in sufficient quantity, so the finished surface will conform to grade and smoothness requirements. The corrective area shall conform to all material and density specification requirements.
    3) When the corrective work consists of an overlay, the overlay shall cover the full width of the pavement including shoulders or the paver passes sufficient to correct the defective work. The area overlaid shall begin and end with a transverse butt joint which shall be constructed with a transverse sawcut and asphalt | bituminous concrete removal.
    4) All materials shall meet contract requirements. The overlay shall be placed so the finished surface will conform to grade and smoothness requirements. The overlaid area shall be compacted to the specified density.
g. The Owner’s Representative and/or Designer can have the Independent Testing Agency retest any sections where corrections were made to verify that the corrections produced a surface that conforms to the grade and smoothness requirements.

2. Uniformity.
    a. The HMA | bituminous concrete mat shall be smooth, dense, and uniform. Uniformity is generally affected by Thermal and/or Aggregate segregation.

b. If segregation is evident and discernable by either the General Contractor or the Owner's Representative/Designer, the Installation Contractor shall immediately cease production and take steps to correct and eliminate the cause(s) of the segregation.
c. The Installation Contractor shall review all potential causes of segregation as it relates to its operation, including but not limited to HMA | bituminous concrete Plant issues, loading and transportation issues, placement issues, thermal segregation, and hand work. The General Contractor shall employ additional investigation methods and make the necessary changes in their operation such that segregation is eliminated, and mat uniformity is acceptable.

3. Thickness.
   a. The thickness requirements contained herein shall apply only when each pavement layer is specified to be a uniform compacted thickness of one inch or greater. Thickness shall be evaluated for acceptance by the Owner's Representative and/or Designer to the requirements shown on the plans. Measurements of thickness may be checked periodically by the Installation Contractor in following their QC system for field operations. Measurements of thickness for acceptance shall be made by the Independent Testing Agency using four-inch minimum diameter pavement cores removed also for subsequent density measurement.
   b. The finished surfaces of each HMA | bituminous concrete pavement course shall not vary from that specified or cross sections shown on the contract drawings by more than 1/4 inch. The Installation Contractor shall correct pavement areas varying more than this amount by removing and replacing the defective work or as ordered by the Owner's Representative and/or Designer. Skin patching will not be permitted.
4. Grade.
   a. The finished surface of the pavement shall not vary from the gradeline elevations as shown on the plans by more than 1/2 inch. Remove deficient areas and replace with new material. Sufficient material shall be removed to allow at least 1 1/2 inches of hot mix asphalt | bituminous concrete to be placed. Skin patching for correcting low areas shall not be permitted. High points may be ground off.
5. Rejection of Inferior HMA | bituminous concrete.
   a. The Owner's Representative and/or Designer may at any time, notwithstanding previous acceptance, reject and require the General Contractor to dispose of any batch of hot mix asphalt | bituminous concrete which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. Similarly, the Owner's Representative and/or Designer may at any time, notwithstanding field acceptance for mat density, reject and require the Installation Contractor to correct any HMA | bituminous concrete pavement that was placed with unacceptable mat uniformity or paving joints due to low density, segregation, improper elevation, or tearing. In the event of such rejection, the General Contractor and the Owner's Representative and/or Designer may take random split samples of the area(s) in question, and if it can demonstrate in the laboratory, in the presence of the Owner's Representative and/or Designer, that such material/pavement was erroneously rejected, payment will be made for the material at the contract unit price.

C. General: Immediately before placing asphalt | bituminous concrete materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving. The General Contractor shall ensure that it is in conformance with the required

grade, cross-section, and in- place density. The compacted subbase shall not be frozen or have standing water.

D. Proof roll prepared base material surface, if applicable, to identify areas requiring removal and re-compaction, and to provide a uniform degree of compaction over the entire pavement area.

E. Do not begin paving work until deficient base material areas and utility trenches have been corrected and are ready to receive paving. Paving shall not be applied until the Designer inspects and accepts the finished base.

F. When an existing surface or new base upon which the bottom course is to be placed contains unsatisfactory irregularities, in the Designer's judgment, such irregularities may be eliminated by an adequate placing and compaction of HMA | bituminous concrete mixture to furnish a surface with true contour and grade before placing any specified course of mixture.

G. Check all frames, covers, grates, water valve boxes and other miscellaneous castings that are located in the proposed pavement areas to ensure that all have been correctly positioned and set to the proper slope and elevation. All covers and grates shall be set flush with the required finished surface. All adjustments shall be made prior to placement of the surface course. No depressions or mounds shall be permitted in the pavement to accommodate inaccuracies in the setting of castings. Hand placement of HMA | bituminous concrete along curbs, edging, or utilities after placement and compaction of the surface course shall not be permitted.

H. Leveling Course. Any HMA | bituminous concrete used for truing and leveling shall meet the requirements of the mix design methods and the requirements of MassDOT Standard Section 450.10 for the applicable mixtures. Leveling courses shall not be subject to density requirements. The thickness of the Leveling Course shall be measured off the interface with the existing milled or un-milled pavement surface. The leveling course shall be compacted with the same effort used to achieve placement and density of the test section. The truing and leveling course shall not exceed a nominal thickness of 1.5 inches.

I. Immediately before placing the hot mix asphalt | bituminous concrete, the underlying course shall be thoroughly cleaned of all dust and debris by a self-propelled sweeper. Areas inaccessible by power sweepers shall be broom swept until the pavement surface is clean. Extra care shall be required during fall leaf fall.

J. Tack Coat. Apply uniformly to surfaces to be paved.

1. Contact surfaces of manholes, structures, and vertical pavement edges shall be painted with a thin, uniform tack coat just before the material is placed against them.
2. Tack coat is required on all surfaces to be paved; this includes leveling, base, or intermediate layers of HMA | bituminous concrete. Particular attention should be made during the application that the longitudinal joint areas be treated with no bare spots. Missing areas on the longitudinal joint area shall require either re-application or localized hand work application. The existing surface shall be swept clean of all foreign matter and loose material using a mechanical sweeper and shall be dry before the tack coat is applied.
3. Tack Coat shall be applied by a pressure distributor. All nozzles on the distributor shall be open and functioning. All nozzles shall be turned at the same angle to the spray bar. The nozzles shall be offset at an angle from the spray bar to prevent the fan from one nozzle from interfering with the fan from another. Proper nozzle angle shall be as determined by the Manufacturer of the distributor spray bar. The spray bar shall be adjusted so that it is at the proper height above the pavement surface to provide a triple overlap spray for a uniform coverage of the pavement surface. A triple lap application requires that the nozzle spray patterns overlap one another such that every portion of the pavement receives spray from exactly three nozzles.
4. The tack distributor system shall be equipped with the following to control and monitor the application:

a. System for heating the asphalt emulsion uniformly to specified temperature.
b. Thermometer for measuring the asphalt emulsion temperature.
c. Adjustable full circulation spray bar.
d. Positive controls including tachometer, pressure gauge, and volume measuring device.

5. Tack coat application rates for specific surface conditions shall be in accordance with the following:
   a. On a new HMA | bituminous concrete surface, not opened to traffic, the emulsion application rate shall equal 0.06 to 0.08 gallons per square yard
   b. On an existing tight smooth pavement, the emulsion application rate shall equal 0.06 to 0.08 gallons per square yard.
   c. On a milled surface the emulsion application rate shall equal 0.07 to 0.09 gallons per square yard.
   d. On cement concrete base course, the emulsion application rate shall be equal to spray application for adjacent surface.
   e. On new HMA | bituminous concrete patches the emulsion application rate shall equal 0.06 to 0.09 gallons per square yard. Allow tack coat to cure undisturbed before applying hot-mix asphalt | bituminous concrete paving.
6. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
7. Tack Coat shall be applied to cover a minimum of 95 percent of the pavement surface.

3.04 HOT-MIX ASPHALT | BITUMINOUS CONCRETE TRANSPORTING, PLACING AND FINISHING

A. The trucks used to transport HMA | bituminous concrete to the field placement site shall have tight, clean, smooth metal beds. When necessary to maintain the required HMA | bituminous concrete temperature, trucks shall be equipped with insulated beds. The truck beds shall be evenly and lightly coated with an approved release agent meeting the requirements of MassDOT Standard Specification Section M3.01.6. Truck beds shall be free of kerosene, gasoline, fuel oil, solvent, or any other materials negatively impacting the HMA | bituminous concrete. The HMA | bituminous concrete shall be protected from foreign debris during transport.

B. Machine place hot-mix asphalt | bituminous concrete on prepared surface, spread uniformly, and strike off. Place asphalt | bituminous concrete mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

C. HMA | bituminous concrete deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver.

D. Upon arrival, the mixture shall be placed to the full width by a hot mix asphalt | bituminous concrete paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the hot mix asphalt | bituminous concrete mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet except where edge lanes require less width to complete the area. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least six inches. However, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least two feet from transverse joints in the previous layer. The placement of the material along the longitudinal joint may be performed by setting the screed to overlap the first mat. The elevation of the screed above the surface of the first mat should be equal to the amount of roll- down expected during compaction of the new mat. The

overlapped material shall be bumped by the lutes, if necessary, to optimize the density along the longitudinal joint. Under no circumstances should the overlapped material be broadcast across the mat. Excess material should be removed by hand. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt | bituminous concrete to prevent segregation of mix; use suitable hand tools to smooth surface.

F. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools.

G. When hand spreading is permitted, the mixture shall be distributed into place by means of hot shovels and spread with lutes in a loose layer of uniform density and correct depth. The use of rakes to spread the hot mix asphalt | bituminous concrete shall not be permitted. Loads shall not be dumped any faster than they can be properly handled by the shovelers and the shovelers shall not distribute the dumped load any faster than it can properly be handled by the luters. The luting shall be carefully and skillfully done to avoid segregation and so that, after the first passage of the roller over the luted mixture, no back patching shall be necessary. Compaction shall immediately follow hand spreading such that specification density is achieved while the mixture temperature is above the manufacturers recommended compaction temperature for the performance graded binder.

H. The mixtures shall only be placed in the work when they can be efficiently and satisfactorily placed, compacted, smoothed, and made uniform in accordance with these specifications. Unless otherwise permitted by the Owner's Representative and/or Designer for special particular conditions, only machine methods of placing shall be used.

I. No mixture shall be placed unless the breakdown, and intermediate rolling can be completed by the time the material has cooled to 195 degrees Fahrenheit, or that minimum compaction temperature specified by the binder manufacturer and provided that the density and uniformity of the completed pavement attains specification compliance.

J. No traffic of any kind shall be permitted on the HMA | bituminous concrete intermediate or HMA | bituminous concrete base when dirt or any other foreign substance may be tracked thereon.

K. Immediately after any course is screeded and before roller compaction is started, the surface shall be checked, any irregularities adjusted, any accumulation from the screed removed by rake or lute, and all fat spots in any course removed and replaced with satisfactory materials. Irregularities in alignment and grade along outside edges shall be corrected by the addition or removal of mixture before the edges are rolled. Indiscriminate casting of mix on the new screeded surface, where irregularities are not evident, shall not be permitted.

L. All hot mix shall be placed and compacted in such a manner as to ensure a continuous bond between the tacked hot mix pavement surfaces and obtain the required density.

M. No vehicular traffic or loads shall be permitted on newly completed HMA | bituminous concrete until adequate stability has be attained and the material has cooled to a temperature of 140 degrees Fahrenheit or less.

3.05 COMPACTION

A. The mixture shall be thoroughly and uniformly compacted by rolling. Equipment may include steel wheeled rollers, vibratory rollers, oscillation rollers, or pneumatic-tired rollers. The surface shall be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Installation Contractor so that the required compaction and surface texture are consistently attained while the mixture is in a workable condition. When possible, use pneumatic or oscillation rollers. Rolling shall be initiated with the drive roll or wheel towards the paving machine. When rolling

on steep grades, the previous procedure may need to be altered. The Installation Contractor shall provide the proper number of rollers to achieve the target in-place density and course thickness.

B. The speed of the roller shall, at all times, be sufficiently slow and of uniform speed to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring because of reversing the direction of the roller, or from any other cause, shall be corrected at once. Rollers shall not be permitted to stop on the mat except to reverse direction or refill water.
C. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. The number of rollers and passes required shall be governed by the compaction results; however, at least two rollers shall be provided for each paver employed on the paving operation. Each roller shall be operated by a competent, experienced roller operator and shall be kept in nearly continuous operation as practicable while work is underway. A plate shall be attached to each roller showing the ballasted and unballasted weight per length-width of tread.
D. To prevent adhesion of the mixture to the steel roller, the drums or shall be kept properly moistened, cocoa mats kept clean and scrapers used, but excessive water shall not be permitted. Pneumatic rollers shall be operated on adjacent pavement surfaces to get the tires warm to hot from friction, then moved to the fresh mat.
E. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers and vibratory plate compactors.
F. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Installation Contractor’s expense. Skin patching shall not be allowed.
G. Breakdown Rolling. Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
H. Intermediate Rolling. Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt | bituminous concrete is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt | bituminous concrete course has been uniformly compacted to the required field density.
I. Finish Rolling. Finish roll paved surfaces to remove roller marks while hot-mix asphalt | bituminous concrete is still warm.
J. Edge Shaping. While the surface is being compacted and finished, the Installation Contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back of a lute or smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.
K. Protection. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
L. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
M. PAVEMENT CLEANING AND PROTECTION
    1. The pavement surface and all work areas shall be left in a clean condition.
    2. Vehicular traffic shall not be permitted on the pavement that has been sealed during the dry period. The General Contractor shall supply all temporary traffic control devices (barricades, cones, signing) to protect the sealant. Any damage to uncured sealant shall be repaired at the Installation Contractor’s expense.

3.06 INSTALLATION TOLERANCES

A. Accessibility: Comply with requirements of Massachusetts Architectural Access Board and ADAAG requirements. Remove and replace paving that does not meet required tolerances when measured with a two-foot straight edge.

B. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
   1. Base Course: Plus or minus 3/8 inch.
   2. Surface Course: Plus 1/4 inch, no minus.

C. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within MassDOT Standard Specification tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas.

3.07 SPORT COURT SURFACING

A. Refer to Section 32 18 10 “COURT SURFACING” for athletic sealcoat on athletic asphalt | bituminous concrete sport court paving.

3.08 RECREATIONAL PAVEMENT MARKINGS

A. Refer to Section 32 18 23.43 “RECREATIONAL PAVEMENT MARKINGS” for line striping on athletic asphalt | bituminous concrete sport court paving.

3.09 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from the Project site, and legally dispose of them in an EPA-approved landfill.

END OF SECTION

SECTION 32 12 18
FLEXIBLE PERVIOUS PAVEMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Multi-layer rubber pavement for tree well.
   2. Edge curb restraints.

B. Related Requirements:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for installing cast-in-place concrete edge restraints for tree well as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for filling and grading and for drainage course drainage/separation geotextiles, and subbase courses.

1.03 DEFINIATIONS:

A. Subbase: A layer in a paving system between the sub-grade and the surface course, or between the subgrade and the permeable paving.

B. Base Reinforcement: The use of a geo synthetic within the aggregate base course to enhance the performance of the paving.

C. Geogrid: Biaxial or triaxial woven polypropylene material for base course reinforcement and confinement, and subgrade stabilization and increased subgrade load capacity.

D. Subgrade: The soil prepared and compacted to support a structure or paving system.

E. Panel: An individual paving slab bordered by joints or slab edges.

F. Exposure Conditions, Moderate: Exposure to a climate where the paving will not be in a saturated condition when exposed to freezing and will not be exposed to deicing agents or other aggressive chemicals.

G. Exposure conditions, Severe: Exposure to deicing chemicals or other aggressive agents or where the paving can become saturated by continual contact with moisture or free water before freezing.

H. Permeable/Porous Paving: A paving system comprising of material with sufficient continuous voids to allow water to pass from the surface to the underlying layers.

I. Pervious/Permeable: The property of a material which permits movement of water through it under ordinary hydrostatic pressure.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Submit color chart representing full range of manufactures color options.
   2. Submit flexible pervious pavement sample, four inch by four inch square in full thickness of color selected by Owner’s Representative.
   3. Submit copy of Manufacturer’s Technical Data Sheets on each product to be used.
   4. Submit installation guidelines.

B. Shop Drawings: shop drawings shall include plan view cross section.

C. Field Layout: For each area of color sealcoat.
   1. Field layout of color sealcoat shall be accepted by Owner’s Representative prior to installation.

D. Submit a list of successfully completed projects. The Submittal must include the project name, year or date of installation, location, and a contact name, email and phone number for the projects submitted.

E. Close Out Submittals:
   1. Submit Manufactuer standard product materials warranty signed by company officer with Corporate Seal.
   2. Submit Standard Labor Warranty.
   3. Submit Copy of Surface Care and Maintenance Guide.

1.05 QUALITY ASSURANCE

A. Delivery and Handling:
   1. Deliver materials and products and provide adequate protection against damage.
   2. Handle in strict compliance with manufacturer's instructions and recommendations and store off the ground.
   3. Storage of Materials: The contractor shall provide a secure, clean, dry location for storage of materials at temperatures above 50 degrees Fahrenheit. Under no circumstances should material be stored outside unless fully protected from moisture with 10 mil polyethylene barrier and tarpaulin. All materials stored outside shall be inspected by dealer for moisture contamination before application. Store out of direct sunlight to avoid moisture and condensation.
   4. Protect from all possible damage including, but not limited to chipping, staining, cracking and other damage.
   5. Sequence deliveries to avoid delays but minimize on-site storage.

B. The Manufacturers Qualifications: Manufacturer must have a minimum of 15 years manufacturing with the products specified.

C. Contractors Qualifications: The installing foreman must be a certified installer or authorized agent of the manufacturer and have specialized or similar experience installing and performing the work of this section that is required for this project scope.

D. Guarantee:
   1. The surface materials shall be guaranteed against defects for a period if ten years from the date of completion.

1.06 FIELD CONDITIONS

A. Environmental site conditions must be between 50 and 85 degrees Fahrenheit. Do not install when subbase is saturated or wet or when ground is frozen. Moisture level of the sub-base should not exceed four to seven percent at the time of installation.

B. Sub-base shall be free of any materials and debris and released to the applicator clean and in good stable compacted condition.

C. Protect area after installation to avoid damage – up to 24 hours.

D. Upon completion of installation, installer shall remove all unused materials, tools, equipment, and rubbish.

E. No smoking, open flames, or sparks from electrical equipment shall be permitted during the application of materials.

1.07 MATERIAL GUARANTEE

A. The permeable pavement shall be guaranteed against defects in materials for ten years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. Rubberway, Inc., distribution USSA, Inc. (Dba United Sustainable Surfacing of America); Telephone: 877-288-0045; East Coast Address: 9 Soundview Court Suite 2A, Greenwich, CT 06830; Email: info@rubberway.com; Website: www.rubberway.com.
   2. Atlantic Power and Infrastructure; Telephone: 727-723-3300; Address: 4600 140th Avenue North Suite 200, Clearwater, FL 33762; Website: www.apaicorp.com.

3. Porous Pave; Telephone: 888-448-3873; Address: 1907 E 120th Street, Grant, MI 49327; Email: sales@porouspaveinc.com; Website: www.porouspaveinc.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer's products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 "SUBSTITUTION PROCEDURES".

2.02 MULTI-LAYER RUBBER PAVEMENT FOR TREE WELL

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings by Rubberway, Inc., or approved equal:

B. General: Use materials and gradations that have performed satisfactorily in previous installations.

C. Bonding Agent: Must have the capacity to bind with: rubber, wood, steel, concrete, aluminum, compacted aggregate, enamel tile or fiberglass.

D. Bonding Material – Delivered in five-gallon pails or drums.
   1. Base Layer Bonding: Labeled Rubberway 3000.
   2. Waer Layer Bonding: Labeled Rubberway 3000.

E. Recycled Rubber Base Layer
   1. Rubber: Recycled Granulated Rubber, clean, free of metals and fiber.
   2. Packaged in 55-pound bags.

F. Wear Surface Layer
   1. Synthetic virgin rubber, clean, free of dust.
   2. Packaged in clear bags displaying color – bagged in 55 pounds.
   3. Color: to be a Medium Brown selected from standard color options by Owner Representative from submitted samples.

G. Mix Design
   1. Using materials acceptable by the manufacturer and owner, design a tentative mix and test mock up for the consistency intended for use on the system specified. Follow instructions per the manufacturer's installation overview provided.

H. Forms
   1. Make forms with temporary wood, steel, concrete or pressure treated lumber or other material that is sufficiently rigid to maintain specified tolerances, and capable of supporting finished surfacing to specified height.
   2. Forms shall be clean and free of debris of any kind, including rust.
   3. Form release: Bio Performance Maintenance solvent or TXIB finish insolvent.

2.03 GEO TEXTILE FABRIC

A. Geo textile fabric shall be a permeable non-woven geo textile composite composed of polypropylene fibers which are formed into a stable network such that the fibers retain their relative position. The Marafi 140 NC or approved equal is inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids. The flow rate shall be 140 (gallons/minutes/square feet). Fabric shall be installed over compacted sub grade under permeable aggregate.
   1. Fabric shall be held in place with subbase aggregate.

2.04 SUBBASE

A. Prepare subbase in accordance with contract documents and detail drawings.
B. Subbase shall be performed in conformance to the alignment, grade and cross section indicated on the drawing. The stone shall be placed in two lifts, horizontal layers and each layer proof rolled to 90 to 95 percent compaction.
C. Modified proctor with a vibratory smooth drum roller.
D. Moisture content of the stone shall be four to seven percent of dry weight to ensure no migration of fines during transport and installation.

2.05 EDGE RESTRAINTS

A. Job-Built Concrete Edge Curb Restraints: Comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 5,000 pounds per square inch (34 Megapascals).

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Prepare subgrade as specified in the contract documents and detailed drawings.
B. Construct subgrade to ensure that the required paving thickness is obtained in all locations.
C. Keep all traffic off the subgrade during construction to the maximum extent practical. Regrade subgrade disturbed by delivery vehicles or other construction traffic.
D. Compact the material added to obtain final subgrade elevation.
E. Determine subgrade permeability in accordance with ASTM D3385 before porous paving placement.

3.02 SITE PREPARATION

A. The Contractor shall strip all debris and organic matter from areas to be graded and shall haul this material off site for legal disposal.
B. The Contractor shall be responsible for placing and compacting approved base material in accordance with the specifications.
C. The Contractor shall be responsible to have adjacent grass edged and removed from all areas receiving the synthetic surface. It may be necessary to apply a liquid herbicide such as Roundup or approved equal, to any adjacent edges of surfacing areas.
D. Turn off any surrounding adjacent sprinklers one week prior to work being performed.

3.03 EXAMINATION

A. Do not begin installation until substrates have been properly laid and compacted according to manufacturer’s instructions and inspected by an authority approved by the owner.
B. Consulting arborist is recommended for tree root inspection when porous pavement is being installed around tree roots. Roots can be left intact up to 1½ inches from grade (flush to base layer of proposed system detail when installation is specific to sidewalk repair and the sub-base is permeable). Any tree root trimming should be approved and supervised by a consulting arborist.
C. Protect all surrounding areas to avoid damage to adjacent surfaces.

3.04 PLACING FINISHED PAVING

A. Installation of the permeable paving surface material shall take place only when proper environmental conditions and the temperature is 50 degrees Fahrenheit and rising. If, in the installer’s opinion, the weather or climate conditions are harmful for proper surface installation, work will be delayed until conditions are agreeable.
B. The materials shall be prepared in a mechanical mixer until a homogenous mix is obtained.
C. Application to be monolithic, in one single layer to the specified depth, unless otherwise specified.

D. Install per manufacturer's installation instructions provided specifically for the project. All joint work shall be troweled flush with the adjacent mat.
E. All cold dry seams shall be cut straight at an inward 45-degree angle and primed prior to commencing with subsequent work.

3.05 EDGE RESTRAINTS

A. Provide edge restraints as indicated
B. All edge restraints shall be flush to avoid any tripping hazards or dips that could cause differential settlement of surfacing, ponding of water and ultimately failure of safety surfacing.
C. Install edge restraints before placing safety surfacing.
    1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after safety surfacing installation.
    2. If concrete curbs are used prime the interior edges of concrete curbs and field areas. If the surfacing is being installed over newly poured asphalt or concrete allow 28 days cure time and acid etch concrete.
    3. Install job-built concrete edge curb restraints to comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).
D. When curbs or steel edging are not used, temporary forms can be used and then bevel the edge of the top surface to a 45-degree angle.

3.06 GEOSYNTHETIC INSTALLATION

A. General: Install geosynthetics according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions.
    1. Geotextiles: Completely cover area indicated, overlapping sides and edges a minimum of four inches (100 millimeters) with manufacturer's standard treatment for overlapping loosely laid seams.
        a. Perimeter: Adhere edges on all sides to top of perimeter curb or footing.

3.07 PROTECTION

A. No traffic or other trades shall be allowed on the surface following completion for ample cure time.
B. Other Trades: It shall be the responsibility of the general contractor to protect the surface from damage by other trades before acceptance by the Owner or his agent. Completely cover the paving surface with four mil thick polyethylene sheet until the project is completed and turned over to the owner.

END OF SECTION

SECTION 32 13 13.13
CONCRETE PAVING (SITE)

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Concrete sidewalk and plazas.
   2. Sealing exterior concrete.

B. Related Sections:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for general building applications of concrete as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   3. Section 32 12 16 “ASPHALT PAVING” for adjacent asphalt | bituminous concrete paving construction.
   4. Section 32 12 16.36 “ATHLETIC ASPHALT-BIT CONC SPORT COURT PAVING” for court paving as released in Early Release Package 1 (ERP1).
   5. Section 32 13 73 "CONCRETE PAVING JOINT SEALANTS" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction as released in Early Release Package 2 (ERP2).
   6. Section 32 14 13 “UNIT PAVING ON BITUMINOUS SETTING BED” for precast concrete paving units.
   7. Section 32 17 26 “TACTILE WARNING SURFACE” for cast iron detectable warning strip set in concrete setting bed.
   8. Section 32 17 26.13 “DETECTABLE WARNING SURFACE– RADIAL” for requirements for radial tactile warning surfaces.

1.03 REFERENCES

A. The following Standards shall apply to the Work of this Section:
   1. ACI: American Concrete Institute:
      Guide for Measuring, Mixing, Transporting and Placing Concrete: 304R.
      Hot Weather Concreting: 305R.
      Standard Specifications for Cold Weather Concreting: 306.1.
      Standard Practice for Curing Concrete: 308.
      Building Code Requirements for Structural Concrete and Commentary: 318.
      Detailing Manual: SP-66.
   2. ASTM: American Society for testing and Materials:
      Specification of Concrete Aggregates: C33.
      Ready-Mixed Concrete: C94.
      Portland Cement: C150.
      Air Entraining Admixture for Concrete: C260.
      Chemical Admixtures for Concrete: C494.
      Blended Hydraulic Cements (Metric): C595M.
      Chemical Admixtures for Use in Producing Flowing Concrete: C1017.
      Packaged Dry, Hydraulic Cement Grout (Nonshrink): C1107.
      Preformed Expansion Joint Filler for Concrete (Bituminous Type): D994.
      Concrete Joint Sealer, Hot-Poured Elastic Type: D1190.

Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types): D1751.

Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction: D1752.

1.04 DEFINITIONS

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

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Indicate pavement Control / Contraction and Expansion joint layout plan for review and acceptance by Owner's Representative.

C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

D. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where required by Owner's Representative and not less than 96 inches (2400 millimeters) by 96 inches (2400 millimeters).
3. Accepted mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Submit Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.

F. Submit Qualification Data: For firms and persona specified in "Quality Assurance" article to demonstrate their capabilities and experiences. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.

G. Submit Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.

H. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to concrete paving, including but not limited to, the following:
   a. Concrete mixture design.
   b. Quality control of concrete materials and concrete paving construction practices.
   c. Pavement Joints.

I. LEED

1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
   a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paver is 29 or greater.

4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.06 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Semi-rigid joint filler.
   6. Joint-filler strips.
   7. Repair materials.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Engage and experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this project and with a record of successful in-service performances.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. 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.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1.09 ADA AND MAAB COMPLIANCE

A. Special attention is to be given to compliance with the American with Disabilities Act (ADA) and the requirements of the Massachusetts Architectural Access Board (MAAB).
   1. Slopes: All Walkways as defined by Section 22.1 of 521 CMR shall be graded to a maximum 4.5 percent. The cross pitch (perpendicular to travel) for all walkways and paths shall be constructed at 1.5 percent (1.9 percent maximum). All Plazas as defined by Section 22.3.2 of 521 CMR shall be graded to a maximum two percent in any direction. The slope of sidewalks ramps and handicap curb cuts as defined by Section 21.1 of 521 CMR shall be constructed at 7.6 percent maximum. Ramps as defined by Section 24.1 of 521 CMR shall be constructed to a maximum slope of 7.6 percent and shall have code compliant handrails.
   2. The General Contractor is to assume that all grades in pedestrian paths of travel shall be verified/checked with a four-foot electronic "Smart Level".
   3. A five-foot minimum level (1.5 percent pitch, 1.9 percent maximum) area shall be provided at all flush entrances to buildings. Puddling of water at the entrances will not be allowed.

B. The above requirements shall supersede the grades shown on the Drawings. If these requirements cannot be met with the grades as shown on the Drawings, the Owner's Representative shall be notified immediately.

1.10 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic and for other construction activities.

PART 2 PRODUCTS

2.01 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other accepted panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 meters) or less. Do not use notched and bent forms.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.02 STEEL REINFORCEMENT

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from steel wire into flat sheets.

C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.

2.03 CONCRETE MATERIALS

A. Cement: Shall be American-made Portland Cement; and conform to chemical and physical requirements of ASTM C150/C 150M for Type I for exposed concrete and Type II, low alkali, standard gray color for all other work.

B. A maximum of 15 percent fly ash or 30 percent slag is to be used to comply with the requirements of LEED v4 BD+C.

C. Use set retarding admixtures during hot weather only when accepted by Owner's Representative.

D. Prepare design mixtures, proportioned according to ACI 211.IR-91 and ACI 304 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trail mixes or field experience.

1. Use a qualified independent testing agency for prepping and reporting proposed concrete mixture designs for the trail batch method.
2. Total Cementitious Content: 705-pounds per cubic yard, maximum.
    a. If a low-alkali cement is used to address potential aggregate reactivity, its effectiveness shall be demonstrated by testing according to ASTM C1567.
    b. Limit use of fly ash in concrete exposed to deicing chemicals in service to not exceed 25 percent of cement content by weight. If fly ash contents above 25 percent are required for reactive aggregate mitigation, provide ASTM C666 testing results indicating satisfactory performance.
    c. Limit use of slag in concrete exposed to deicing chemicals in service to not exceed 50 percent of cement content by weight. If fly ash contents above 25 percent are required for reactive aggregate mitigation, provide ASTM C666 and ASTM C672 testing results indicating satisfactory performance.

E. Limit water-soluble, chloride ion content in hardened concrete to 0.15-percent by weight of cement.

F. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength 28-days:
    a. F3 (freezing and thawing with exposure to water and deicing chemicals) = 5,000 pounds per square inch (34.4 Megapascals), i.e., exposed paving.
2. Water/Cement Ratio (maximum): 0.45-percent by weight (mass).
3. Slump Limit: Maximum three-inches (16.2 millimeters) to five-inches (125 millimeters) a time of placement.

G. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: six percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregates size (applies to footings and foundation walls and all other concrete exposed to freeze/thaw action).

H. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

I. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements, only as authorized by the Owner in writing as follows:
   1. Fly Ash or Pozzolan: 25 percent.

J. Color Pigment: No Color Pigment should be added to concrete mixture.

K. Water: ASTM C 94/C 94M and potable.

L. Concrete Transit Mixers: Mix concrete materials in transit mixers, complying with requirements of ASTM C 94.
   1. At ambient temperatures of 85 to 90 degrees Fahrenheit, reduce mixing and delivery time to 75 minutes.
   2. At ambient temperatures above 90 degrees Fahrenheit, reduce mixing and delivery time to 60 minutes.

2.04 CURING MATERIALS

A. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

B. Water: Potable.

2.05 PENETRATING CLEAR SEALER

A. Penetrating clear sealer for exterior concrete shall be "MasterProtect H 1000" Penetrating Clear Sealer as manufactured by BASF, or approved equal from Euclid Chemical or Sika Corporation. Clear breathable, high-performance, 100 percent silane, water repellent sealer for protecting horizontal and vertical concrete surfaces. Penetrates deeply, sealing out water, chloride ions, and acids, preventing damage from freeze/thaw cycles

B. Provide 5-year labor and materials warranty.

2.06 JOINT MATERIALS, GENERAL

A. Compatibility: Provide joint backings and other related materials that are compatible with one and other and with products provided under Section 32 13 73 "CONCRETE PAVING JOINT SEALANTS".

B. Location of joints shall comply with plans. Submit layout of joints for review and accepted prior to proceeding with the work.

2.07 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber; 1/2-inch (12.7 millimeters), unless otherwise indicated.

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Non-Shrink Grout: ASTM C1107; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 2,400 pounds per square inch (16.5 Megapascals) in 48-hours, and 7,000 pounds per square inch (48.2 Megapascals) in 28-days.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

3.02 SUBBASE

A. Prepare subbase in accordance with Section 31 00 00 "EARTH MOVING".

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to three miles per hour (five kilometers per hour).
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 millimeters) according to requirements in Section 31 00 00 "EARTH MOVING".

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.04 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides 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.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.05 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.06 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   2. Provide tie bars at sides of paving strips where indicated.
   3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
   4. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Expansion Joints: Form expansion joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
   1. Extend joint fillers full width and depth of joint.
   2. Terminate joint filler not less than 1/2 inch (13 millimeters) or more than one inch (25 millimeters) below finished surface if joint sealant is indicated.
   3. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.

4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
5. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction 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 to a radius of 1/8 inch (3.2 millimeters). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints (only upon Client Acceptance): Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (three millimeters) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   a. Tolerance: Ensure that sawed joints are within three inches (75 millimeters) either way from centers of dowels.

3.07 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
F. 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.
G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
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.

H. Screed paving surface with a straightedge and strike off.
I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below 40 degrees Fahrenheit (4.4 degrees Celsius), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees Fahrenheit (10 degrees Celsius) and not more than 80 degrees Fahrenheit (27 degrees Celsius) 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 design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 degrees Fahrenheit (32 degrees Celsius) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is General Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.08 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and 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. Refloat surface immediately to uniform granular texture.
   1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
   3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to three millimeters) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.09 DETECTABLE WARNINGS

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 32 17 26 “DETECTABLE WARNING SURFACE”.
   1. Tolerance for Opening Size: Plus 1/4 inch (six millimeters), no minus.

3.10 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot by height (one kilograms per square meter by height) 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.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
E. Curing Methods: Cure concrete by 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 12-inch (300-millimeters) lap over adjacent absorptive covers.
    2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 millimeters) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or 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 that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during the curing period.

3.11 APPLICATION OF PENETRATING SEALER

A. Apply 2 coats of the approved penetrating sealer to all exterior cast in place concrete including paving, stairs and walls between 28 to 42 days after installation in accordance with the manufacturer’s recommendations. All surfaces exposed above finish grade shall be uniformly coated.
B. Sealer application shall be performed in the presence of the Owner’s Representative.
C. Sealed surfaces shall be protected from rain for a minimum of 12 hours. Access to sealed surfaces shall be prohibited with effective barriers until surfaces are completely dry.

3.12 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:
    1. Elevation: 3/4 inch (19 millimeters).
    2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (six millimeters).
    3. Surface: Gap below 10-foot- (three meters) long, unleveled straightedge not to exceed 1/2 inch (13 millimeters).
    4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 millimeters per 300 millimeters) of tie bar.
    5. Lateral Alignment and Spacing of Dowels: one inch (25 millimeters).
    6. Vertical Alignment of Dowels: 1/4 inch (six millimeters).
    7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (six millimeters per 300 millimeters) of dowel.
    8. Joint Spacing: three inches (75 millimeters).
    9. Contraction Joint Depth: Plus 1/4 inch (six millimeters), no minus.
    10. Joint Width: Plus 1/8 inch (three millimeters), no minus.

3.13 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner’s Representative.
B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
C. Sweep and clean the surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 millimeters).
   1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
   2. Broadcast glass beads uniformly into wet markings at a rate of six pounds per gallon (0.72 kilograms per liter).

3.14 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least one composite sample for each 100 cubic yards (76 cubic meters) or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 degrees Fahrenheit (4.4 degrees Celsius) and below and when it is 80 degrees Fahrenheit (27 degrees Celsius) and above, and one test for each composite sample.
   5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
      a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 pounds per square inch (3.4 Megapascals).
D. Test results shall be reported in writing to Owner’s Representative, concrete manufacturer, and General Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both seven- and 28-day tests.
E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner’s Representative but shall not be used as a sole basis for acceptance or rejection of concrete.
F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met.
G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at the General Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.15 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise accepted by Owner’s Representative.

B. Drill test cores, where required by Owner’s Representative, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign materials. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.

B. Related Sections:
   1. Section 07 92 00 "JOINT SEALANTS" for sealing nontraffic and traffic joints in locations not specified in this Section.
   2. Section 32 12 16 “ASPHALT PAVING” for adjacent asphalt | bituminous concrete paving construction.
   3. Section 32 12 16.36 “ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" for court paving as released in Early Release Package 1 (ERP1).
   4. Section 32 13 13.13 "CONCRETE PAVING (SITE)" for constructing joints in concrete pavement as released in Early Release Package 2 (ERP2).
   5. Section 32 14 13 “UNIT PAVING ON BITUMINOUS SETTING BED” for precast concrete paving units.
   6. Section 32 18 23.43 “RECREATIONAL PAVEMENT MARKINGS” for court line stripe.

1.03 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.
   1. Use manufacturer's standard test method to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.04 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch (13 millimeters) wide joints formed between two six-inch- (150-millimeters) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

C. Pavement-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

D. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Preinstallation Conference: Conduct conference at Project site.

1.07 PROJECT CONDITIONS

A. Do not proceed with the installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 degrees Fahrenheit (five degrees Celsius).
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 PRODUCTS

2.01 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: Shall match as closely as possible the color of the surrounding materials and selected by Owner's Representative from Manufacturer's full range.

2.02 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Sika Corporation; 728 NS.
   b. Crafco Inc., an ERGON company; RoadSaver Silicone.
   c. Dow Corning Corporation; 888.
   d. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Sika Corporation; 728 SL.

b. Crafco Inc., an ERGON company; RoadSaver Silicone.
c. Dow Corning Corporation; 890-SL.
d. Pecora Corporation; 300 SL.

2.03 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Crafco Inc., an ERGON company; Superseal 402/117.

B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Meadows, W. R., Inc.; Sealtight Hi-Spec.
b. Right Pointe; D-3405 Hot Applied Sealant.

2.04 JOINT-SEALANT BACKER MATERIALS

A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.05 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.03 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
   1. Remove excess joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.04 CLEANING

A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.06 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.
   1. Joint Location:
      a. Expansion and isolation joints in cast-in-place concrete pavement.
      b. Contraction joints in cast-in-place concrete slabs.
      c. Other joints as indicated.
   2. Silicone Joint Sealant for Concrete: Single component, nonsag.
   3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
   4. Hot-Applied Joint Sealant for Concrete: Single component.
   5. Joint-Sealant Color: Shall match as closely as possible the color of the surrounding materials and be selected by Owner’s Representative from manufacturer's full range.

B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement.
   1. Joint Location:
      a. Joints between concrete and asphalt pavement.
      b. Joints between concrete curbs and asphalt pavement.
      c. Other joints as indicated.

2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.
3. Joint-Sealant Color: Shall match as closely as possible the color of the surrounding materials and be selected by Owner's Representative from manufacturer's full range.

END OF SECTION

SECTION 32 14 13
UNIT PAVING ON BITUMEN SETTING BED

PART 1 GENERAL

1.01 GENERAL PROVISIONS

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

1.02 SUMMARY

A. Section includes the following:
   1. Concrete Pavers
   2. Joint Sand
   3. Bitumen Setting Bed
   4. Asphalt Tack Coat
   5. Aluminum edge restraints.
   6. Edge curb restraints.

B. Related Sections:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for cast-in-place concrete base under unit pavers and curbs that serve as edge restraints for paving as released in Early Release Package 2 (ERP2).
   2. Section 04 43 00 “STONE MASONRY” for stone landscape curb serving as edge restraints for pavers
   3. Section 31 00 00 "EARTH MOVING" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   4. Section 31 50 00 "EXCAVATION SUPPORT AND PROTECTION" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   5. Section 32 13 73 "CONCRETE PAVING JOINT SEALANTS" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt | bituminous concrete paving or adjacent construction as released in Early Release Package 2 (ERP2).
   6. Section 32 13 13.13 “CONCRETE PAVING (SITE)” for concrete pavement and walks that edge the pavers as released in Early Release Package 2 (ERP2).

1.03 REFERENCES

A. ASTM International, latest edition:

Standard Specification for Concrete Aggregates: C 33.
Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; C 136.
Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units; C 140.
Standard Specifications for Aggregate for Masonry Mortar; C 144.
Standard Classification for Sizes of Aggregate for Road and Bridge Construction; D 448.
Standard Specification for Solid Concrete Interlocking Paving Units; C 936.
Standard Specification for Pigments for Integrally Colored Concrete; C 979.
Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5 lb (24.4 N) Rammer and 12 in. (305 mm) drop; D 698.
Standard Specification for Emulsified Asphalt; D 977.
Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (44.5 N) Rammer and 18 in. (457 mm) drop; 1D 1557.
Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units; C1645.
Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement

Construction; D 3381.

B. U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) Building Design + Construction, latest edition

1.04 SUBMITTALS

A. Concrete Pavers:
   1. Samples for verification: Three representative full-size samples of each paver type, thickness, color and finish that indicate the range of color variation and texture expected upon project completion.
   2. Accepted samples become the standard of acceptance for the product produced.
   3. Test results from an independent testing laboratory for compliance of concrete pavers with ASTM C 936.
   4. Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

B. Joint Sand:
   1. Provide three representative one-pound samples in containers of Joint Sand materials.
   2. Provide three representative one-pound samples in containers of Setting Bed Sand materials.
   3. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.

C. Polymeric Joint Sand:
   1. Test results from an independent testing laboratory for sieve analysis per ASTM C 136 conforming to the grading requirements of ASTM C 144.
   2. Samples for Initial Selection: Provide three representative samples in containers of Polymeric Joint Sand material, cured and dried, for color selection.
   3. Samples for Verification: Provide three one-pound samples in containers of Polymeric Joint Sand.

D. Neoprene modified asphalt adhesive product catalog sheets with specifications.

E. Bitumen Setting Bed: asphalt cement mix design to be used in the Bitumen Setting Bed conforming to ASTM D 3381.

F. Sieve analysis per ASTM C 136 for sand mixed with bitumen and sand for joints between concrete pavers.
   1. Cast-in-Place Concrete Underlayment: Per Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).

G. Paving Installation Contractor:
   1. Job references from a minimum of three projects similar in size and complexity. Provide Owner/Client/General Contractor names, postal address, phone, fax, and email address.

H. LEED:
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paver is 29 or greater.

4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 QUALITY ASSURANCE

A. Utilize a Manufacturer having at least ten years of experience manufacturing concrete pavers on projects of similar nature or project size.

B. Source Limitations:
   1. Obtain Concrete Pavers from one source location with the resources to provide products of consistent quality in appearance and physical properties.
   2. Obtain Joint Sands from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.
   3. Obtain Polymeric Joint Sand from one source with the resources to provide materials and products of consistent quality in appearance and physical properties.

C. Paving Contractor Qualifications:
   1. Utilize an installer having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.

D. Mockups:
   1. Install a five feet by five feet paver area per each paving pattern.
   2. Use this area to determine surcharge of the Setting Bed Sand layer, joint sizes, lines, laying pattern(s) and levelness. This area will serve as the standard by which the workmanship will be judged.
   3. Subject to acceptance by owner, mock-up may be retained as part of finished work.
   4. If mock-up is not retained, remove and dispose legally.

1.06 DELIVERY, STORAGE AND HANDLING

A. In accordance with Conditions of the Contract and Division 1 Product Requirement Section.

B. Deliver Concrete Pavers in manufacturer's original, unopened and undamaged container packaging with identification labels intact.
   1. Coordinate delivery and paving schedule to minimize interference with normal use of streets and sidewalks adjacent to paver installation.
   2. Deliver Concrete Pavers to the site in steel banded, plastic banded or plastic wrapped packaging capable of transfer by forklift or clamp lift.
   3. Unload Concrete Pavers at job site in such a manner that no damage occurs to the product or adjacent surfaces.

C. Store and protect materials free from mud, dirt and other foreign materials.

D. Prevent Joint from exposure to rainfall or removal by wind with secure, waterproof covering.

E. Store Polymeric Joint Sand on elevated platforms, under a cover and/or in a dry location.

1.07 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
   1. Install Concrete Pavers only on unfrozen Bitumen Setting Bed.
   2. Install the Neoprene Tack Coat only to unfrozen Bitumen Setting Bed or when the temperature is within the manufacturer's recommended temperature range.
   3. Install Bitumen Setting Bed materials only when the temperature is above freezing.
   4. Install Bitumen Setting Bed materials only when there is no heaving rain or snowfall.
   5. Install Setting Bed Sand or Concrete Pavers only when there is no heavy rain or snowfall.

B. Weather Limitations for Polymeric Jointing Sand:
   1. Install Polymeric Joint Sand only when ambient temperature is above 40 degrees Fahrenheit (five degrees Celsius), under dry conditions with no rain forecast for 24 hours and when surface of pavement is completely dry.

1.08 CONCRETE PAVER OVERAGE AND ATTIC STOCK

A. Provide a minimum of five percent additional material for overage to be used during construction.

B. General Contractor to provide 100 square feet of each product and size used to owner for maintenance and repair. Furnish Pavers from the same production run as installed materials.

C. Manufacture to supply maintenance and reinstatement manuals for Concrete Paver units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:

1. Unilock New York, New England Division; 35 Commerce Drive; Uxbridge, MA 01569; Telephone: 508.278-6700; Website: www.unilock.com; Daniel Neviackas Massachusetts Sales Representative; Telephone: 508.341 4306 or your local Territory Manager.
2. Techo-Bloc Group; 70 East Brookfield Road, North Brookfield, MA 01535; Telephone: 774.449.8400; Website: www.techo-bloc.com; Rich Brown; Sales Representative; Telephone: 857.286.9828; Email: rich.brown@techo-bloc.com.
3. Hanover Architectural Products, 5000 Hanover Road, Hanover, PA 17331; Telephone: 800.426.4242; Fax: 717.637.7145; E-mail: info@hanoverpavers.com; Website: www.hanoverpavers.com.
4. Glen-Gery; 445 5th Avenue, New York, New York; Telephone: 914.215.7844; Website: www.glengery.com
5. Belgard, Oldcastle APG New England, 46 Spring Street, Holbrook, MA 02343; Telephone: 781.767.2202; Website: www.belgardcommercial.com; Chip George; Sales Representative; Telephone: 603.340.4337.
6. Whitacre Greer, 1400 S. Mahoning Avenue, Alliance, OH 44601; Telephone: 330.823.1610; Website: www.wgpaver.com; Jaquelyn Cox Regional Representative, Telephone: 423.802.7645; E-mail: jcox@wgpaver.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer’s products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 “SUBSTITUTION PROCEDURES”.

2.02 CONCRETE PAVERS

A. Basis-of-Design Product: The Concrete Paver shapes are based on:

1. Unilock:
   a. Treo
   b. Umbriano

B. Product requirements:

1. Concrete Paver Type One: Unilock Treo Rectangle (Band A)
   a. Finish:
      1) Treo – Smooth Premier.
   b. Color: Fossil; See Plans.
   c. Edge: Rounded Edge.

d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.
    1) One-piece sizes:
        (a) Rectangle: 4½-inches by 9-inches by 2 3/8-inches.

Note: Imperial dimensions are nominal equivalents to the metric dimensions.

2. Concrete Paver Type Two: Unilock Treo Rectangle (Band A)
    a. Finish:
        1) Treo – Smooth Premier.
    b. Color: Dark Charcoal; See Plans.
    c. Edge: Rounded Edge
    d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.
        1) One-piece sizes:
            (a) Rectangle: 4½-inches by 9-inches by 2 3/8-inches.

    Note: Imperial dimensions are nominal equivalents to the metric dimensions.
3. Concrete Paver Type Three: Unilock Umbriano Square (Paver Band B)
    a. Finish:
        1) Umbriano – Mottled.
    b. Color: French Grey.
    c. Edge: Rounded Edge.
    d. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.
        1) One-piece sizes
            (a) Rectangle: 24-inches by 24-inches by 2 3/8-inches.

    Note: Imperial dimensions are nominal equivalents to the metric dimensions.
4. Concrete Paver Type Four: Unilock Umbriano Three Piece Random Pattern (Field A)
    a. Finish:
        1) Umbriano - Mottled.
    b) Color: Summer Wheat.
    c) Edge: Rounded Edge.
    d) Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 inch for length and width. Maximum height tolerance of plus or minus 1/8 inch.
        1) Three-piece sizes:
            a) Large Rectangle: 14 1/4-inches by 21 1/4-inches inches by 2 3/8-inches (360-millimeters by 540-millimeters by 60 millimeters).
            b) Square: 14 1/4-inches by 14 1/4-inches by 2 3/8-inches (360-millimeters by 360 millimeters by 60 millimeters).
            c) Small Rectangle: seven-inches by 14 1/4-inches by 2 3/8-inches (180-millimeters by 360-millimeters by 60 millimeters).

    Note: Imperial dimensions are nominal equivalents to the metric dimensions.

C. Provide pavers meeting the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.
    1. Average compressive strength 8,000 pounds per square inch (55Megapascals) with no individual unit under 7,200 pounds per square inch (50 Megapascals).
    2. Average absorption of five percent with no unit greater than seven percent when tested according to ASTM C 140.
    3. Conforming to ASTM C 1645 when tested for freeze-thaw requirements.
    4. Height tolerances +/- 3.2 millimeters (1/8 inches).
D. Accept only pigments in concrete pavers conforming to ASTM C 979.

2.03 JOINT SAND

A. Provide natural Joint Sand as follows:
   1. Washed, clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
   2. Reject limestone screenings, stone dust, or sand for the Joint Sand material that does not conform to conform to the grading requirements of ASTM C 33.
   3. Utilize sands that are as hard as practically available where concrete pavers are subject to vehicular traffic.
   4. Gradation as shown in Table 1 below:

TABLE 1 – JOINT SAND
GRADATION REQUIREMENTS FOR JOINT SAND

ASTM C 144		
Sieve Size	**Natural Sand Percent Passing**	**Manufactured Sand Percent Passing**
No. 4 (4.75 mm)	100	100
No. 8 (2.36 mm)	95 to 100	95 to 100
No. 16 (1.18 mm)	70 to 100	70 to 100
No. 30 (0.600 mm)	40 to 75	40 to 75
No. 50 (0.300 mm)	10 to 30	20 to 40
No. 100 (0.150 mm)	2 to 15	10 to 25
No. 200 (0.075)	0 to 1	0 to 10

2.04 POLYMERIC JOINT SAND

A. Provide Polymeric Joint Sand as manufactured by:
   1. Alliance Gator G2
      a. Product Type: Dry mix, contains polymeric binding agent, activated with water.
      b. Color: Beige.
   2. Unicare HP Polymeric Max Sand
      a. Product Type: Dry mix, contains polymeric binding agent, activated with water.
      b. Color: Tan.
   3. Techniseal HP Next Gel
      a. Product Type: Dry mix, contains polymeric binding agent, activated with water.
      b. Color: Grey.

B. Provide Polymeric Joint Sand meeting the minimum material and physical properties as follows:
   1. Compression Strength: proven resistance to compression of 550 pounds per square inch after drying for seven days under controlled conditions (73 degrees Fahrenheit (23 degrees Celsius) at 50 percent humidity).
      a. Test sand sample shape: cylinder (two-inch (five centimeters) diameters by four inches (10 centimeters) high).
   2. Gradation as shown Table 1 above.

2.05 NEOPRENE TACK COAT

A. Neoprene modified asphalt adhesive:
   1. Karnak 230 2 percent neo-asphalt paving block adhesive.
   2. Note: Only apply enough Neoprene Tack Coat to completely cover the Bitumen Setting Bed. Applying an excessive amount of Neoprene Tack Coat can cause the material to expand during summer months and ooze up through the paver joint damaging the paver surface.

2.06 BITUMEN SETTING BED MATERIALS

A. Sand for asphalt bed:
   1. Clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.
   2. Graded according to ASTM C 136.
   3. Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C 33 with modifications as shown in Table 2.

TABLE 2 – BITUMEN SETTING BED
GRADATION REQUIREMENTS FOR BITUMEN SETTING BED

ASTM C 33	
Sieve Size	**Percent Passing**
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	85 to 100
No. 16 (1.18 mm)	50 to 85
No. 30 (0.600 mm)	25 to 60
No. 50 (0.300 mm)	10 to 30
No. 100 (0.150 mm)	2 to 10
No. 200 (0.075)	2 to 10

B. Asphalt Cement:
   1. Provide Asphalt Cement used in the bituminous setting bed conforming to ASTM D 946 with a penetration at 77 degrees Fahrenheit 100G., five sec of minimum 85 millimetres and a maximum of 100 millimetres.
   2. Combine the dried fine aggregate with hot asphalt cement and heat the mix to approximately 300 degrees Fahrenheit (150 degrees Celsius), at an asphalt plant. Mix the approximated proportion of materials including seven percent asphalt cement and 93 percent fine aggregate. Proportioned by weight each ton of the batch in the approximate ratio of 145 pounds (66 kilograms) asphalt to 1,855 pounds (840 kilograms) sand.

C. Primer for base:
   1. Anionic asphalt emulsion SS-1h, per ASTM D 977.

2.07 EDGE RESTRAINTS

A. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Permaloc Corporation.
      b. Curv-Rite, Inc.
      c. Sure-Loc Edging Corporation.
   2. Edging Size: 3/16 inches (4.8 millimeters) wide by four-inches (102 millimeters) deep by 16-feet (4.8 meters) long.
   3. Stakes: Aluminum, 12- inches (305 millimeters) long, stakes to interlock in section hoops.
   4. Finish: Black Anodized.

B. Aluminum L-Shaped Edge Restraints: Standard-profile extruded-aluminum edging, ASTM B 221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections; paver

restraint edging for straight-line and curvilinear applications in corrugated L-shaped profile, Horizontal base shall have holes spaced 4 inches (102 millimeters) apart along its length to receive spikes.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Permaloc Corporation.
   b. Curv-Rite, Inc.
   c. Sure-Loc Edging Corporation.
2. Edging Size: 3/16-inch (4.8 millimeters) wide by 2 1/4-inches (102 millimeters) deep by eight-feet (2.4 meters) long.
3. Spikes: Steel spiral spike, 3/8-inch (9.5 millimeters) by 10-inches (254 millimeters). In hardened surfaces (concrete, masonry) use 3/16-inch (4.8 millimeters) by 1 1/2-inch (38 millimeters) concrete nail or drive pin fastener equal to Hilti DX 40 powder actuated pin.
4. Finish: Black Anodized.
5. Job-Built Concrete Edge Curb Restraints: Comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 5000 pounds per square inch (34 Megapascals).

C. Stone Edge Curb Restraints: Comply with requirements in Section 04 43 00 "STONE SITE MASONRY" for stone curbing in shapes and sizes indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas indicated to receive paving for compliance with requirements for installation tolerances and other conditions affecting performance for the following items before placing the Concrete Pavers.

1. Verify that Cast-in-Place Concrete Underlayment strength, thickness, surface tolerances and elevations conform to specified requirements.
2. Verify that the Bitumen Setting Bed materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.
3. Verify location, type, and elevations of edge restraints, concrete curbing, concrete collars around utility structures, and drainage inlets.
4. Verify location of two inches (50 millimeters) diameter weep holes at 20 feet (seven meters) centers and at lowest elevations against curbs, walls, or other permanent structures or as indicated on the drawings. Verify holes filled with IDOT CA-16. Provide temporary plugs for holes to prevent ingress of sand-asphalt setting bed or neoprene adhesive during construction. Remove plugs when paving adjacent to drain holes.
5. Verify that concrete surfaces to receive the bitumen bedding material are free of dust, oil, grease, paint, wax, curing compounds, primer, sealers, form release agents, from cracks over 3/16 inches (five millimeters) in width, or any deleterious substances and debris which may prevent or reduce bonding.
6. Conduct moisture tests to verify that concrete surfaces are cured, free from hydrostatic pressure and having a moisture content of less than five percent.
7. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.
8. Do not proceed with installation of Bitumen Setting Bed or Concrete Pavers until base conditions are corrected by the General Contractor or designated subcontractor.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Beginning of Bitumen Setting Bed and Concrete Paver installation signifies acceptance of Cast-in-Place Concrete Underlayment.

3.02 PREPARATION

A. Verify that Cast-in-Place Concrete Underlayment is clean, dry, and ready to accept Primer, Bitumen Setting Bed, Tack Coat, Concrete Pavers, and imposed loads.

B. Stockpile Joint Sand materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

C. Remove any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities before placing the Aggregate Base.

D. Keep area where pavement is to be constructed free from sediment during entire job. Remove and replace all Joint Sand contaminated with sediment with clean materials.

E. Complete all subdrainage of underground services within the pavement area in conjunction with subgrade preparation and before the commencement of Cast-in-Place Concrete Underlayment construction.

F. Prevent damage to underdrain pipes, overflow pipes, observation wells, or inlets and other drainage appurtenances during installation. Report all damage immediately.

G. Compact soil subgrade uniformly to at least 95 percent of Standard Proctor Density per ASTM D 698 for pedestrian areas. Compact soil subgrade uniformly to at least 98 percent Modified Proctor per ASTM D 1557 for vehicular areas. Stabilization of the subgrade may be necessary with weak or saturated subgrade soils.

H. Backfill all service trenches within the pavement area to the subgrade level with approved material placed in uniform lifts not exceeding four inches (100 millimeters) loose thickness. Compact each lift to at least 100 percent Standard Proctor Density as specified in ASTM D 698.

I. Trim the subgrade to within zero to 1/2 inch (zero to 13 millimeters) of the specified grades. Do not deviate the surface of the prepared subgrade by more than 3/8 inch (10 millimeters) from the bottom edge of a 39 inches (one meter) straight edge laid in any direction.

J. Do not proceed with further pavement construction, under any circumstances, until the subgrade has been inspected by the Architect/Engineer.

3.03 EDGE RESTRAINTS

A. Provide edge restraints as indicated.

B. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least one inch (25 millimeters) below top edge.
3. Install job-built concrete edge curb restraints to comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).
4. Install stone edge curb restraints to comply with requirements in Section 04 43 00 "STONE SITE MASONRY".
5. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
6. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

C. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
   1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.04 INSTALLATION

A. CONCRETE BASE PREPARATION:
   1. Fill any cracks under 3/16 inches (five millimeters) wide with mortar.
   2. Sweep the surface clean.

B. ASPHALT PRIMER:
   1. Apply Bitumen Setting Bed Asphalt primer to Cast-in-Place Concrete Underlayment to bond the bituminous bedding material to the concrete base.
   2. Apply according to manufacturer's recommendation at a rate.
      Note: Utilize Cut Back Asphalt Specification (Rapid Curing Type), per ASTM D 2028-97 (2004) and AASHTO M-81.

C. BITUMEN SETTING BED:
   1. Place in panels between 3/4 inches (20 millimeters) high screed rails spaced approximately 12 feet (four meters). Set the depth screed rails carefully to bring the Bitumen Bedding material to proper grade, to ensure proper Concrete Paver finished height. Place Bitumen Bedding material between the parallel screed rails. Rake and screed smooth with strike board. Fill any depressions with fresh bituminous material to produce a smooth, firm and even setting bed after each pass.
   2. Use screed rails to achieve a level setting bed conforming to elevations and slope shown on the drawings. After one panel is completed, advance screed rails to the next position in readiness for screeding adjacent panels with strike board. Fill depressions left from removed screed rails and smooth to height consistent with panel.
   3. Place an area in size that will remain at least 270 degrees Fahrenheit (130 degrees Celsius) during compaction.
   4. Compact the Bitumen Setting Bed with a powered roller compactor to an even, nominal thickness of 3/4 inch (20 millimeters) after compaction while still hot. Adjusted the Bitumen Setting Bed to accommodate the required finished grade of the Concrete Pavers. Proper attention to elevations during the construction of the concrete base material to insure maintaining the required nominal 3/4-inch-thick Bitumen Setting Bed.
   5. Re-heat, fill, and compact low areas with Bitumen Setting Bed materials to conform to slope and elevation shown on the drawings.
   6. Re-heat, remove, level, and compact Bitumen Setting Bed in high areas to conform to slope and elevation shown on the drawings.
   7. Correct irregularities or evenness in the grade of the concrete base surface with Setting Bed materials only.

D. NEOPRENE MODIFIED ASPHALT ADHESIVE:
   1. Apply to cold asphalt setting bed with notched trowel with serrations not exceeding 1/16 inch (two millimeters). Do not apply pavers to adhesive until dry skin forms on surface of adhesive, approximately two to three hours depending on air temperature.

E. CONCRETE PAVERS
   1. Replace Concrete Pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.
   2. Mix Concrete Pavers from a minimum of three bundles simultaneously drawing the paver vertically rather than horizontally, as they are placed, to produce uniform blend of colors and textures. (Color variation occurs with all concrete products. This phenomenon is

influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three bundles simultaneously, variation in color is dispersed and blended throughout the project).

3. Exercise care in handling face mix concrete pavers to prevent surfaces from contacting backs or edges of other units.
4. Place Concrete Pavers using laying pattern as indicated. Adjust laying pattern at pavement edges such that cutting of edge pavers is minimized. Cut all pavers exposed to vehicular tires no smaller than one-third of a whole paver.
5. Use string lines or chalk lines on Setting Bed Sand to hold all pattern lines true.
6. Set surface elevation of pavers 1/8 inch (three millimeters) above adjacent drainage inlets, concrete collars or channels.
7. Place units hand tight against spacer bars. Adjust horizontal placement of laid pavers to align straight.
8. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
9. Provide space between paver units of 1/32 inch (one millimeters) wide to achieve straight bond lines.
10. Prevent joint (bond) lines from shifting more than ±1/2 inch (±13 millimeters) over 50 feet (15 meters) from string lines.
11. Fill gaps between units or at edges of the paved area that exceed 3/8 inch (10 millimeters) with pieces cut to fit from full-size unit pavers.
12. Cut Concrete Pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
13. Prevent all traffic on installed Concrete Pavers until Joint Sand has been vibrated into joints. Keep skid steer and forklift equipment off newly laid Concrete Pavers that have not received initial compaction and Joint Sand material.
14. Vibrate Concrete Pavers into leveling course with a low-amplitude plate vibrator capable of a to 5000-pound force (22-kilo-newton) compaction force at 80 to 90 Hertz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
    a. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
    b. Compact installed Concrete Pavers to within six feet (two meters) of the laying face before ending each day's work. Cover Concrete Pavers that have not been compacted and leveling course on which pavers have not been placed, with nonstaining plastic sheets to prevent Setting Bed Sand from becoming disturbed.
15. Protect face mix Concrete Paver surface from scuffing during compaction by utilizing a urethane pad.
16. Remove any cracked or structurally damaged Concrete Pavers and replace with new units prior to installing Joint Sand material.

F. JOINT SAND

1. Provide, spread and sweep dry Joint Sand into joints immediately after vibrating pavers into Tack Coat and Bitumen Setting Bed course until full. Vibrate pavers and add Joint Sand material until joints are completely filled, then remove excess material. Perform a minimum of four passes with a plate compactor.
2. Leave all work to within three feet (one meter) of the laying face fully compacted with sand-filled joints at the completion of each day.
3. Remove excess Joint Sand broom clean from surface when installation is complete.

4. Polymeric Joint Sand
    a. Install Polymeric Joint Sand per manufacturers recommended instructions.

3.05 FIELD QUALITY CONTROL

A. Verify final elevations for conformance to the drawings after sweeping the surface clean.
    1. Prevent final Concrete Paver finished grade elevations from deviating more than ±3/8 inch (±10 millimeters) under a 10 feet (three meters) straightedge or indicated slope, for finished surface of paving.

B. Lippage: Paver-to-Paver Lippage:
    1. No greater than three millimeters (1/8 inch) difference in height between adjacent pavers.

3.06 REPAIRING, CLEANING AND SEALING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Cleaning: Remove excess dirt, debris, stains, and grit from exposed paver surfaces; wash and scrub clean.
    1. Clean Concrete Pavers in accordance with the manufacturer's written recommendations.

C. Seal as indicated.

3.07 PROTECTION

A. Protect completed work from damage due to subsequent construction activity on the site.

END OF SECTION

SECTION 32 16 14
PRECAST CONCRETE CURBS

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

A. Earth Moving: Section 31 20 00.

1.02 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

1.03 SUBMITTALS

A. Product Data: Catalog sheets, specifications, and installation instructions for precast curbs.

B. Quality Control Submittals:

1. Test Reports: Random freeze thaw tests will be conducted by the manufacturer. Test specimens will retain 60 percent of its initial modulus of elasticity after 300 cycles. Test results will be made available to the Director upon request.

PART 2 - PRODUCTS

3.01 MATERIALS

A. Provide precast concrete curbs with a minimum compression strength of 5000 pounds per square inch. Castings will have plane smooth surfaces, true to line and face, free from defects, sharp arises, and with curved surfaces accurately reproduced. Overall dimensions for each casting will not vary more than 1/16 inch from those indicated.

B. Curb units will be cast at the manufacturers plant. Job site castings will not be permitted.

C. Curbing to be set on a radius of 100 feet or less will be cast to the curve required. Ends will be formed or sawed on radial lines.

D. Curb Foundation: One part of Portland cement to six parts No. 1A coarse aggregate dry mix.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set curb true to line and grade on a foundation of one cubic foot of dry concrete for each linear foot of curb installed. Ram all spaces under the curb so that it is completely supported throughout the entire length.

B. Butt joint curb sections together.

C. Install joint sealer where curb abuts existing walls, posts, buildings, and fixed structures or appurtenances.

3.02 RESETTING EXISTING CURBS

A. Remove mortar and concrete from existing curbs to be reused. Replace units damaged by the Construction Manager’s negligence.

B. Reset existing curbs accepted for reuse by the Town of Wilmington.

3.03 FIELD QUALITY CONTROL

A. The Town of Wilmington may conduct additional tests at their discretion. Replace curb units taken for testing, not to exceed 10 linear feet for each 1000 feet or fraction thereof delivered to the project.

END OF SECTION

SECTION 32 16 40
GRANITE CURB

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

1.02 WORK INCLUDED

A. The work includes furnishing all labor, materials, equipment, and supervision to construct the various types of granite curbing, in accordance with the Drawings and Specifications.

1.03 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
   1. Section 01 40 00 - Quality Requirements; Inspection and testing.
   2. Provision of waste management: Section 01 74 19 - Construction Recycling Waste Management Plan.
   3. Section 03 30 00 - Cast-In-Place Concrete; Concrete curb; concrete for base.
   4. Section 31 20 00 - Earth Moving; Establishment of subgrade elevations and courses.
   5. Section 32 12 16 - Asphalt Paving.

1.04 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements will govern.
   1. American Society for Testing and Materials (ASTM):
      a. ASTM C 131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
      b. ASTM C 615 Structural Granite
   2. Commonwealth of Massachusetts Highway Department (MHD): Specifications Standard Specifications for Highway and Bridges

1.05 SUBMITTALS

A. Submit complete shop drawings of each curb type and size for Architect's acceptance.

1.06 SAMPLE SECTION

A. A sample curb section, full dimension, 6 feet long minimum, will be fabricated prior to start of granite curbing. The work will be inspected by the Architect. If the original sample is not acceptable, the Construction Manager will construct additional sample sections until an accepted sample is obtained. The accepted sections will become the standard for the entire job and will remain undisturbed until completion of all granite curbing.

1.07 QUALITY ASSURANCE

A. Unless otherwise indicated, granite curb materials and construction will conform to the applicable portions of the following:
   1. MHD Specifications Section 500, "Curb and Edging."

1.08 DELIVERY, STORAGE, AND HANDLING

A. Granite curb units will be delivered to the job adequately protected from damage during transit.

B. Curb will be protected against staining, chipping, and other damage. Cracked, badly chipped, or stained units will be rejected and will not be employed in the work.

PRODUCTS

2.01 BASE COURSE

A. Material for base course will be Dense Graded Crushed Stone, as specified in Section 31 20 00 - Earth Moving.

2.02 GRANITE CURB

A. Granite curb required to complete the work of this Section will be a structural granite conforming to ASTM C 615, Class I Engineering Grade, suitable for curbstone use.
   1. Curb will be light grey, free from seams which impair structural integrity, and with percentage of wear less than 32 percent, as determined by ASTM C 131.

B. Curb materials will conform to MHD Specifications Section M9.04.0 and will meet requirements specified in the subsection of Division III, Materials of the MHD Specifications:
   1. Item:
      a. Vertical Granite Curb.
      b. Transitional Granite Curb.
      c. Flush Granite Curb.

C. Provide sawn vertical faces on both sides for all curb sizes. Provide thermal finish on exposed pavement/paver side only.

2.03 CEMENT MORTAR

A. Mortar for pointing joints between curbstones will be a cement mortar composed of one-part Portland cement and two parts sand, by volume with sufficient water to form a workable, stiff mixture.

2.04 CONCRETE

A. Concrete for foundation at joints will conform to Section 03 30 00 - Cast-In-Place Concrete.

PART 2 - EXECUTION

3.09 GRADING

A. Areas to receive granite curb will be compacted and brought approximately to subgrade elevation under Section 31 20 00 - Earth Moving before work of this section is performed. Final fine grading, filling, and compaction of subgrade to receive curbing to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, will be done under this Section.

B. Existing subgrade material which will not readily compact will be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed will be material conforming to Section 31 20 00 - Earth Moving.

C. Subgrade of areas to receive curbing will be recompacted to bring top eight inch of material immediately below gravel base course to a compaction of at least 90 percent of maximum density, as determined by ASTM D 1557, Method D. Subgrade compaction will extend for a distance of at least one foot. beyond curb edge.

D. Excavation required in subgrade will be completed before fine grading and final compaction of subgrade are performed. Where excavation shall be performed in completed subgrade or subbase subsequent backfill and compaction will be performed as specified in Section 31 20 00 - Earth Moving. Completed subgrade after filling such areas will be uniformly and properly graded.

E. Areas being graded or compacted will be kept shaped and drained during construction. Ruts greater than or equal to two inch deep in subgrade, will be graded out, reshaped and recompacted before placing granite curb.

F. Materials will not be stored or stockpiled on subgrade.

G. Disposal of debris and other material excavated and/or stripped under this section, and material unsuitable for or in excess of requirements for completing work of this Section will be legally disposed of off-site.

H. Prepared subgrade will be inspected by the Architect. Subgrade will be accepted by the Architect before installation of aggregate base course. Disturbance to subgrade caused by inspection procedures will be repaired under this Section of the specification.

3.010 AGGREGATE BASE COURSE

A. Aggregate base course for paving and the spreading, grading, and compaction methods employed will conform to Section 31 20 00 - Earth Moving.

B. Subgrade and base course will be kept clean and uncontaminated. Less select materials will not be permitted to become mixed with gravel. Materials spilled outside pavement lines will be removed and area repaired.

C. Portions of subgrade or of construction above which become contaminated, softened, or dislodged by passing of traffic, or otherwise damaged, will be cleaned, replaced, and otherwise repaired to conform to the requirements of Section 31 20 00 - Earth Moving before proceeding with next operation.

3.011 SETTING CURB

A. Curb will be set in aggregate base with continuous concrete haunch foundation, with trench bottom at minimum six inches below bottom of curb. Excavation will be filled to required level with base course material as specified above.

B. Vertical face of vertical curb will be plumb, with curb top parallel to adjacent surface.

C. Curb will be set accurately to line and grade in continuous haunch. Curb units will be fitted together as closely as possible. Curb will not be field cut.

D. Joints, between curb units will be carefully filled with a cement mortar, and neatly pointed on the top and front exposed portions. After pointing, excess mortar will be cleaned from curb surface.

E. Backfill material on each side of curb will be as specified for adjacent surface and will be thoroughly compacted by means of power tampers. Extreme care will be taken not to destroy alignment. Curb sections disturbed during backfilling or otherwise will be reset to line and grade, and properly backfilled.

END OF SECTION

SECTION 32 17 00
LANDSCAPE PAVING SPECIALTIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Stone drip strip.
   2. Aluminum edge restraints.
   3. Edge curb restraints
   4. Geotextiles.

B. Related Sections:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for flush cast-in-place concrete edge curb restraints as released in Early Release Package 2 (ERP2).
   2. Section 04 43 00 "STONE SITE MASONRY" for flush stone edge curb restraints.
   3. Section 31 00 00 "EARTH MOVING" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.

1.03 PERFORMANCE REQUIREMENTS

A. Perform gradation of decomposed granite material or 3/8-inch or 1/4-inch minus crushed aggregate in accordance with ASTM C 136 – Method for Sieve Analysis for Fine and Course Aggregates.

1.04 REFERENCES

A. The following Standards shall apply to the Work of this Section:
   1. ASTM: American Society for Testing and Materials:
      Specification of Concrete Aggregates: C33.
      Test Methods for Absorption and Bulk Specific Gravity of Dimensional Stone: C97.
      Test Methods for Modulus of Rupture of Dimension Stone: C99.
      Standard Terminology Relating to Dimension Stone: C119.
      Test Method for Sieve Analysis of Fine and Coarse Aggregates: C136.
      Test Method for Compressive Strength on Dimension Stone: C170.
      Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic: C241.
      Standard Specification for Granite Dimension Stone: C615.
      Test Method for Flexural Strength of Dimension Stone: C880.
      Specification for Solid Concrete Interlocking Paving units: C936.
      Test method for Softening Point of Bitumen (Ring and Bell Apparatus): D36.
      Test method for Ductility of Bituminous Materials: D113.
      Test Method for laboratory Compaction Characteristics of Soil using Modified Effort [56,000 ft-lbf/ft3 (2,700 kN-m/m3)]: D1557.
      Specification for Viscosity-Graded Asphalt Cement for use in Pavement Construction: D3381.

1.05 ACTION SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Product Data: For the following:
   1. Stone drip strip materials.
   2. Edge restraints.
   3. Reinforcement.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

D. Samples for Initial Selection: For the following:
   1. Each type of stone indicated.
   2. Exposed edge restraints involving color selection.
E. Samples for Verification:
   1. Stone drip strip; one quart bag; minimum
   2. Exposed edge restraints; 12-inches with one stake.
F. Maintenance Instructions: Submit copy(ies) of manufacturer's written maintenance instructions in accordance with Section 01 78 00 – "CLOSEOUT SUBMITTALS".
G. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paving is 29 or greater.
   4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of stone and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
B. Compaction testing to be provided by General Contractor, one test per 2,000 square feet of base course.
C. Manufacturer's technical representative shall visit the site at the start of an installation to ensure the installer understands the correct installation methods to use.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
B. Upon receipt at site, protect surfacing during storage and construction against erosion, soiling or contamination from earth and other materials.
   1. Cover surfacing with plastic or use other packaging materials to prevent damage and erosion
C. Delivered materials shall be identical to the previously acceptable sample and mock-up. Remove materials which are damaged or otherwise not suitable for installation for the job and replace with acceptable materials.
D. Any pavement delivered to the job site which exhibits flaws, imperfections, dimensional errors, improper tolerances or is not considered acceptable shall be rejected and such stone shall be removed from the job site and replaced so as not to delay job progress

1.08 PROJECT CONDITIONS

A. Field Measurements: Each bidder is required to visit the site of the Work to verify the existing conditions. No adjustments shall be made to the Contract Sum for variations in the existing conditions.
   1. Where surfacing is indicated to fit with other construction, verify dimensions of other construction by field measurements before proceeding with the work.

PART 2 PRODUCTS

2.01 AGGREGATE BASE COURSE

A. Graded Aggregate for Subbase: Sound, crushed stone or gravel complying requirements in Section 31 00 00 "EARTH MOVING" for subbase material.

B. Graded Aggregate for Base: Sound, crushed stone or gravel complying with requirements in Section 31 00 00 "EARTH MOVING" for base course.

2.02 STONE DRIP STRIP

A. Stone shall be hard, durable stone, washed free of loam, sand, clay and other foreign substances, of following type, size range and color:
   1. Type: Crushed Stone; Angular
   2. Size Range: 3/4-inch
   3. Match: Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects
   4. Color: Readily available natural gravel color range, provide sample for acceptance.

2.03 EDGE RESTRAINTS

A. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Permaloc Corporation.
      b. Curv-Rite, Inc.
      c. Sure-Loc Edging Corporation.
   2. Edging Size: 3/16 inch (4.8 millimeters) wide by four-inches (102 millimeters) deep by 16-feet (4.8 meters) long.
   3. Stakes: Aluminum, 12- inches (305 millimeters) long, stakes to interlock in section hoops.
   4. Finish: Black Anodized.

B. Job-Built Concrete Edge Curb Restraints: Comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 5000 pounds per square inch (34 Megapascals).

C. Stone Edge Curbs Restraints: Comply with requirements in Section 04 43 00 "STONE SITE MASONRY" for stone curbing in shapes and sizes indicated.

2.04 FILTER FABRIC FOR STONE DRIP STRIP

A. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2, AASHTO M 288.
   2. Apparent Opening Size: No. 60 (0.250-millimeters) sieve, maximum; ASTM D 4751.
   3. Permittivity: 0.02 per second, minimum; ASTM D 4491.
   4. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing pavement.

3.03 EDGE RESTRAINTS

A. Provide edge restraints as indicated.

B. Install edge restraints before placing stone surfacing.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after stone installation.
2. For metal edge restraints with top edge exposed, drive stakes at least one inch (25 millimeters) below top edge.
3. Install job-built concrete edge curb restraints to comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).
4. Install stone edge curb restraints to comply with requirements in Section 04 43 00 "STONE SITE MASONRY".

3.04 STONE DRIP STRIP AGGREGATE BASE COURSE

A. Compact soil subgrade uniformly to at least 100 percent of ASTM D 698 laboratory density.

B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill.

C. For Drip strip, place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 millimeters).

D. For Drip strip, place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 millimeters).

3.05 STONE DRIP STRIP SURFACING

A. Drip strip surfacing shall be placed only after planting, excavation and construction work that might injure the surfacing have been completed. Damage to edging, drip strip surfacing, adjacent grades or materials occurring during construction shall be repaired by the General Contractor before acceptance at no additional cost to the Owner.

B. Any stone with a dimension greater than that permitted for the type of aggregate specified shall be removed from the base before the stone is compacted. Compaction shall continue until the surface is even and true to the proposed lines and grades within a tolerance of 1/8-inch.

C. Any specific area of drips trip surfacing, which after being rolled, does not form satisfactory, solid, stable foundation shall be removed, replaced and re-compacted by the General Contractor without extra compensation.

3.06 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the General Contractor under requirements of the Contract Documents.

1. Premature wear and tear provided the material is maintained in accordance with manufacturer’s written maintenance instructions.
2. Failure of system to meet performance requirements.

B. Warranty Period: General Contractor shall provide warranty for performance of product. General Contractor shall warranty installation of product for the time of one year from completion.

END OF SECTION

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 WORK INCLUDED

A. Provide all equipment and materials, and do all work necessary for pavement marking, including crosswalks and lines, handicap striping, and parking lot striping, as indicated on the Drawings and as specified.

1.03 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 01 45 00, QUALITY REQUIREMENTS; Inspection and testing.
2. Section 32 12 16, ASPHALT PAVING; Asphaltic concrete paving, including asphaltic concrete base for concrete pavers.
3. Provision of waste management: Section 01 74 19, Construction of Waste Management Plan.

1.04 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

1. Federal Specifications (Fed. Spec.):

   TT-P-115E Paint, Traffic, Highway, White, and Yellow
2. Commonwealth of Massachusetts Highway Department (MHD):

   Specifications Standard Specifications for Highways and Bridges.
3. Rules and Specification, For excavation activity within the Town of Yarmouth, Public Works Department.

1.05 LAYOUT OF WORK

A. The Contractor shall furnish to the Architect for approval a schedule of pavement marking operations in accordance with MHD Specifications Section 860.

1.06 SUBMITTALS

A. Lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation.

1.07 DELIVERY AND STORAGE

A. All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.08 EQUIPMENT

A. All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.09 TRAFFIC CONTROL

A. Traffic Controls: NOTE: Guidance for traffic control procedures can be obtained from the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.

B. Place traffic cones along newly painted lines to control traffic and prevent damage to newly painted surfaces. Remove when paint has dried fully.

1.010 WEATHER LIMITATIONS

A. Pavement surfaces shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operations shall cease during thunderstorms. Operations shall cease during rainfall, except for water blasting and removal of previously applied chemicals. Water blasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All thermoplastic pavement markings furnished and applied by shall be in accordance with the Massachusetts Department of Public Works Specifications dated 2024, sections 860 and M7, subsection M7.01.20 or latest revisions thereof. The raw materials used must be thoroughly melted, blended and mixed in the manufacturing process before delivery.

B. Paint and reflective media shall be in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, formulation number and directions, all of which shall be plainly legible at time of use.

2.02 PAINT MATERIAL

A. The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of six months, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.03 APPLICATION EQUIPMENT

A. Application Equipment for Marking Materials

1. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment that come into contact with the material shall be easily accessible and exposed for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.
2. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skip lines". The equipment shall be capable of applying varying widths of traffic markings.

B. Mobile and Maneuverable: Application equipment shall be mobile and maneuverable to the extent that straight lines can be followed, and normal curves can be made in a true arc. The equipment used for the placement of pavement markings shall be of two general types:

1. Mobile Application Equipment: The mobile applicator shall be defined as a truck mounted, self-contained pavement marking machine that is capable of applying paint markings. The unit shall be equipped to apply the marking material at widths ranging from three to 12 inches and at varying thickness. The mobile unit shall be capable of operating continuously and of installing a minimum of 20,000 lineal feet of longitudinal markings in an eight-hour day.
    a. The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal feet of markings applied to the pavement surface with an accuracy of half a percent.

2. Portable Application Equipment: The portable applicator shall be defined as hand operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be equipped with all the necessary components so as to be capable of extruding a line of three to 12 inches in width, and in varying thicknesses and of generally uniform cross section.

2.04 SURFACE PREPARATION EQUIPMENT

A. Sandblasting Equipment: shall include an air compressor, hoses, and nozzles of proper size and capacity for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

B. Water blast Equipment: The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

C. Marking Removal Equipment: shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Water blasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

D. Shot blasting Equipment: shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

E. Chemical Equipment: shall be capable of application and removal of chemicals from the pavement surface and shall leave only non-toxic biodegradable residue.

2.05 REFLECTIVE MEDIA DISPENSER

A. The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Surfaces to be marked shall be thoroughly cleaned before application of the pavement marking material. New pavement surfaces shall be allowed to cure for a period of not less than 48 hours before application of marking materials.

B. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods. Rubber deposits, surface laitance and other coatings adhering to the pavement shall be completely removed.

C. Where oil or grease are present on old pavements to be marked, affected areas shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be recleaned, when work has been stopped due to rain.

3.02 PRIMER

A. After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the final paint composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the manu-

facturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

3.03 APPLICATION OF MARKING MATERIALS

A. Marking materials shall be applied to clean, dry surfaces. Pavement marking materials shall be applied evenly to the pavement surface to be coated at a rate specified recommended by the paint manufacturer

B. Paint: Paint shall be applied with approved equipment. Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied with approved equipment at rate of coverage specified. The Contractor shall provide guidelines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

C. Guidelines and templates shall be employed as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

D. Maximum drying time requirements of the paint manufacturer shall be enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by vehicle tires.

E. If markings require more drying time than stated by the paint manufacturer, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.04 PROTECTION OF MARKINGS

A. Markings shall remain protected until sufficiently dry to bear traffic.

END OF SECTION

SECTION 32 17 26
TACTILE WARNING SURFACES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specifications Section, apply to this Section.

1. Provision of waste management: Section 01 74 19, Construction of Waste Management Plan.
2. Section 32 13 13.13, CONCRETE PAVING (SITE)

1.02 DESCRIPTION

A. This Section specifies furnishing and installing Cast Iron Detectable/Tactile Warning Surface Indicator Plates where indicated.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.

B. Samples for Verification Purposes: Submit one plate sample that shows dome size and spacing.

C. Shop drawings are required for products specified showing fabrication details, fastener and anchor locations, plans of plate placement including joints, and material to be used as well as outlining installation materials and procedure.

D. Material Test Reports: Submit complete test reports from qualified accredited independent testing laboratories to qualify that materials proposed for use are in compliance with requirements and meet or exceed the properties indicated on the specifications. All tests shall be conducted on a Cast Iron Detectable/Tactile Warning Surface Indicator Plate (or approved equal) as certified by a qualified independent testing laboratory.

E. Maintenance Instructions: Submit manufacturer's written installation and maintenance instructions for each type of detectable/tactile warning surface indicator plate and all associated accessories.

1.04 QUALITY ASSURANCE

A. Provide Cast Iron Detectable/Tactile Warning Surface Indicator Plates and accessories by a single supplier with a minimum of three (3) years' experience in the supply of Cast Iron Detectable/Tactile Warning Surface Indicator Plates.

B. Installer's Qualifications: Engage an experienced installer certified in writing by Cast Iron Detectable/Tactile Warning Surface Indicator Plate supplier as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for the project.

C. Provide Cast Iron Detectable/Tactile Warning Surface Indicator Plates which are in compliance with the following standards (or most recent):

1. Americans with Disabilities Act (Title III Regulations, 28 CFR Part 36 ADA STANDARDS FOR ACCESSIBLE DESIGN, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).

D. Gray Cast Iron Detectable/Tactile Warning Surface Indicator Plates shall be according to ASTM A 48M, Class 35B, and shall be bare and not coated with paint or other coatings or substances. Castings shall be sound, free from pouring faults, cracks, blowholes, and other defects.

E. Dimensions: The plate shall incorporate an in-line pattern of truncated domes measuring nominal 0.2" height, 0.90" base diameter, 0.45" top diameter spaced center-to-center 2.35" (+/- 0.05) For wheelchair safety the field area shall consist of a series of micro texture 0.06" high.

F. Product Data: Cast Iron Detectable/Tactile Warning Surface Indicator Plates shall meet or exceed the following test criteria:

ASTM A 327	Impact Resistance	No damage @ 54 J
ASTM A 48	Standard Specification for Gray Iron Castings	
ASTM D695	Compressive Strength	114,000 psi
ASTM D638	Tensile Strength	35,000 psi
ASTM C 501	Abrasive Wear Index	≥ 8800

1.05 DELIVERY, STORAGE AND HANDLING

A. Cast Iron Detectable/Tactile Warning Surface Indicator Plates shall be suitably packaged or crated to prevent damage in shipment and handling. Detectable/Tactile Warning Surface Indicator plate type shall be identified by part number.

B. Cast Iron Detectable/Tactile Warning Surface Indicator Plates shall be delivered to the location at the building site for storage prior to installation.

1.06 SITE CONDITIONS

A. Environmental Conditions and Protection: Maintain a minimum temperature of 41 degrees F in spaces to receive Cast Iron Detectable/Tactile Warning Surface Indicator Plates for at least 24 hours prior to installation, during installation, and for not less than 24 hours after installation.

B. The use of water for work, cleaning, or dust control shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect the general public.

1.07 MANUFACTURER'S WARRANTY

A. Cast Iron Detectable/Tactile Warning Surface Indicator Plates shall be warranted in writing for a period of ten years from date of substantial completion. The warranty includes factory defects, breakage, and deformation.

1.08 INSTALLATION WARRANTY

A. Cast Iron Detectable/Tactile Warning Surface Indicator Plate installation shall be warranted in writing for a period of two years. Alternate products approved during the tendering process must be guaranteed for an additional three years. The product must be guaranteed from defective work.

PART 2 – PRODUCTS

2.01 MATERIALS

A. DETECTABLE WARNING SURFACE, Detectable warning panel shall be cast iron.

1. Tile shall have integral embedment flanges for complete anchoring system.
2. Shall be capable of sustaining dynamic vehicle loading, AASHTO HS20-44 wheel load test.
3. Tile shall be easily cut to conform to angled and radius ramps.
4. Sizes: shall be manufacturer's standard sizes, or as indicated on the Drawings
5. Color shall be homogeneous throughout the tile. Color to be confirmed by the Architect, with visual contrast with surrounding paving in accordance with ADA Guideline A4.29.2 "Detectable Warnings on Walking Surfaces".
6. Pattern shall consist of raised truncated domes of height and diameter as specified in ADA Guideline 4.29.2.

B. Anchoring Materials:

1. Color matched, flat head drive anchors 1/4 in. diameter x 1-1/2 in. long.
2. Adhesive as supplied by manufacturer.
3. Perimeter Sealant as supplied by manufacturer.

C. Detectable warning tiles as manufactured by the following:

1. Tuf-Tile
2. Duralast
3. Neenah Foundry
4. Or approved equal

PART 3 - EXECUTION

3.01 INSTALLATION

A. During all surface preparation and installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.

B. The specifications and related materials shall be in strict accordance with the contract documents and the guidelines set by their respective manufacturers. Contact manufacturer for asphalt applications.

C. Coordinate with the Contractor or Engineer to ensure that the surfaces being prepared and fabricated to receive the plates are constructed correctly and adequately for plate installation. Review manufacturer and contract drawings with the Contractor prior to the construction and refer any and all discrepancies to the Engineer.

D. The physical characteristics of the concrete shall be consistent with the contract specifications while maintaining a slump range of three to four inches to permit solid placement of the Cast Iron Detectable/Tactile Warning Surface Indicator Plates.

E. When preparing to set the plate, ensure that the area to receive the plates has been finished to its final elevation. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the plate placement. Vents in the plate allow air and displaced concrete to escape during the installation process.

F. Lift the Detectable/Tactile Warning Surface Indicator plate and gently place into position onto the wet concrete. The plate shall be placed true and square to the curb edge in accordance with the contract drawings. Press into the concrete. The Cast Iron Detectable/Tactile Warning Surface Indicator Plates shall be tamped into the fresh concrete to ensure that the field level of the plate is flush to the adjacent concrete surface.

G. Immediately after placement, the plate elevation is to be checked to adjacent concrete, and the concrete around the perimeter of the tile should be finished. The elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the plate is flush with the surrounding concrete and back of curb so that no ponding is possible on the plate at the back side of curb, and to eliminate tripping hazards between adjacent finishes.

H. While concrete is workable, create a 1/4” concrete-free recess around the perimeter of the plate. Use a 3/8” radius edging tool to create a finished edge of concrete, then a steel trowel shall be used to finish the concrete around the plate’s perimeter, flush to the field level of the plate.

I. Clean the surface of the tile of any concrete that has protruded from the vent holes.

J. During and after the Detectable/Tactile Warning Surface Indicator Plate installation and the concrete curing stage, it is imperative that there is no walking, leaning or external force placed on the plate that may rock the plate causing a void between the underside of Detectable/Tactile Warning Surface Indicator Plate and concrete.

K. Following Detectable/Tactile Warning Surface Indicator Plate placement, review installation tolerances to contract drawings and adjust plate before the concrete sets.

L. Following the concrete curing stage, a soft brass wire brush will clean the residue without damage to the plate surface.

3.02 PROTECTION AND MAINTENANCE

A. Protect plates against damage during construction period to comply with Detectable/Tactile Warning Surface Indicator plate manufacturer’s specification.

B. Protect plates against damage from rolling loads following installation by covering with plywood or hardwood.

C. Comply with manufacturer’s maintenance manual for cleaning and maintaining plate surface. It is recommended to perform annual inspections for safety and plate integrity.

END SECTION

SECTION 32 17 26. 13
DETECTABLE WARNING SURFACE - RADIAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes:
   1. Furnishing and installing embedded Cast Iron Detectable Warning Surface Plates with an in-line truncated dome pattern embedded in concrete at radial pedestrian crossings.

B. Related Sections:
   1. Section 31 00 00 "EARTH MOVING" for excavation for installing concrete paving.
   1. Section 03 30 00.13 “CAST-IN-PLACE CONCRETE (SITE)” for concrete base under unit pavers as released in Early Release Package 2 (ERP2).
   2. Section 04 43 00 “STONE SITE MASONRY” for stone landscape curb serving as edge restraints for unit pavers.
   3. Section 32 14 00 “UNIT PAVING” for precast concrete paving units.
   4. Section 32 14 13 “UNIT PAVING ON BITUMIN SETTING BED” for precast concrete paving units.
   5. Section 32 17 26 “TACTILE WARNING SURFACE” for cast iron detectable warning strip set in concrete setting bed at standard curb cuts (non-radial).
   6. Section 32 17 26.13 “DETECTABLE WARNING SURFACE– RADIAL” for requirements for radial tactile warning surfaces.

1.03 REFERENCES

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specifications Section, apply to this Section.
   1. Department of Justice ADA Standards (2010)
   2. Department of Transportation ADA Standards for Transportation Facilities (2006)
   3. Proposed Guidelines for Accessible Public Rights-of-Way (2011)
   4. California Title 24
   5. ISO 23599:2019-01 – Assistive products for blind and vision-impaired persons — Tactile walking surface indicators
   6. ISO 21542:2011 – Building Construction – Accessibility and Usability of the Built Environment
   7. ISO 9001 – Certificate No. 0502011, ISO 1409 and ISO/B 16949 Certified Manufacturing Facility located in Jefferson, Ohio.

1.04 SUBMITTALS

A. Product Data Sheet: Submit ADA Solutions literature describing products, installation procedures and routine maintenance.

B. Samples for Verification Purposes: Submit two detectable warning surface plate samples. Samples shall be properly labeled and shall contain the following information: Name of Project, Submitted By, Date of Submittal, and Manufacturer’s Name.

C. Shop Drawings: Submit the Standard Manufacturer Shop Drawings showing all pertinent characteristics of the Cast Iron Detectable Warning Surface Plates including profile, plate surface profile, plans of plate placement including joints, and material to be used as well as outlining installation materials and procedures.

D. Material Test Reports: Submit all completed current test results from qualified, accredited independent testing laboratories by ASTM and UL/Canada guidelines and indicating that materials proposed for use follow specification requirements and meet or exceed the properties indicated on these specifications.

E. Maintenance Instructions: Submit copies of the manufacturer's specified installation and maintenance practices for each type of Detectable Warning Surface plates and accessories.

F. LEED

1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.
2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
   a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paving is 29 or greater.
4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 QUALITY ASSURANCE

A. Provide Radial Cast Iron Detectable Warning Surface Plates and accessories as produced by a single manufacturer with a minimum of five years of experience in manufacturing Cast-In-Place Detectable Warning Surface Products.

B. Installer's Qualifications: Engage an experienced installer certified in writing by Cast Iron Detectable Warning Surface Plates manufacturer as qualified for installation, who has completed installations similar in material, design, and extent to that indicated for the Contract.

C. Cast Iron Detectable Warning Surface Plates shall be compliant with ADAAG, PROWAG, and California Title 24 requirements.

D. Cast Iron Detectable Warning Surface Plates shall meet or exceed the following test criteria using the most current test methods:

Standard	Standard Description	Value
ASTM C 1028	Standard Test Method for Determining the Static Coefficient of Friction (Slip Resistance)	0.93 Dry, 0.91 Wet
ASTM A 48	Standard Specification for Gray Iron Castings	Complies Class 35B Gray Iron
ASTM A 159	Standard Specification for Automotive Gray Iron Castings	Complies
ASTM D 638	Tensile Strength	34,700 psi
AASHTO M105	Standard Specification for Gray Iron Castings	Complies Class 35B Gray Iron
ASTM D5420	Standard Test Method for Impact Resistance of by Means of a Striker Impacted by a Falling Weight (Gardner Impact)	600 in-lbs minimum
FM 5-594	Florida Method - Test for Wear Resistance of Surface Applied Detectable Warning Surfaces	0.00189 g/cm^3

E. Gray Iron Casting compliant with ASTM A 159 (G3000), ASTM A 48-03, and AASHTO M105-09 (Grade 35B).

F. Stamped concrete, polymer concrete, concrete pavers/tile, brick, or composite products are not acceptable for use on this project.

G. Plate body shall meet or exceed 0.20 inches (6.35 millimeters) thickness (not including truncated domes).

H. Plates shall have perimeter flange on all four sides with a minimum flange length of 0.38 inches (9.7 millimeters) long; 0.25 inches (6.35 millimeters) x 1.5 inches (38.1 millimeters) corrosion resistant metallic anchors with 0.25 inches (6.35 millimeters) x 1.25 inches (31.75 millimeters) stainless steel truss head bolts and washers.

I. Dimensions: Cast Iron Detectable Warning Surface Plates shall be held within the following dimensions and tolerances:

Part Number	No. of Anchors	Part Size	Part Weight
CI1224	4	Rectangular Plate 12” x 24” (305 mm x 610 mm)	19.30 lbs. (8.75 kg)
CI2424	6	Rectangular Plate 24” x 24” (610 mm x 610 mm)	34.25 lbs. (15.54 kg)
CI2430	8	Rectangular Plate 24” x 30” (610 mm x 762 mm)	43.35 lbs. (19.66 kg)
CI_15	-	15’ Radial Wedge Plate 24” x 5” (610 mm x 127 mm)	5.50 lbs. (2.49 kg)
CI_20	-	20’ Radial Wedge Plate 24” x 4” (610 mm x 101 mm)	5.50 lbs. (2.49 kg)
CI_25	-	25’ Radial Wedge Plate 24” x 4” (610 mm x 101 mm)	6.00 lbs. (2.72 kg)
CI_30	-	30’ Radial Wedge Plate 24” x 4” (610 mm x 101 mm)	6.00 lbs. (2.72 kg)

1.06 DELIVERY, STORAGE AND HANDLING

A. Cast Iron Detectable Warning Surface Plates shall be suitably packaged or crated to prevent damage in shipment and handling. Finished surfaces shall be protected by sturdy plastic wrappings to protect the plate from concrete residue during installation.

B. Cast Iron Detectable Warning Surface Plates shall be delivered to a location at the building site for storage before installation. Store plates in an area so that the plates are maintained in a clean, dry condition to prevent contamination or damage to the plates.

1.07 SITE CONDITIONS

A. Environmental Conditions and Protection: Maintain a minimum temperature of 40 degrees Fahrenheit (4 degrees Celsius) in spaces to receive Cast Iron Detectable Warning Surface Plates for at least 24 hours before installation, during installation, and for not less than 24 hours after installation.

B. The use of water for work, cleaning, and/or dust control shall be contained and controlled and shall not be allowed to come into contact with the general public. Provide barricades or screens to protect pedestrians.

1.08 MANUFACTURER’S WARRANTY

A. Cast Iron Detectable Warning Surface Plates shall be guaranteed in writing for a period of 15 years from date of Contract’s final completion. The guarantee includes manufacturing defects, breakage, and deformation.

1.09 INSTALLATION WARRANTY

A. Cast Iron Detectable Warning Surface Plates installation shall be warranted in writing for two years by the installer. Products shall be guaranteed from defective work and loosening of plates.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:

1. ADA Solutions, 323 Andover Street; Suite 3, Wilmington, MA 01887; Telephone 844.339.5967; Fax: 978.262.9125; E-mail: sales@adatile.com; Website: www.adatile.com.

2. Advantage Tactile Systems, 241 Main Street; Suite 100, Buffalo, NY 14203; Telephone: 1.800.679.4022; Website: www.advantagetactile.com.
3. NEI/ Neenah Foundry, 2121 Brooks Avenue, Neenah, WI 54956; Telephone: 920.725.7000; E-mail: infrastructureSolutions@groupnei.com; Website: www.groupnei.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers shall have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer’s products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 “SUBSTITUTION PROCEDURES”.

2.02 CAST IRON DETECTABLE WARNING SURFACE PLATES

A. Product: IRON DOME® Cast Iron Plates manufactured by ADA Solutions.

B. Plate Sizes
1. Standard Rectangular Plates
   a. 12 inches by 24 inches (304.8 x 609.6 millimeters)
   b. 24 inches by 24 inches (609.6 x 609.6 millimeters)
   c. 24 inches by 30 inches (609.6 x 762 millimeters)
2. Radius Wedge Plates (to be used in conjunction with rectangular plates)
   a. 24 inches by four inches or five inches (609.6 x 101.6 or 127 millimeters)
   b. Radius: four feet (1.2 meters) minimum to 150 feet (45.7 meters)

C. Existing engineered and field-tested products, which have been in successful service for five years are subject to specification compliance, may be incorporated in the project and shall meet or exceed the specified test criteria and characteristics. Requests for Approved Equal status must be submitted and accepted by the Owner before the Tender Phase of the project.

D. Color: Color shall be Dark Gray #36118.

E. Domes: Raised truncated domes of 0.2 inches (5.0 millimeters) nominal height, base diameter of 0.9 inches (22.8 millimeters) and top diameter of 0.45 inches (11.4 millimeters). ADA Standards and Public Rights-of-Way Accessibility Guidelines require truncated dome spacing range of 1.6 inches to 2.4 inches (40.6-60.9 millimeters).

F. Dome Spacing:
1. Standard Rectangular Plates: 2.4 inches (60.9 millimeters) dome spacing in square grid pattern
2. Radius Wedge Plates: 1.67 inches to 2.4 inches (40.6-60.9 millimeters) dome spacing in radial pattern

G. The Specifications of the concrete, sealants, and related materials shall be in accordance with the Contract Documents and the guidelines set by their respective manufacturers.

PART 3 EXECUTION

3.01 PREPARATION

A. During all concrete pouring and detectable warning plate installation procedures, ensure adequate safety guidelines are in place and that they comply with the applicable industry and government standards.

B. Before installation, General Contractor to ensure all submittals have been reviewed and accepted by the contract Engineer/Architect. Detectable warning plates shall be installed as per manufacturer's instructions.
C. Before placement of the detectable warning plates, review manufacturer's instructions and contract drawings with the Paving Contractor before the construction and refer all discrepancies to Project Engineer/Manager.
D. The physical characteristics of the concrete shall be consistent with the Contract Specifications while maintaining a slump range of four-inches to seven inches (102 millimeters to 178 millimeters) to permit solid placement of the detectable warning plates. An overly wet concrete mix may cause the plates to float. Under these conditions, suitable weights such as two concrete blocks or sandbags 25 pounds (11.4 kilograms) shall be placed on each cast iron plate until the concrete sets.
E. The concrete shall be poured and finished, true and smooth using typical mason's tools to the required dimensions and slope before detectable warning plate placement. Immediately after finishing, use a four feet (1.2 meters) long level with electronic slope readout to level to the required specified slope is achieved. The plates shall be placed true and square to the curb edge, or by the contract drawings/specifications.

3.02 INSTALLATION

A. Maintain a four inch to seven-inch slump range, pour, and float the concrete and prepare for detectable warning plate installation.
B. Without removing any concrete, place plates on the curb ramp six inches to eight inches from the curb line.
C. Tamp the plates in grid pattern across the top face, embedding the plates into the concrete using a rubber mallet or vibrate into place using a vibrating mechanism fixed with a soft base such as wood.
D. Create an edge around the perimeter of the detectable warning plates using a 3/8-inch radius edging tool then float the concrete around plate perimeter using a steel trowel.
E. Using a smart level, make sure ramp and plates maintain compliance with ADA requirements and in accordance with contract documents.
F. Apply a broom-finish to the curb ramp and ensure face of tile is clean and free of any concrete debris.
G. When preparing to set the detectable warning plates, it is important that no concrete be removed from the area to accept the plates. It is recommended that the installation technique eliminate any air voids under the plates. Air holes at anchor locations allow air to escape during the installation process.
H. Detectable warning plates shall be tamped, vibrated, and cast into place to provide an adequate bond between the back side of the plate and the wet concrete; this shall ensure that the plate is flush to the adjacent concrete surface or as the drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes. Care should be taken to avoid stepping on the plate while it is being set. Doing so shall result in the possible unevenness of the plates, creating an air void(s) under the surface.
I. Radius wedge plates are recommended to accommodate most radius conditions. Radius wedge plates are to be installed between rectangular plates.
J. Immediately after placement, the detectable warning plate elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. Ensure that the field surface of the plate is flush with the surrounding concrete and back of curb so that no ponding is possible on the plate at the back side of the curb.

K. While concrete is workable, create a 0.25 inches (6.35 millimeters) concrete-free recess around the perimeter of the plates. Use a 0.75 inches (9.5 millimeters) radius edging tool to create a finished edge of the concrete. Then a steel trowel shall be used to finish the concrete around the perimeter of the plate flush to the field level.

L. During and after the detectable warning plate installation and the concrete curing stage, it is imperative that there is no walking, leaning, or external force placed on the plate that may rock the plate causing a void between the underside of plate and the concrete. Use proper safety barriers or cones to keep the pedestrians away.

M. Following detectable warning plate placement, review installation tolerances to contract drawings and adjust plate before the concrete sets. Suitable weights of 25 pounds (11 kilogram) each may be required to be placed on each plate to ensure solid contact with the underside of the plate to concrete.

3.03 CLEANING AND PROTECTING

A. Protect detectable warning plates against damage during the construction period to comply with manufacturer’s specifications.

B. Protect plates against damage from rolling loads following installation by covering with plywood or hardwood.

C. Replace plates by the method specified by ADA Solutions.

D. If requested by the Project Manager, clean detectable warning plates not more than four days before the date scheduled for observation intended to establish the date of substantial completion in each area of the project. Clean the plates by the method specified by ADA Solutions.

E. Comply with ADA Solutions maintenance manual for cleaning and maintaining plate surface. It is recommended to perform annual inspections for safety and plate integrity.

END OF SECTION

SECTION 32 18 10
COURT SURFACING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Basketball sealcoat.
   2. Cleaning, Repair and Protection.

B. Related Requirements:
   1. Section 31 00 00 "EARTH MOVING" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   2. Section 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" for court paving as released in Early Release Package 1 (ERP1).
   3. Section 32 18 23.43 “RECREATIONAL PAVEMENT MARKINGS” for court line stripe.

1.03 REFERENCES

A. The following Standards shall apply to the Work of this Section:
   1. National Federation of State High School Associations (NFSHSA).
   2. International Amateur Athletic Federation (IAAF).
   3. National Collegiate Athletic Association (NCAA).

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Color Sealcoat: The General Contractor shall submit catalog cuts, manufacturer’s specifications and color chips or charts.

B. Field Layout: For each area of color sealcoat.
   1. Field layout of color sealcoat shall be accepted by Owner’s Representative prior to installation.

C. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paving is 29 or greater.
   4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 QUALITY ASSURANCE

A. Delivery and Handling:
   1. Deliver materials and products and provide adequate protection against damage.
   2. Handle in strict compliance with manufacturer’s instructions and recommendations and store off the ground.

3. Protect from all possible damage including, but not limited to chipping, staining, cracking and other damage.
4. Sequence deliveries to avoid delays, but minimize on-site storage.

1.06 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt | bituminous concrete materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the ambient or base surface temperature is less than 40 degrees Fahrenheit (4.4 degrees Celsius), or if surface is wet or frozen.

B. Do not apply the color seal filler coats and finish coat in foggy or rainy weather, or when the ambient temperature is below 45 degrees Fahrenheit (7.2 degrees Celsius), or if such conditions are anticipated during the next 48-hours.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
1. California Sports Surfaces, “Plexipave”, 150 Dascomb Road, Andover, MA 01810; Telephone: 978.623.9980; Fax: 978.623.9970; Website: www.californiasportsurfaces.com.
2. Nova Sports USA, Inc., “Novaplay”, 8 Commercial Way, Milford, MA 01757; Telephone: 508.473.6540; Fax: 508.473.4077; Website: www.novasports.com.
3. SportMaster Sport Surfaces, “Colorplus & Standard Court System”, P.O. Box 2277, Sandusky, OH 44870; Telephone: 800.395.7325; Fax: 419.626.5477; Website: www.sportmaster.net.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer’s products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 “SUBSTITUTION PROCEDURES”.

2.02 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

2.03 ASPHALT | BITUMINOUS CONCRETE MATERIALS

A. Asphalt | bituminous concrete paving for basketball court, and four-square, construction shall be Class I, Type I-1 hot plant mix, conforming to the applicable sections of the MassDOT Highway Division Standard Specifications (for Highways and Bridges) and shall consist of two courses of asphalt | bituminous concrete with a minimum finished pavement thickness as shown on Drawings and specified in 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" as released in Early Release Package 1 (ERP1).

2.04 COLOR SEALCOAT

A. The layout and design of color sealing shall be installed per Drawings.

B. Filler Coats: The two filler coats shall be “Plexipave” as manufactured by California Products Corporation, 169 Waverly Street, Cambridge, Massachusetts, or approved equal.
1. Color shall be as indicated on Drawings.
a. Basketball Court Color F: Light Blue.

b. Basketball Court Color G: Light Green.
c. Basketball Court Color H: Gray.
d. Final color selection to be determined by Shop Drawing.

2. The two “Plexipaver” filler coats shall be applied to the cleaned asphalt | bituminous concrete pavements as specified in 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" as released in Early Release Package 1 (ERP1). It shall be non-flammable upon exposure to flame.
3. The filler coats shall contain a minimum of nine pounds/gallon of Silica, 100 percent passing through a 100 percent mesh as pre-mixed at the manufacturer’s plant. No sand or silica shall be added to the emulsion in the field. The asphalt shall cure for fourteen days prior to applying the Plexipave Acrylic Color System.

C. Water:
1. Water, if accepted, may be added to the “Plexipave” emulsion mixes.
2. In no case may the quantity of water in the filler coat emulsion mix exceed 33 percent of the emulsion volume (One part water: Two parts filler coat).
3. In no case may the quantity of water in the finish coat emulsion mix exceed 50 percent of the emulsion volume (One part water: One part finish coat).
4. Water shall be potable and its temperature above 40 degrees Fahrenheit (4.4 degrees Celsius) upon addition to the emulsions.

D. Color Emulsion Color: The color emulsion color shall be “Plexichrome” as manufactured by California Products Corporation, 169 Waverly Street, Cambridge, Massachusetts, or approved equal.
1. Colors shall match those of the “Plexipave” filler coats.
2. The “Plexichrome” shall be applied lengthwise of the court with a wide type push broom.

E. Finish Coat:
1. The base vehicle for the finish coat shall be an acrylic polymer dispersed in water, and which has the ability to withstand extremes in temperature and general weathering.
2. The film former shall provide a non-skid surface upon drying and under all weather conditions.
3. Pigment dispersions in the color coating are to be of the best quality chrome oxides so as to obtain a permanent true color. The coating shall contain no material that will cause cracking due to extremes in temperatures and is to be factory mixed and consistent in color.
4. The finish coat shall be one hundred percent acrylic emulsion containing no alkyds, butadiene styrene, or vinyls and shall be thinned with water. It shall not chalk or discolor any equipment.

F. The finished surface shall be smooth and uniform, true to required grade and cross section, and free of depressions, ridges, or other irregularities.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.
B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
C. Verify gradients and elevations of base are correct.
D. Proceed with paving only after unsatisfactory conditions have been corrected.

3.02 SUBBASE

A. Construct subbase in accordance with Drawings and Section 31 00 00 "EARTH MOVING".

3.03 ASPHALT | BITUMINOUS CONCRETE PAVING

A. Construct subbase in accordance with Drawings and 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" as released in Early Release Package 1 (ERP1).

3.04 COLOR SEALCOAT

A. The asphalt | bituminous concrete pavement shall cure for 14 days prior to the applying of the Color Sealcoat System as indicated in the Drawings.

B. The General Contractor shall furnish and apply to the accepted asphalt | bituminous concrete pavements as designated in the Drawings: two filler coats and one finish coat of acrylic emulsion color coating.

C. Prior to application of the filler coats, all dirt, sand, dust, and other loose material shall be cleaned from the paved areas to be covered, by sweeping and pressure washing with water. All surfaces shall be dry prior to starting any color seal coating process.

D. The Paving Contractor shall take special precautions to assure that existing pavements are thoroughly cleaned and that all cracks or joints in existing pavements are repaired in conformance with 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" as released in Early Release Package 1 (ERP1).

E. Limits or areas to be colored shall be taped with minimum two inches (51 millimeters) wide tape true as to alignment prior to application of the color coating material.

F. The entire system of two filler coats and one finish coat shall be applied with accepted squeegees and hair-type push brooms, respectively. The material shall be thoroughly mixed by mechanical agitation and all Work shall be done in a through manner. The emulsion shall be thoroughly stirred in its container as received by stationary bucket power mixer so that a creamy, smooth consistency of all emulsion in the container is assured for the ready application. The entire Work of color coat surfacing shall be done in accordance with the recommendations of the manufacturer’s representative.

G. Special care shall be taken so as to allow none of the material to splatter or flow beyond the perimeter to be covered. The filler coats and finish coat shall not be applied in foggy or rainy weather, or when the ambient temperature is below 45 degrees Fahrenheit, nor shall they be applied if such conditions are anticipated during the next 48-hours.

H. The two filler coats shall be applied so that both coats are of a total quantity and with a uniform spread at the rate of one gallon per 100 square feet of surface area. Additional filler coating material is to be used to complete the court surfaces to be smooth and uniform. The first coat shall be applied lengthwise of the court, and the second coat cross-wise of the court.

I. After the filler coat applications have been completed and accepted by the Owner’s Representative, apply one acrylic color emulsion coating to the properly prepared surfaces with a uniform spread at the rate of one gallon per 200 square feet of surface area. The acrylic color emulsion shall be applied lengthwise of the court with a wide type push broom.

J. The finished surface shall be smooth and uniform, true to required grade and cross section, and free of depressions, ridges, or other irregularities.

3.05 WARRANTY

A. The General Contractor shall provide the manufacturer’s standard written warranty for each product within this specification. All of these warranties shall be in addition to, and not in lieu of, other liabilities that the General Contractor may have by law or other provisions of the Contract Documents.

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

3.06 CLEANING, REPAIR AND PROTECTION

A. Repair minor damage to eliminate all evidence of repair. Remove and replace Work that cannot be satisfactorily repaired.

B. Provide temporary protection to ensure that the Work will be without dirt, stains, damage or deterioration at the time of final acceptance. Clean up stains and spills as they occur. Remove protections and clean immediately before final acceptance.

C. Upon completion of the Work and before acceptance, the General Contractor shall remove and dispose of in an approved manner all surplus materials, and rubbish which the General Contractor may have accumulated during the course of the Work and shall leave the site in a clean and orderly condition. The General Contractor shall not abandon any materials at or near the site regardless of whether or not it has any value.

END OF SECTION

SECTION 32 18 13
SYNTHETIC TURF SURFACING ACTIVE USE – FALL ZONE

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Synthetic turf surfacing, including artificial turf.
   2. Supplementary turf surfacing: high use, and shock pad.
   3. Subbase preparation and placement of aggregate base course.
   4. Turf infill.
   5. Edge curb restraints

B. Related Information:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for installing nailer board flush edge curb restraints as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for excavation for installing subbase.
   3. Section 32 13 13.13 "CONCRETE PAVING (SITE)" for installing nailer board into concrete paving as released in Early Release Package 2 (ERP2).
   4. Section 32 90 00 – “UNDERDRAIN SYSTEM” for piping and drainage course serving as subbase for synthetic turf surfacing as released in Early Release Package 1 (ERP1).

1.03 REFERENCES

A. ASTM International (ASTM): www.astm.org:
   1. ASTM D1335 - Test Method for Tuft Bind of Pile Yarn Floor Coverings.
   2. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials.
   3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   4. ASTM E108 - Standard Test Methods for Fire Tests of Roof Coverings.
   5. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
   6. ASTM F1015 - Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces.
   7. ASTM F1292 - Standard Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment.
   8. ASTM F1951 - Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.

B. International Play Equipment Manufacturers Association (IPEMA): www.ipema.org:

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Conference: Conduct conference at Project site following award of contract. Review methods and procedures related to synthetic turf surfacing installation including, but not limited to, the following:
   1. Review survey of subbase conditions.
   2. Review delivery, storage, and handling procedures.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product specified.

B. Shop Drawings: Provide installation details including roll and seaming layout, methods of attachment and details at penetrations and terminations
   1. Show layout of marking plan if any, indicating details for specified activity areas.

C. Samples: For each type of synthetic turf surfacing indicated.
   1. Minimum 12-by-12-inch- square sample of synthetic turf surface with tufted perimeter line and carpet seam.

D. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paver is 29 or greater.
   4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Installation Schedule: Showing planned commencement and completion dates for each portion of the Work; include critical dates indicated on Owner's project schedule.

C. Warranty: Sample warranty specified in this Section.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Seaming Materials: Sufficient quantity for 100 square feet.
   2. Synthetic Turf Fiber: Sufficient quantity for 100 square feet.
   3. Infill Material: Sufficient quantity for 100 square feet., in weatherproof bags.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing synthetic turf surfacing materials similar to those specified for this project, with a record of successful service for a minimum of five years.

B. Installer Qualifications: An experienced Installer certified by the manufacturer, employing workers trained and approved by manufacturer, who has successfully installed work similar in design and extent to that required for the project, in not less than five projects of similar scope. Installer shall be STC Certified (Synthetic Turf Council).

C. Source Limitations: Obtain synthetic turf surfacing materials through one source from a single manufacturer.
   1. Provide secondary materials including adhesives, paint, thread, and repair materials of type and from source recommended by manufacturer of synthetic turf surfacing materials.

1.09 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit synthetic turf surfacing installation to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate installation of synthetic turf surfacing with installation of site paving, playground equipment, adjacent lawns, landscaping materials, site lighting, and related work.

1.11 WARRANTY

A. Manufacturer's Warranty: Submit manufacturer's standard published limited warranty form in which manufacturer agrees to repair or replace components of synthetic turf surfacing installation installed by manufacturer-certified Installer that fail in materials under normal use and maintenance, or provide other relief, within specified warranty period.
   1. Failures include ultraviolet degradation, backing integrity, more than 50 percent loss of face fiber, and loss of tuft bind strength.
   2. Warranty Period: Life of product.

B. Installer Project Warranty: Submit synthetic turf surfacing Installer's warranty, signed by Installer, covering the Work of this Section, including installation of all components of synthetic turf surfacing system, for the following warranty period:
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. SYNLawn®; 2680 Abutment Road SE, Dalton, GA 30721. Telephone: 706.227.1128. Website: www.synlawn.com; Massachusetts Representative; 5 Fulton Street #100; Canton, MA 02021 Telephone: 781.821.0112; Website: www.newenglandturfstore.com.
   2. ForeverLawn; 8007 Beeson Street, Louisville, OH 44641; Telephone: 866.922.7876; Fax: 330.249.2170; Website: www.foreverlawn.com.
   3. Ideal Turf Solutions; 281 Middlesex Avenue, Medford, MA 02155; Telephone: 781.866.6161; E-mail: infoturfsolutions@gmail.com; Website: www.idealturfsolutions.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations will not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer’s products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 “SUBSTITUTION PROCEDURES”.

D. Source Limitations: Obtain synthetic turf surfacing materials through one source from a single manufacturer.
   1. Provide secondary materials including adhesives, paint, thread, and repair materials of type and from source recommended by manufacturer of synthetic turf surfacing materials.

2.02 PERFORMANCE REQUIREMENTS

A. Environmental: Provide synthetic turf surfacing system with EN 71-3 Heavy Metal Analysis.Specifier: Retain "Fire-Test-Response Characteristics" Paragraph below if fire-tested product is required by authorities having jurisdiction or desired by Owner.

B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

C. Exterior Fire-Test Exposure: Provide synthetic turf surfacing materials identical to those of assemblies tested for Class A fire resistance according to ASTM E108 or UL 790 by Underwriters Laboratories or another testing and inspecting agency acceptable to authorities having jurisdiction.

D. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for recreation surfaces.
   1. Provide synthetic turf system meeting requirements of ASTM F1951.

2.03 SYNTHETIC TURF SURFACING

A. Synthetic Turf Surfacing: Complete surfacing system, consisting of synthetic yarns bound to water-permeable primary and secondary backing and accessory materials.

B. Product Basis-of-Design: Synthetic Turf Surfacing: Complete surfacing system, consisting of delustered UV-stabilized antimicrobial synthetic yarns bound to water-permeable bio-based primary and secondary backing. IPEMA-certified. Non-abrasive blades with low surface temperature. Anti-Static and Ultraviolet reflective pigment enhanced.
   1. Basis of Design Product: SYNLawn Play Platinum.
   2. Artificial Turf Fiber and Construction Characteristics:
      a. Yarn, Turf Zone: Tufted polyethylene, high emissivity omega.
         1) Color: Field green and apple.
         2) Denier, ASTM D1577: 10,800/6.
         3) Antimicrobial Protection: Sanitized®
         4) Antistatic Protection: StatBlock™
         5) IR Reflective: DualChill™
      b. Yarn, Thatch Zone: Polyethylene.
         1) Color: Field Green and beige.
         2) Denier, ASTM D1577: 5,000/8.
      c. Finished Pile Height, ASTM D5823: 1-1/2 inch.
      d. Face Weight, ASTM D5848: 100 ounce per square yard.
      e. Tuft Machine Gauge: 3/8 inch.
      f. Backing, Primary: six ounce per square yard, 15/18 polypropylene, two layers with fiber-reinforcing core.
      g. Backing, Secondary: 22 ounce per square yard bio-based urethane.
         1) Enviroloc+™
            (a) Anti Fungi and Anti Algae blended into secondary backing.
      h. Total Fabric Weight: 128 ounce per square yard.
      i. Ballast: Silica sand ballast.
      j. Temperature-Reducing Ballast: Silica sand and moisture-retaining coated sand ballast.
   3. Performance Characteristics:
      a. Tuft Bind, ASTM D1335: Not less than eight pounds.
      b. Grab tear strength, ASTM D5034: Not less than 200 pound-force.
      c. Elongation to break, ASTM D2256: Not less than 30 percent.
      d. Yarn breaking strength, ASTM D5793: Not less than 20 pound-force.
      e. Flammability, ASTM D2859: Pass.
      f. Fire Test Exposure, ASTM E108: Class A.
      g. Heavy Metal Analysis, EN71-3

2.04 SUPPLEMENTARY TURF SURFACING MATERIALS

A. High Use Area Package: High density, crush-resistant component, configured for easy replacement without disturbing surrounding turf surfacing.
   1. Product: SYNLawn, TrampleZone.

B. Shock Pad:
   1. Basis of Design: Subject to compliance with requirements, provide products by the following, or approved equal:

2. Brock USA LLC; 3090 Sterling Circle, Boulder, CO 80301; Telephone: (303) 544-5800; Fax: 866-850-9421; E-mail: sales@brockusa.com.
3. Product: Brock Shock Pad 20mm Pad.
4. Product Number: SP20XL.
5. Pad Thickness: 0.79 inches (20 millimeters).
6. Material Type: Expanded polypropylene composite containing approximately 30% by volume reprocessed PR consumer and/or post-consumer recycled material.
7. Vertical Permeability: Greater than 250 inches per hour.
8. Product format: Edge locking panels.
9. Size: 67.25 inches by 47.5 inches (1708 millimeters by 1207 millimeters) overall dimensions.
10. Area: Net coverage per panel 21.0 square feet per panel (1.95 square meters).
11. Panel Weight: approximately five pounds per panel.

C. Turf Spikes: Manufacturer's approved fasteners.

D. Nailer Board: Manufacturer's approved nailer/edger board.

2.05 EDGE CURB RESTRAINTS

A. Job-Built Concrete Edge Curb Restraints: Comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 5,000 pounds per square inch (34 Megapascals).

2.06 MATERIALS

A. Infill Material: Silica sand in manufacturer’s recommended formula for application to synthetic turf surfacing.
   1. Product: SYNLawn, Envirofill.
      a. Color: Green.

B. Glue, Seaming Fabric, and Thread: Manufacturer’s recommended product for application.

C. Aggregate Base: Refer to Section 31 00 00 "EARTH MOVING”.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine synthetic turf surfacing base and perimeter conditions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.
   1. Verify substrate meets profile required.
   2. Confirm base material, compaction of substrate, permeability, and drainage system installation meets requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 SUBBASE PREPARATION

A. Refer to Section 31 00 00 "EARTH MOVING" for requirements for preparing subbase for Work of this Section.

B. General: Prepare substrates to receive surfacing products according to synthetic turf surfacing manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions. Remove organic debris. Grade soil subgrade level and compact.

C. Finish grade soil subgrade with slope between 1/2-percent and one percent toward path of site drainage.
   1. Compact subgrade in both directions with mechanical compacting equipment to achieve specified compaction at 90 percent standard Proctor.
   2. Prepare subgrade to tolerance of within 1/2-inch of design grade.
   3. Prepare subgrade within 1/4-inch in 10 feet in any direction from design grade over entire playing surface.

3.03 EDGE CURB RESTRAINTS

A. Provide edge restraints as indicated.

B. Install edge restraints before installing synthetic turf surfacing.

1. Install job-built concrete edge curb restraints to comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).

3.04 AGGREGATE COURSE INSTALLATION

A. Refer to Section 31 00 00 "EARTH MOVING" for requirements for preparing aggregate course for Work of this Section.

B. Gravel for Synthetic Turf Dynamic Base shall consist of durable crushed rock or crushed gravel stone, free of ice, snow, sand, silt, clay, loam, shale, or other deleterious or organic matter; washed and graded. Fragmentation shall be at least 100 percent. No round stone or sand shall be accepted. It shall be graded within the following limits:

1. Base Stone:

U.S. Sieve Size	Percent Finer by Weight
1 inch	100
3/4 inch	85-100
1/2 inch	55-85
3/8 inch	40-75
1/4 inch	25-65
No. 4	5-35
No. 8	0-20
No. 16	0-10
No. 200	0-2

2. Finishing Stone:

U.S. Sieve Size	Percent Finer by Weight
1/2 inch	100
3/8 inch	85-100
1/4 inch	75-100
No. 4	60-90
No. 8	35-75
No. 16	10-55
No. 30	0-40
No. 50/60	0-15
No. 100	0-8
No. 200	0-2

C. Place aggregate base course, compact by tamping with plate vibrator to 90 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated. Install a four-inch base course unless otherwise indicated.

1. Slope base course between 1/2-percent and one percent, measured from the longitudinal center of the installation towards the edges. Grade base course to tolerance of within 1/2-inch of design grade, and with a maximum variation of 1/4-inch in 10 feet in any direction.

3.05 SYNTHETIC TURF INSTALLATION

A. General: Comply with synthetic turf surfacing manufacturer's written installation instructions. Install synthetic turf surfacing over area and in thickness indicated.

B. Shock Pad: Panels must be installed in a brick-like pattern, where the joints of two panels meet at the middle of the panel in the next row. Begin installation at one end of the field, installing successive full rows across the field. Panels and artificial turf ate laid out progressively. When cutting panels inside the turf nailer or utility boxes, leave a ¼" gap for thermal expansion. Save all panel cutoff pieces. The cutoff ends of the panels should be usable on other rows or at the far end of the field. Panels that will

not be covered by turf overnight should be weighed down with ballast. Static loads on panels may not exceed 50 psi and any vehicle load should not remain stationary for more than 30 minutes Install shock pad panels per manufacturer's instructions.

C. Artificial Turf: Loose-lay artificial turf and allow fabric to relax for period recommended by manufacturer. Stretch carpet and attach at perimeter in accordance with accepted submittals.

D. Seaming: Form seams flat and snug, with no gaps or fraying. Remove yarns that are trapped within seams. Form seams per manufacturer's written instructions using manufacturers provided or recommended materials.

E. Attachment: Attach turf fabric to perimeter restraint system per manufacturer recommendations.

3.06 ACTIVITY LINES AND MARKERS

A. Install lines in accordance with accepted submittals.

B. Provide As-Built drawing including verification of field layout dimensions in accordance of with CONTRACT CLOSEOUT.

3.07 INSTALLATION, INFILL

A. Mix and install infill material components in accordance with manufacturer's requirements for accepted system. Groom material and leave surface ready for use.

B. Infill materials shall be uniformly filled to a depth which leaves no more than 1/2-inch of exposed pile after settlement. If the results of the infill depth test show an infill with more than 1/2-inch exposed, additional infill shall be installed to meet the specified infill heights. Additional G-Max, and Head Injury Criterion may be required once the installed infill heights meet the specified heights at no additional cost to the Owner.

3.08 PROTECTION

A. Protect completed installation from damage. Prevent traffic over system prior to acceptance by Owner.

3.09 CLOSE OUT

A. Infilled Synthetic Turf System Vendor shall provide the Owner's Representative with an electronic copy of the accepted Standard Warranty and Third Party Insured Warranty.

B. Infilled Synthetic Turf System Vendor shall train the Owner's designated personnel in the proper maintenance and care of the field and provide the Owner's Representative with an electronic copy of the Standard Maintenance Manual. Training shall at a minimum address:

1. Use and maintenance of equipment including when/how often to use the particular pieces of machinery, how fast/slow to operate machinery.
2. How to clean stains/markings from the field.
3. Snow removal (plow versus snowblowing)
4. What to do if a problem is encountered in the field – who to call/contact.
5. Any small repairs that can be done by the Owner (if any) without affecting the warranty.
6. How to inspect a field and what to look for as well as how often this should be done.
7. Maintenance Log Information – discuss the importance in respect to warranty.

END OF SECTION

SECTION 32 18 16.13
PLAYGROUND PROTECTIVE SURFACING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Unitary synthetic dual density Poured-in-Place Resilient Rubber Surfacing; bonded rubber seamless surface.
   2. Edge curb restraints.

B. Related Sections:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for installing cast-in-place concrete edge restraints for playground surfacing as released in Early Release Package 2 (ERP2).
   2. Section 04 43 00 “STONE MASONRY” for stone landscape curb serving as edge curb restraints for playground surfacing.
   3. Section 11 68 00 “PLAY EQUIPMENT AND STRUCTURES” for required critical fall height for each playground equipment piece per Appendix A.
   4. Section 31 00 00 "EARTH MOVING" for filling and grading and for drainage course drainage/separation geotextiles, and subbase courses.
   5. Section 32 90 00 “UNDERDRAIN SYSTEM” for underdrain connection to site storm drainage system as released in Early Release Package 1 (ERP1).
   6. Section 33 41 00 “STORM UTILITY DRAINAGE PIPING” for playground subdrainage system.

1.03 DEFINITIONS

A. Critical Height: Standard measure of shock attenuation. According to CPSC No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."

B. SBR: Styrene-butadiene rubber, base layer

C. TPV: Thermoplastic vulcanized rubber, top (wear) layer

D. EPDM Rubber: Ethylene Propylene Diene Monomer rubber, top (wear) layer

E. Polyurethane binders: Aromatic (tends to “yellow” with time) and Aliphatic (recommended for shades of blue, purple and gray colors)

1.04 PERFORMANCE REQUIREMENTS

A. Impact Attenuation: According to ASTM F 1292-17 or latest version.

B. Accessibility of Surface Systems: According to ASTM F 1951-14 or latest version.

C. International Playground Equipment Manufacturers Equipment IPEMA Certification

D. Inspection by Third party Certified Playground Safety Inspector CPSI with a minimum of 10 years’ experience in at least 15 playground surfacing inspections

E. Standard Guide for Specification, Purchase, Installation and Maintenance of Poured-In-Place Playground Surfacing: ASTM F2479-17. In addition, as supplied by manufacturer:
   1. ASTM D412 Standard Test Methods or Vulcanized Rubber, Thermoplastic Rubbers, and Thermoplastic Elastomers-Tension
   2. ASTM D624 Standard Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
   3. ASTM D2047 Standard Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as measured by the James Machine.

4. ASTM D2859 Standard Test Method for Flammability of Finished Textile Floor Covering Materials.
5. ASTM E303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For each playground surface system, including materials, plans, cross sections, drainage, installation, penetration details, and edge termination. Include layout illustrating playground surfacing layout, patterns, graphics, typical banding, and direction. Show playground equipment with use zones and type and length of edging on each drawing to confirm compliance of playground safety surface materials.

C. Samples for Initial Selection: For each type of playground surface system indicated.
   1. Include similar Samples of playground surface system and accessories involving color selection.

D. Samples for Verification: For each type of playground surface system indicated.
   1. Minimum four-inch (101-millimeters) disk sample of synthetic rubber seamless surface.
   2. Minimum one-quart (0.95-liter) loose-fill surface sealed in a container.
   3. Minimum six-by-six-inch (150-by-150-millimeters) Sample of synthetic rubber seamless surface.
   4. Six-inch (150-millimeters) long by full-size cross section of border edging.
   5. Minimum 12-by-12-inch (300-by-300-millimeters) Sample of geosynthetic fabric.
   6. Minimum six-by-six-inch (150-by-150-millimeters) Sample of geosynthetic, molded-sheet drainage panel.
   7. Joint materials involving color selection.
   8. Exposed edge restraints; 12-inches (305-millimeters) in length with one stake.
   9. Edge curb restraints.

E. Product Schedule: For playground surface systems. Use same designations indicated on Drawings.

F. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paver is 29 or greater.
   4. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans drawn to scale, on which the following items are shown and coordinated with each other, using input from CPSI Installers of the items involved:
   1. Extent of surface systems and use zones for equipment.
   2. Critical heights for playground surfaces and fall heights for equipment.

B. Qualification Data:

1. For qualified Installer / Installer Supervisor, Installation Contractor to submit current CPSI license number and proof / references demonstrating a minimum of five years of experience, having installed a minimum of 15 playground surfaces with varying fall zone depths.
2. Submit qualifications of testing agencies as listed or supplied by manufacturer.
3. Submit manufacturers' installation instructions for each play surface specified herein.

C. Material Certificates: For each type of playground surface system, from manufacturer.
D. Material Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each playground surface system.
E. Product Certificates: For each type of playground surface system, from manufacturer.
F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each unitary synthetic playground surface system.
G. Field quality-control reports.
H. Warranty: Sample Warranty.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Data: For playground surface system to include in maintenance manuals.
B. Warranty documentation.
C. Material Certificates: Material certificates shall be filled out and signed by a specified manufacturer/supplier that specified materials were shipped and in proper amounts for square footage/thickness/color.
D. LEED documentation.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sample of each color combination of bounded Poured-in-Place Resilient Rubber surface, with annotated percentages and codes of each color combinations for Owner's quick reference.
   2. Termination Edge Units: three full-size units.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer. Crew Chief shall be IPEMA Certified.
B. Source Limitations: Obtain playground surface system materials, including primers and binders, from single source from single manufacturer.
   1. Provide secondary materials including adhesives, primers, geosynthetics, and repair materials of type and from source recommended by manufacturer of playground surface system materials.
C. Standards and Guidelines: Comply with CPSC No. 325, "Handbook for Public Playground Safety"; ASTM F 1292-17; and ASTM F 1487.

1.10 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit playground surface system installation to be performed according to manufacturers' written instructions and warranty requirements. Temperature should be 50 degrees Fahrenheit and rising during the installation period. The installer shall have sole discretion based on their judgement to proceed or to halt the installation based on their judgement.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:

a. Failure for impact attenuation as per ASTM 1292-17 or latest version.
b. Deterioration of surface and other materials beyond normal weathering.
c. Loose or easily scraped rubber surface.
d. Excessive UV fade/Loss of color.
e. TRIAX 2015 GMAX/HIC testing, with accompanied certificate for compliance that this device meets the testing equipment specifications as stated in ASTM 1292-09.

2. Warranty Period: All safety surfacing shall be free of defects due to workmanship or material for a minimum of two years from the date of installation.
   a. A minimum of 10 years performance warranty is required for Poured-in-Place safety surfacing from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. “DuraTurf Poured in Place (PIP)” (TPV) as manufactured by Robertson Recreational Surfaces/Sport Surface Specialties (PlayCore, Inc.); New England Region Address; P.O. Box 577, East Aurora NY 14052; Tele: 716.652.2039 Fax: 716.805.1001; Web: www.sportsurface.net.
   2. “Playbound Poured-in-Place, Extreme-10” (EPDM) with aliphatic urethane, as manufactured by Surface America, Inc.(Ecore Co.), 505 Aero Drive; Suite 1, Cheektowaga, NY 14225; Tele: 800.999.0555, 716.632.8413; Fax: 716.632.8324; E-mail: info@surfaceamerica.com; Web: www.surfaceamerica.com.
   3. “Vitriturf; V-10 System” (EPDM Standard & Mirco), as manufactured by Hanover Specialties Inc., 35 Feldland Street, Bohemia, NY 11716; Tele: 631.231.1300; Fax: 631.231.1329; E-mail: stevenoskin@vitriturf.com; Web: www.vitriturf.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer’s products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 “SUBSTITUTION PROCEDURES”.

2.02 UNITARY SYNTHETIC DUAL-DENSITY SEAMLESS SURFACE (Poured-in-Place Resilient Rubber Surfacing; bonded rubber seamless surface or PIP)

A. Surface System: Poured-in-place, two-layer system with wearing course over cushion course. Provide manufacturer's standard thickness for each layer for overall thickness indicated, tested for impact attenuation according to ASTM F 1292-17 or latest version, and for accessibility according to ASTM F 1951-14 or latest version.
   1. Products: Subject to compliance with requirements, provide the following, or approved equal:
      a. “DuraTurf Poured in Place (PIP)” (TPV) as manufactured by Robertson Recreational Surfaces/Sport Surface Specialties (PlayCore, Inc.); New England Region Address; P.O. Box 577, East Aurora NY 14052; Telephone: 716.652.2039 Fax: (716)805.1001; Website: www.sportsurface.net

b. “Playbound Poured-in-Place, Extreme-10” (EPDM) with aliphatic urethane, as manufactured by Surface America, Inc.(Ecore Co.), 505 Aero Drive; Suite 1, Cheektowaga, NY 14225; Telephone: 800.999.0555, 716.632.8413; Fax: 716.632.8324; E-mail: info@surfaceamerica.com; Website: www.surfaceamerica.com
c. “Vitriturf; V-10 System” (EPDM Standard & Micro), as manufactured by Hanover Specialties Inc., 35 Feldland Street, Bohemia, NY 11716; Telephone: 631.231.1300; Fax: 631.231.1329; E-mail: stevenoskin@vitriturf.com; Website: www.vitriturf.com

2. Primer/Adhesive: Manufacturer’s standard primer and weather-resistant, moisture-cured aliphatic polyurethane adhesive suitable for unit, substrate, and location indicated.
3. Wearing Course: Formulation of TPV or EPDM rubber particles, as recommended by the manufacturer. All colors shall be UV stable for a minimum of five years. Polymer content shall be 25 percent minimum. Aliphatic grout or .5-to-1.5-millimeter granules shall be applied under all high impact areas. Tiles will not be allowed. Wear mats will not be allowed. Black rubber used in the wear course shall be pre consumer high quality virgin rubber.
4. Cushion Course: Manufacturer’s standard formulation of SBR particles and polyurethane, site mixed and applied. Rubber SBR mix may not contain wire, metal, or fabric.
5. Binder: Weather-resistant, UV-stabilized, flexible, nonhardening, 100 percent solids polyurethane complying with requirements of authorities having jurisdiction for nontoxic and low VOC content. No TDI urethanes will be permitted.
6. Cushion Course/Base Mat Thickness: The type of playground equipment determines the required cushion course/base mat thickness, and the cushion course/base mat thickness may be different at various locations on the playground site. Specify project requirements per individual equipment specifications supplied by play equipment manufacturer(s).
7. Critical Height: Choose a protective surfacing material that has a Critical Height Value of at least the height of the Highest Accessible Part/Fall Height of the adjacent equipment. (Ref. ASTM F1487.) Typical Fall Heights range between three feet (one meter) and 10 feet (three meter) depending on the equipment configuration. See individual equipment requirements as supplied by play equipment manufacturer(s).
8. Overall Thickness: Not less than the minimum fall height as indicated by the individual play equipment specifications per the manufacturer’s information and for critical height indicated on Drawings. Overall Thickness ranges from 1-1/2-inches (38 millimeters) to four-inches (100 millimeters). See individual equipment requirements as supplied by play equipment manufacturer(s).
9. Thickened High-use Wearing Course to be one-inch thick.
    a. Location: As indicated on Drawings.
10. Wearing Course Color(s): as selected by Owner’s Representative and indicated on the drawings from manufacturer's full range.
    a. Color and Pattern: As indicated on Drawings and in Specification.
        1) PIP Color A: 25 percent Pearl, 25 percent Teal, 50 percent Bright Green.
        2) PIP Color B: 25 percent Pearl, 25 percent Sky Blue, 50 percent Teal.
        3) PIP Color C: 25 percent Pearl, 25 percent Beige, 50 percent Brown.
        4) PIP Color D: 25 percent Pearl, 25 percent Eggshell, 50 percent Orange.

B. Leveling and Patching Material: Portland cement-based grout or epoxy- or polyurethane-based formulation suitable for exterior use and approved by playground surface system manufacturer.

2.03 EDGE RESTRAINTS

A. Job-Built Concrete Edge Curb Restraints: Comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 5,000 pounds per square inch (34 Megapascals).

B. Stone Edge Curb Restraints: Comply with requirements in Section 04 43 00 "STONE SITE MASONRY" for stone curbing in shapes and sizes indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, sub grade and substrate conditions, drainage, and other conditions affecting performance of the Work. Drainage at the low end of the site is of the utmost importance. Any brick or concrete walls or curbs at the low end of the area to receive the play surface shall have drainage access via weep holes. Weep holes shall extend a minimum of two inches above the top of the new concrete slab and a minimum of 1/8 inch below the top of the new concrete slab. The latter is necessary because the rubber surfacing system is porous and water to permeate (drain downward) to the concrete slab.

B. General Contractor shall coordinate other paving schedules to make sure playground surfacing has a clear, defined and well-structured edge prior to proceeding with installation.

C. Hard-Surface Substrates: Verify that substrates are satisfactory for unitary playground surface system installation and that substrate surfaces are dry, cured, and uniformly sloped to drain within recommended tolerances according to playground surface system manufacturer's written requirements for cross-section profile.

1. Crushed Stone: dense graded aggregate base shall be a homogeneous mixture of fine and medium stone (3/4-inch stone) applied in multiple layers and compacted using a mechanical compactor and/or roller to provide an even plane. The crushed stone base shall be tightly compacted and smooth to a Standard Proctor Compaction of 95 percent or greater (as per ASTM test). Depth of the dense graded aggregate base shall be between four and six inches to achieve Standard Proctor Compaction. Thickness shall not exceed ten inches. Crushed stone shall be contained. Use filter fabric when using rubber tiles, but not with PIP Resilient Rubber surfacing. This base is not acceptable for mounding areas. In this case the crushed stone base shall be skim-coated with concrete or asphalt to be stabilized.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. General: Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

B. Crushed Stone Substrates: Provide sound surface free of laitance, efflorescence, curing compounds, and other contaminants incompatible with playground surface system.

1. Repair unsatisfactory surfaces and fill holes and depressions.
2. Mechanically scarify or otherwise prepare concrete substrates to achieve recommended degree of roughness.
3. Saw cut concrete for terminal edges of playground surface systems as indicated.
4. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through playground surface system.
5. Provide 3/4-inch homogenous crushed stone per Section 31 00 00 "EARTH MOVING".
6. The crushed stone base shall be tightly compacted to a 95 percent Standard Proctor Compaction (per ASTM test) and smooth.
7. A two percent maximum (one percent minimum) slope is recommended.

3.03 INSTALLATION, GENERAL

A. General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated.

B. Tolerances: Do not exceed 1/32-inch (0.8-millimeters) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (three millimeters in three meters) from level, or indicated slope, for finished surface of paving.

3.04 EDGE RESTRAINTS

A. Provide edge restraints as indicated

B. All edge restraints shall be flush to avoid any tripping hazards or dips that could cause differential settlement of surfacing, ponding of water and ultimately failure of safety surfacing.

C. Install edge restraints before placing safety surfacing.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after safety surfacing installation.
2. Install job-built concrete edge curb restraints to comply with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).
3. Install stone edge curb restraints to comply with requirements in Section 04 43 00 "STONE SITE MASONRY".

3.05 GEOSYNTHETIC INSTALLATION

A. General: Install geosynthetics according to playground surface system manufacturer's and geosynthetic manufacturer's written instructions.

1. Geotextiles: Completely cover area indicated, overlapping sides and edges a minimum of four inches (100 millimeters) with manufacturer's standard treatment for overlapping loosely laid seams.
   a. Perimeter: Adhere edges on all sides to top of perimeter curb or footing.

3.06 INSTALLATION OF UNITARY SYNTHETIC DUAL-SENSITY SEAMLESS PLAYGROUND SURFACE SYSTEMS (Poured-in-Place Resilient Rubber Surfacing; bonded rubber seamless surface or PIP).

A. Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface and impact-attenuating system of total thickness indicated.

1. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.
2. Poured Cushion Course: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints. Thickness of cushion course should meet ASTM 1292-17 or latest version guidelines. Varying thickness is allowed to match fall height.
3. Intercoat Primer: Over cured cushion course, apply primer at manufacturer's standard spreading rate.
4. Wearing Course: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with a minimum of cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.
   a. Where colored pattern is or graphics are indicated, place adjacent colored material as soon as placed colored material is sufficiently cured, using primer or adhesive if required by manufacturer's written instructions.
5. Lacquer Topcoat: Spray or roller applied at manufacturer's standard coating rate in one continuous operation. Apply two coats of aliphatic polyurethane binder to ensure bonding of rubber particles.

6. Edge Treatment: As indicated on the Drawings. Fully adhere edges to substrate with full coverage of substrate. Maintain fully cushioned thickness required to comply with safety performance requirements.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting completed applications of the playground surface system shall take place according to ASTM F 1292-17 or latest version. The following testing reports shall be presented before substantial completion:
   1. Shock Attenuation (ASTM F 1292-17 or latest version).
   2. Gmax: Less than 150.
   3. Head Injury Criteria (HIC): Less than 850.
   4. Flammability (ASTM D 2859): Pass.
   5. Tensile Strength (ASTM D 412): 60 pounds per square inch (413 kilopascal).
   6. Tear Resistance (ASTM D624):140 percent.
   7. Water Permeability: 0.4 gallons per square yard per second.
   8. Accessibility: Compliant with requirements of ASTM F 1951.

C. Remove and replace applications of playground surface system where test results indicate that it does not comply with requirements.

D. Additional testing and inspecting, at General Contractor's expense, from a third-party CPSI certified inspector, will be performed to determine compliance of replaced or additional work with requirements.

3.08 PROTECTION

A. Tile Systems: Prevent traffic over the system for not less than 48 hours after installation. General Contractor shall utilize a temporary chain link mesh construction fence along all publicly accessible playground protective surface edges. Fence shall be closed and secured with a lock and/or meet structure walls flush without any gaps. Any vandalism or damage shall be repaired by the General Contractor and no extra cost to the Owner.

3.09 MAINTENANCE INSTRUCTIONS FOR OWNER:

A. For all types of surfacing: Visual Observation: Owner shall observe that the level of Playground Protective Surface does not fall below the design depth (refer to post line demarcations). For unitary bound surfacing, this observation should be carried out a minimum of two times a year, especially after installation, as there will be settling of material. Observations always depend on the frequency of use in addition to manufacturer’s recommendations.

B. Poured-in-place Rubber Surface
   1. In order to maintain the top TPV or EPDM surface in compliance, a roll coat of Polyurethane Binder Composition should be applied to the entire top surface every 18 months. This cost is not included in these Contract Documents; however, it is recommended by the manufacturers.
   2. Keeping the surface clean of debris is critical in maintaining the product and its optimal performance (impact attenuation properties). A minimum of biweekly cleaning is recommended by most manufacturers. Owner should refer to manufacturer’s instructions for approved cleaning products.

END OF SECTION

SECTION 32 18 23.43
RECREATIONAL PAVEMENT MARKINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Painted markings applied to asphalt basketball court pavement.
   2. Painted markings applied to asphalt four-square pavement.
   3. Painted markings applied to asphalt obstacle course play pavement.

B. Related Requirements:
   1. Section 03 30 00.13 “CAST-IN-PLACE CONCRETE (SITE)” for pavement and walks as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   3. Section 32 12 16.36 “ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT” as released in Early Release Package 1 (ERP1).
   4. Section 32 18 10 “COURT SURFACING” for basketball, and four-square.

1.03 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to marking pavement including, but not limited to, the following:
      a. Pavement aging period before application of pavement markings.
      b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include technical data and tested physical and performance properties.

B. Shop Drawings: For pavement markings.
   1. Indicate all basketball, and four-square, colors and dimensions to adjacent Work.

C. Samples: For each exposed product and for each color and texture specified.

D. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. Product Data for Credit IEQ 4.2: For interior, field-applied, pavement-marking paints, documentation including printed statement of VOC content.
   3. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   4. LEED Sustainable Sites Credit 7.1, Non-roof: Submit letter from manufacturer certifying the solar reflectance index (SRI) of the paving is 29 or greater.
   5. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements for pavement-marking work.

B. Delivery and Handling:

1. Deliver materials and products and provide adequate protection against damage.
2. Handle in strict compliance with manufacturer's instructions and recommendations and store off the ground.
3. Protect from all possible damage including, but not limited to chipping, staining, cracking and other damage.
4. Sequence deliveries to avoid delays but minimize on-site storage.

1.06 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not apply asphalt | bituminous concrete materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the ambient or base surface temperature is less than 40 degrees Fahrenheit (4.4 degree Celsius), or if surface is wet or frozen.
2. Do not apply the pavement markings in foggy or rainy weather, or when the ambient temperature is below 45-degree Fahrenheit (7.2-degrees Celsius) for alkyd materials, below 55-degrees Fahrenheit (12.8-degrees Celsius) for water-based materials, and not exceeding 95-degrees Fahrenheit (35-degrees Celsius), or if such conditions are anticipated during the next 48-hours.

PART 2 PRODUCTS

2.01 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Graded Aggregate for Subbase and Base for court construction shall be sound, crushed stone or gravel complying with requirements in Section 31 00 00 "EARTH MOVING" for subbase material.

2.02 ASPHALT | BITUMINOUS CONCRETE MATERIALS

A. Asphalt | bituminous concrete paving for basketball court, and four-square construction shall be Class I, Type I-1 hot plant mix, conforming to the applicable sections of the MassDOT Highway Division Standard Specifications (for Highways and Bridges) and shall consist of two courses of asphalt | bituminous concrete with a minimum finished pavement thickness as shown on Drawings and specified in Section 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" as released in Early Release Package 1 (ERP1).

2.03 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Latex-ite; Dalton Coatings.
2. Transpo Industries.
3. Aexcel Inc.
4. Benjamin Moore & Co.
5. Columbia Paint & Coatings.
6. Ennis Traffic Safety Solutions, Inc.
7. PPG Industries.
8. Sherwin-Williams Company (The).

2.04 BASKETBALL COURT-MARKING PAINT

A. Basketball Court- Marking Paint: Acrylic Latex line-marking paint.

B. The layout and design of color sealing shall be installed per Drawings.

C. Color:
   1. Line Markings on basketball court shall be white textured line paint.

2.05 FOUR SQUARE-MARKING PAINT

A. Four Square- Marking Paint: Acrylic Latex line-marking paint.
B. The layout and design of color sealing shall be installed per Drawings.
C. Color:
   1. Line Markings on four-square shall be white textured line paint.
   2. Apply all acrylic paint colors in two coats each.
   3. Four-Square Color I: Light Blue.
   4. Four-Square Color J: Bike Lane Green.

2.06 OBSTACLE COURSE PLAY-MARKING PAINT

A. Obstacle Course Play-Markings Paint: Acrylic Latex line-marking paint.
B. The layout and design of color sealing shall be installed per Drawings.
C. Color:
   1. Line Markings on obstacle course shall be white textured line paint.
   2. Apply all acrylic paint colors in two coats each.
   3. Obstacle Course Play-Marking Color I: Light Blue.
   4. Obstacle Course Play-Marking Color J: Bike Lane Green.
   5. Obstacle Course Play-Marking Color K: Toll Lane Purple.
   6. Obstacle Course Play-Marking Color L: Orange.
   7. Obstacle Course Play-Marking Color M: Airfield Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.
B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
C. Verify gradients and elevations of base are correct.
D. Proceed with paving only after unsatisfactory conditions have been corrected.

3.02 SUBBASE

A. Construct subbase in accordance with Drawings and Section 31 00 00 "EARTH MOVING".

3.03 ASPHALT | BITUMINOUS CONCRETE PAVING

A. Construct subbase in accordance with Drawings and 32 12 16.36 "ATHLETIC ASPHALT | BITUMINOUS CONCRETE SPORT COURT PAVING" as released in Early Release Package 1 (ERP1).

3.04 PAVEMENT AND COURT MARKING EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer's written instructions.
B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.05 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Owner’s Representative.
B. Allow paving to age for a minimum of 30 days before starting pavement marking.
C. Sweep and clean surface to eliminate loose material and dust.
D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 millimeters).

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.

3.06 COURT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Owner's Representative.
B. Allow paving to age for a minimum of 30 days before starting pavement marking.
C. Sweep and clean surface to eliminate loose material and dust.
D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 millimeters).
E. Marking Application:
   1. Basketball, and Four-Square lines shall be 100 percent acrylic line paint containing no alkyds, butadiene styrene or vinyls and shall be thinned with water only.
   2. The paint shall be suitable for application by brush, spray or roller using masking tape or templates. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.
   3. The paint shall be suitable for use over all types of asphalt surfaces and when applied over emulsified asphalt, it shall not cause lifting, crazing, peeling, or other damage to the base.
   4. Basketball, and Four-square lines shall be striped twice with complete court markings. The first markings shall be installed directly on the asphalt surface to allow the courts to be used prior to the installation of color surfacing. The second installation of court markings shall be performed after the color surfacing is installed and accepted by the Owner's Representative.

3.07 WARRANTY

A. The General Contractor shall provide the manufacturer's standard written warranty for each product within this specification. All of these warranties shall be in addition to, and not in lieu of, other liabilities that the General Contractor may have by law or other provisions of the Contract Documents.
B. The pavement and line striping shall be guaranteed against defects in workmanship or quality for a period of one year after final acceptance. The General Contractor shall replace, repair, recoat or otherwise make satisfactory to the Owner any unacceptable pavement and/or coating at no additional cost to the Owner.

3.08 CLEANING, REPAIR AND PROTECTION

A. Protect pavement markings from damage and wear during remainder of construction period.
B. Repair minor damage to eliminate all evidence of repair. Remove and replace Work that cannot be satisfactorily repaired.
C. Provide temporary protection to ensure that the Work shall be without dirt, stains, damage or deterioration at the time of final acceptance. Clean up stains and spills as they occur. Remove protections and clean immediately before final acceptance.
D. Upon completion of the Work and before acceptance, the General Contractor shall remove and dispose of in an accepted manner al surplus materials, and rubbish, which the General Contractor may have accumulated during the course of the Work and shall leave the site in a clean and orderly condition. The General Contractor shall not abandon any materials at or near the site regardless of whether or not it has any value.

END OF SECTION

SECTION 32 31 10
SELF-LATCHING GATE LATCHES AND LOCKS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Self-Latching Gate Latch – Vertical Pull.
   2. Self-Latching Gate Latch Round Post Kit; Model.
   3. Self-Latching Gate Latch Spacer; Model.

B. Related Requirements:
   1. Section 32 31 13 “CHAIN LINK FENCES AND GATES” for chain link mesh fences at playgrounds or children play areas.
   2. Section 32 31 19 “DECORATIVE METAL FENCES AND GATES” for fencing at playgrounds areas.

1.03 REFERENCES

A. The following Standards shall apply to the Work of this Section:
   1. ASTM: American Society for Testing and Materials:
      ASTM F2049-11 – Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas.
   2. FCC: Federal Communications Commission:
      FCC 47 CFR Part 15 Subpart B – Unintentional Radiators. (Models: ML3ATPKAG2 and ML3AVPKAG 2only).

B. Definitions:
   1. Ideal Gate Gap: Optimal horizontal distance between gate frame and fence post at which the products in this specification are mounted thereto. On products with a fixed gate gap, do not deviate from manufacturer’s recommendation.
   2. Gate Gap Variance: Horizontal distance range between gate frame and fence post at which the products in this specification are mounted thereto. Do not deviate from manufacturer’s horizontal distance range.

1.04 ACTION SUBMITTALS

A. Submit under provisions of Section 01 30 00 “ADMINISTRATIVE REQUIREMENTS”.

B. Product Data: Submit product data sheets for each type of product used on project with full model code.

C. Hardware Schedule:
   1. Submit hardware schedule detailing hardware to be provided at each opening for coordination with gate frames, fence posts and related work.
   2. For load bearing hardware, provide product information showing quantity and type of hardware recommended by manufacturer to safely carry weight of gate and other applied loads.
   3. Coordinate requirements with Site Operator and/or Site Owner and indicate desired position of gate within fence line. This will determine the spacing of the mounting brackets.

D. Installation Instructions: Submit manufacturer’s installation instruction for each hardware device. Mark installation instructions to indicate mounting heights for all operable hardware showing compliance with applicable codes requirements, including, but not limited to:
   1. ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas).

E. Warranty: Submit copy of manufacturer's warranty for each product.
F. Extra Materials: At project closeout provide installation and adjustment instructions, warranties and advisories, extra parts, accessories, and tools normally provided by manufacturer with installed hardware for maintenance and adjustment of installed hardware.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Continuously engaged in manufacturing of gate and fencing hardware of similar type to that specified, with a minimum of 30 years successful experience.
   2. D&D Technologies operates a fully accredited and internationally recognized ISO 9001-2015 Quality Assurance System, which governs the design and manufacture of all our products.
   3. Member: American Fence Association (AFA).

1.06 WARRANTY

A. Limited Lifetime Warranty – Mechanical latching devices listed.

1.07 COMMISSIONING

A. Conduct these tests prior to requesting a certificate of substantial completion:
   1. With Installer present, test gate hardware operation.
   2. With Installer present, ensure gate hardware meets requirements set out in Section 1.3 REFERENCES.
   3. With installer present, ensure documents and instructions are handed to Site Operator and/or Site Owner.
   4. With Installer present, ensure keys and adjustment key tag are handed to Site Operator and/or Site Owner.
   5. With Installer present, ensure training is provided to Site Operator and/or Site Owner, including operating, making adjustments and conducting regular inspection and maintenance as per manufacturer's requirements set out in Part 3 EXECUTION.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. D&D Technologies Inc., 7020 Reames Rd. Suite D, Charlotte, NC 28216; Telephone: 800.716.0888; Fax: 800-464-6400; E-mail: info@ddtechusa.com; Website: https://us.ddtech.com.
   2. Nationwide Industries, 3505 Cragmont Drive, Tampa, FL, 33619; Telephone: 813.988.2628; Email: info@nationwideindustries.com; Website: https://nationwideindustries.com.
   3. DAC Industries, Inc., 600 Eleventh Street, N.W., Grand Rapids, MI 49504; Telephone: 800.888.9768; Fax: 616.235.2901; Website: https://dacindustries.com.
B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers shall have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.
C. Other manufacturer's products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 "SUBSTITUTION PROCEDURES".

2.02 SELF-LATCHING GATE LATCH – VERTICAL PULL

A. Basis-of-Design Project: Self-latching gate latch: Self-Latching latches shall be MagnaLatch Series 3 Vertical Pull variants as manufactured by D&D Technologies Inc. or approved equal.
   1. Magnetic self-latching gate latch:
      a. Automatic self-latching upon gate closure.
      b. No mechanical jamming during closure and stops the latch from disengaging due to shaking the gate.
   2. Vertical Pull Variants –
      a. Suitable for taller play area gates that are 60-inches (1,500-millimeters) or higher as per ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas), or where child safety is important. Always confirm local fence / barrier regulations before installation
      b. Suitable for mounting on garden or household gates to provide a reliable safety barrier. Always confirm local fence / barrier regulations before installation
   3. Mounting: To be mounted on corners of posts with front and side fixing points and suitable for Fencing Materials: Metal, Wood and Vinyl. Chain link requires round posts adapters (ML3RPK) – Refer to section on Self-Latching Gate Latch Accessories.
   4. Orientation: Suitable for left or right-handed gate – rotate striker to suit orientation.
   5. Recommended and Minimum post sections – refer to table below.
   6. Ideal Gate Gap and Gap Variance – refer to table below.

MagnaLatch Series 3 Vertical Pull Models

Model Code	Color	Recommended Post Section		Minimum Post Section		Ideal Gate Gap*	Gap Variance*	Vertical Adjustment
		Latch	Striker	Latch	Striker			
ML3VPKA	Black	1-3/16” by 1-3/16” (30mm by 30mm)	1-3/4” by 1-3/4” (40mm by 40mm)	1” by 1” (25.4mm by 25.4mm)	1” by 1” (25.4mm by 25.4mm)	3/4” (19mm)	1/2” to 1-1/2” (13-38mm)	1-1/2” (38mm)
ML3VPKAWT	White							
ML3AVPKAG2	Black							

* For larger gate gap and/or increased gap variance, use ML3SPACER.

B. Performance Requirements:
   1. General: Provide fence(s) and gate(s) that have been designed and fabricated to specified performance requirements, as demonstrated in Section 1.3 REFERENCES.
   2. Compliance:
      a. Suitable for safety applications, such as child safety gates of 60-inches (1,500-millimeters) or higher – ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas), and required to be paired suitable with gate closers. Always confirm local fence / barrier regulations before installation.
      b. When used on play area gates as per ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas), the MagnaLatch Series 3 Vertical Pull Models shall be paired with suitable self-closing devices for the gate or gate closers. Always confirm local fence / barrier regulations before installation.

3. Suitable for safety applications, such as child safety gates where gates are 60-inches (1,500-millimeters) or higher. Always confirm local fence / barrier regulations before installation.
4. Recommended and Minimum post sections – refer to table above.
5. Ideal Gate Gap and Gap Variance – refer to table above.
6. Operation Temperature range:
   a. -40 degrees Fahrenheit to 140 degrees Fahrenheit (-40 degrees Celsius to 60 degrees Celsius) – Mechanical latching devices.
7. Suitable applications – refer to table below.

MagnaLatch Series 3 Vertical Pull Models – Applications	
Suitable Applications	Suitable Gate and Fencing Materials
• Swimming Pool Safety Gates (ASTM F1908-08 [Standard Guide for Fences for Residential Outdoor Swimming Pools, Hot Tubs, and Spa])**. • Outdoor Play areas (ASTM F2049-11 [Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas])**. • Child Safety Gates. • Pedestrian Gates. • Garden Gates. • Household Gates.	• Metal • Wood • Vinyl • Chain Link***
** Gates are 60-inches (1,500millimeters) or higher and MagnaLatch Series 3 Vertical Pull Models shall be paired with suitable self-closing devices for the gate or gate closers. Always confirm local fence / barrier regulations before installation. *** Requires round posts adapters ML3RPK. See Section 2.5 on ML3RPK below for details and dimensions for Chain Link applications.	

C. Components
   1. Magnetic Latching:
      a. Automatic self-latching upon gate closure.
   2. Lock:
      a. Six-pin re-keyable security lock – re-keyable to match door set. Use Kwikset KW5 blank.
      b. Visual Lock Indicator for knowing when latch is locked or unlocked.
   3. Mounting and Adjustment:
      a. Height setting screw with fine increments to ensure release mechanism knob out is positioned out of reach to meet ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas). Always confirm local fence / barrier regulations before installation.
      b. To be mounted on corners of posts with front and side fixing points.
      c. Alignment Indicators on latch and striker to show recommended alignment.
      d. Vertical and horizontal adjustment.
   4. Materials:
      a. Engineered polymer and aluminum construction with stainless steel components.

2.03 SELF-LATCHING GATE LATCH ROUND POST KIT

A. Self-latching gate latch round post kit shall be MagnaLatch Series 3 Round Post Kit as manufactured by D&D Technologies Inc.
   1. Recommended for use on MagnaLatch Series 3.
   2. Round Post Adaptor Kit: Optional kit for mounting MagnaLatch Series 3 models to gates and fences with round posts. Kit includes adaptor brackets and shims for the following chain link fitments.

MagnaLatch Round Post Kit – Chain Link Shim Fitments	
Post Size	Shim type
Fence post diameter 2-3/8” (60mm)	No shim required. Fence Post adapter bracket is suited for 2-3/8” (60mm) diameter.
Fence post diameter 1-7/8" – 2” (48-51mm)	Use shim marked 2” (51mm) provided
Fence post diameter 2-7/8” (73mm)	Use shim marked 2-7/8” (73mm) provided
Gate frame diameter 1-5/8" (41mm)	No shim required. Gate frame adapter bracket is suited for 1-5/8" (41mm) diameter.
Gate frame diameter 1-3/8" (35mm)	Use shim marked 1-3/8" (35mm) provided

2.04 SELF-LATCHING GATE LATCH SPACER

A. Self-latching gate latch spacer shall be MagnaLatch Series 3 Spacer as manufactured by D&D Technologies Inc.
   1. Recommended for use on MagnaLatch Series 3.
   2. Two-inch Gate Gap Spacer: MagnaLatch Series 3 comes standard with a gate gap variance of 1/2-inch to 1-1/2-inch (13-38-millimeters). Use gap spacer for gaps of 1-1/2-inch to 2-inch (38-50-millimeters).

PART 3 EXECUTION

3.01 EXAMINATION

A. Site Operator and/or Site Owner to examine gate frames and fence posts, with Installer present, for compliance with requirements for gate hardware installation tolerances, assembly construction, and other conditions affecting performance.
B. Proceed with installation once part A above has been met.

3.02 PREPARATION

A. Prepare gate frames and fence posts in accordance with manufacturer's installation instructions. Existing gate hardware shall be removed before installation. Apply corrosion protection and finish to exposed screw hole or area left over from the removal of existing hardware before installation of D&D Technologies' hardware.

3.03 INSTALLATION

A. Install each hardware items to comply with manufacturer’s installation instructions, building code requirements, and requirements of Authorities Having Jurisdiction.
B. Install hardware types and quantities indicated on submitted hardware schedule.
C. Do not install surface-mounted hardware until substrate finishes have been completed.
D. Set all gates, fence posts and gate hardware level, plumb and true to line and location. Adjust and reinforce attachments where necessary for proper installation and operation.
E. Make final installation inspection with Site Operator and/or Site Owner and make final adjustments prior to acceptance, in particular where ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas) and/or local fence / barrier regulations are essential. The key points are as follows:

1. Check placement and position of the release mechanism knob with respect to the standards mentioned above. Always confirm with local fence / barrier regulations.
2. Check alignment between the latching pin of the latch and the keeper of the striker to ensure the latching pin is engaged with the keeper when the gate is in the closed position. Note MagnaLatch Series 3 Vertical Pull Models have alignment indicators for optimal alignment. Where applicable, make necessary adjustment(s) as per manufacturer's recommendation. Always confirm with local fence / barrier regulations.
3. Check paired self-closing devices for the gate or gate closers to enable the gate to be closed from any position and allow the latching pin to be engaged with the keeper. Where applicable, make necessary adjustment(s) as per manufacturer's recommendation. Always confirm with local fence / barrier regulations.
4. Check for any obstruction(s) or potential obstruction(s) that prevents the latching pin being engaged with the keeper when the gate is in the closed position.

F. Ensure documents and instructions are handed to Site Operator and/or Site Owner.

G. Ensure keys and adjustment key tag are handed to Site Operator and/or Site Owner.

H. Ensure training is provided to Site Operator and/or Site Owner including operating, making adjustments and regular maintenance is carried out as per manufacturer's requirements.

I. Highlight to Site Operator and/or Site Owner the following warning notes:
1. MagnaLatch Series 3 Vertical Pull Models:
   a. Safety warning label on the side of the tube.
   b. Adjustment key tag with key.
2. MagnaLatch Side Pull Lockable: Adjustment key tag with key.

3.04 MAINTENANCE

A. NOTE: Gates and Fencing can move due to wind loading, ground movement, and/or other factors. This can cause alignment to shift. Therefore, Site Operator and/or Site Owner shall ensure the following inspection and maintenance is carried out on a regular basis or when the gate(s) is prevented from being self-closed and its self-latching device is prevented from self-latching, i.e. the latching pin engaging with the keeper.

B. Check alignment between the latching pin of the latch and the keeper of the striker to ensure the latching pin is engaged with the keeper when the gate is in the closed position during regular maintenance and make adjustments where required to maintain alignment. Note MagnaLatch Series 3 Vertical Pull Models have alignment indicators for optimal alignment.

C. When self-latching gate latch is paired with suitable self-closing devices for the gate or gate closers to comply with ASTM F2049-11 (Standard Safety Performance Specification for Fences/Barriers for Public, Commercial, and Multi-Family Residential Use Outdoor Play Areas) and/or local fence / barrier regulations, always carry out maintenance on both self-latching gate latch and suitable closing devices for the gate or gate closers at the same time. The key points are as follows:
1. Check placement and position of the release mechanism knob with respect to the standards mentioned above.
2. Check alignment between the latching pin of the latch and the keeper of the striker to ensure the latching pin is engaged with the keeper when the gate is in the closed position. Note MagnaLatch Series 3 Vertical Pull Models have alignment indicators for optimal alignment. Where applicable, make necessary adjustment(s) as per manufacturer's recommendation.
3. Check paired self-closing devices for the gate or gate closers to enable the gate to be closed from any position and allow the latching pin to be engaged with the keeper. Where applicable, make necessary adjustment(s) as per manufacturer's recommendation.

4. Check for any obstruction(s) or potential obstruction(s) that prevents the latching pin being engaged with the keeper when the gate is in the closed position.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Chain Link fences.
   2. Gates: swing.
   3. Gates: swing, self-closing latching.
   4. Gate lock: per Owner's specifications (to be coordinated with installation)

B. Related Sections:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for cast-in-place post footings as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for excavation for installing concrete footings.
   3. Section 32 31 10 "SELF-LATCHING GATE LATCHES AND LOCKS" for gates at playgrounds or children's play areas.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design chain link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Chain link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions.

C. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain link fences and gates.
   1. Fence and gate posts, rails, and fittings.
   2. Chain link fabric, reinforcements, and attachments.
   3. Gates and hardware.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.

C. Samples for Initial Selection: For components with factory-applied color finishes.

D. Delegated-Design Submittal: For chain link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer registered in Massachusetts responsible for their preparation.

E. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.

a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.

3. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Factory-authorized service representative.
B. Product Certificates: For each type of chain link fence and gate, from manufacturer.
C. Product Test Reports: For framing strength according to ASTM F 1043.
D. Field quality-control reports.
E. Warranty: Sample special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
   1. Powder-coated Polymer finishes.
   2. Gate hardware.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
B. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.08 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.
B. The General Contractor and his Subcontractors shall inspect all subbases for unstable, unsuitable or improperly prepared areas. Do not begin work over unacceptable areas. Beginning work means the General Contractor and his Subcontractors accept the subbase, previous work and conditions and shall be held responsible for any corrections required to properly implement the Construction Documents.
C. The work of this Section shall be completely coordinated with the work of other Sections. Verify dimensions and work of other trades which adjoin materials of this Section before installing specified items.

1.09 WARRANTY

A. Special Warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of chain link fences and gates that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of gate operators and controls.
      b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 CHAIN LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top, intermediate (as shown on drawing details), and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with the requirements indicated below:
   1. Fabric Height: As indicated on Drawings.
   2. Steel Wire Fabric: Six-gauge wire with a diameter of 0.192 inch (4.8768 millimeters).
      a. Mesh Size: Two inches (50 millimeters).

b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 ounces per square foot (610 grams per square meter) with zinc coating applied before weaving.
c. Polymer-Coated Fabric: ASTM F 668, Class 2b over Zinc-coated steel wire.
   1) Color: Black, complying with ASTM F 934.
d. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.

3. Selvage: Knuckled at both selvages.

2.02 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083 based on the following:
   1. Fence Height: As indicated on Drawings.
   2. Light Industrial Strength: Material Group II-L, roll-formed steel C-section shapes.
      a. Line Post: 2 3/8-inch (60.3-millimeter) outside diameter.
      b. End, Corner and Pull Post: Three-inch (76.2-millimeter) outside diameter.
   3. Horizontal Framework Members: top, intermediate (as shown on drawing details), and bottom rails complying with ASTM F 1043.
      a. Top Rail: 1 5/8-inch (9.525-millimeter) outside diameter.
   4. Brace Rails: Comply with ASTM F 1043.
   5. Metallic Coating for Steel Framing:
      a. Type B, zinc with organic overcoat, consisting of a minimum 0.9 ounces per square foot (0.27 grams per square meter) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
   6. Polymer coating over metallic coating.
      1) Color: Black, complying with ASTM F 934.

2.03 TENSION WIRE

A. Metallic-Coated Steel Wire: 0.177-inch-(4.5-millimeter) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
   1. Type I, aluminum coated (aluminized).
   2. Type II, zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:
      a. Class 4: Not less than 1.2 ounce per square foot (366 grams per square meter) of uncoated wire surface.

B. Polymer-Coated Steel Wire: 0.148-inch- (3.8-millimeter) diameter, tension wire complying with ASTM F 1664, Class 2b over zinc-coated steel wire.
   1) Color: Black, complying with ASTM F 934.

2.04 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single and double swing gate types.
   1. Gate Leaf Width: As indicated.
   2. Gate Fabric Height: As indicated.

B. Pipe and Tubing:
   1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
   2. Gate Posts: Round tubular steel.
   3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Hardware:
   1. Hinges: 180-degree outward swing.

2. Latches: self-latching device placed four feet above finish grade or to comply with state and local playground regulations. Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Lock: Owner to specify type of electronic or key access required.
4. Closer: Manufacturer's standard.

2.05 FITTINGS

A. General: Comply with ASTM F 626.
B. Post Caps: Provide for each post.
   1. Provide line post caps with loop to receive tension wire or top rail.
C. Rail and Brace Ends: For each gate, corner, pull, and end post.
D. Rail Fittings: Provide the following:
   1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than six inches (152 millimeters) long.
   2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate (as shown on drawing details), and bottom rails in the fence line-to-line posts.
E. Tension and Brace Bands: Pressed steel.
F. Tension Bars: Steel, length not less than two inches (50 millimeters) shorter than full height of chain link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
G. Truss Rod Assemblies: Steel, hot dip galvanized after threading rod and turnbuckle or other means of adjustment.
H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
   1. Standard Round Wire Ties: For attaching chain link fabric to posts, rails, and frames, complying with the following:
      a. Hot-Dip Galvanized Steel: 0.148-inch- (3.76-millimeter-) diameter; galvanized coating thickness matching coating thickness of chain link fence fabric.
      b. Aluminum: Six-gauge wire; 0.192-inch- (4.88-millimeters) diameter wire; coating thickness match chain link fence fabric.
   2. Band-it Ties: For attaching chain link fabric to posts, rails, and frames, complying with the following:
      a. Hot-Dip Galvanized Steel or Stainless Steel: self-locking head with smooth edge, Nominal Size: 15 inches, Actual Length: 14.9 inch (378 millimeters); Width: 0.187 inch (4.76 millimeters); Max Bundle Diameter: Four inch; Minimum Loop Tensile: 200-pound Coating thickness and finish to match coating of chain link fence fabric.
I. Finish:
   1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 ounce per square foot (366 grams per square meter) zinc.
      a. Polymer coating over metallic coating.

2.06 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.07 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   1. Material above Finished Grade: Copper.
   2. Material on or below Finished Grade: Copper.
   3. Bonding Jumpers: Braided copper tape, one inch (25 millimeters) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.
   1. Connectors for Below-Grade Use: Exothermic welded type.
   2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 millimeters).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
   1. Do not begin installation before final grading is completed unless otherwise permitted by Owner's Representative.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 meters) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 INSTALLATION, GENERAL

A. Install chain link fencing to comply with ASTM F 567 and more stringent requirements indicated.
   1. Install fencing on established boundary lines inside property line.

3.04 CHAIN LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
   1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
   2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
      a. Exposed Concrete: Extend two inches (50 millimeters) above grade; shape and smooth to shed water.
      b. Concealed Concrete: Top two inches (50 millimeters) below grade as indicated on Drawings to allow covering with surface material.
      c. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
      d. Posts Set into Voids in Concrete: Form or core drill holes not less than five inches (125 millimeters) deep and 3/4 inches (20 millimeters) larger than outside diameter of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

3. Mechanically Driven Posts: Drive into soil to depths of 36 inches (914 millimeters). Protect post top to prevent distortion.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more.

D. Line Posts: Space line posts uniformly at 10 feet (three millimeters) on center.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches (1830 millimeters) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-millimeter) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 millimeter) on center. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within six inches (152 millimeters) of bottom of fabric and tie to each post with not less than same diameter and type of wire.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Intermediate and Bottom Rails: Install and secure to posts with fittings.

I. Chain link Fabric: Apply fabric to outside of enclosing framework. Leave two inches (50 millimeters) between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 millimeters) on center.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 millimeters) on center and to braces at 24 inches (610 millimeters) on center.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

3.05 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.06 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 millimeters) except as follows:

1. Fences within 100 Feet (30 meters) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 meters).

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 millimeters) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 meters) on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is six inches (150 millimeters) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
   1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
   2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

D. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

E. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

F. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.07 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
   1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after the last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
   2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Owner's Representative promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
   3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of the weather and other phenomena that may affect test results.

3.08 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout

entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain link fences and gates.

END OF SECTION

SECTION 32 31 19
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Decorative steel fence.
   2. Decorative steel double gate with heavy duty hinges and lockable latch hardware.
   3. Decorative steel double gate with heavy duty hinges and self-closing latch hardware; See Specification Section 32 31 00 “SELF-LATCHING GATE LATCHES AND LOCKS”.
   4. Decorative steel single gate with heavy duty hinges and self-closing latch hardware; See Specification Section 32 31 00 “SELF-LATCHING GATE LATCHES AND LOCKS”.
   5. Decorative aluminum single swing gate with panic bar gate hinges with gate stop, 12-inch panic plate, and panic hardware and accessories; See Specification Section 08 71 00 “DOOR HARDWARE”.
   6. Decorative steel vehicular double gate with drop rods, heavy duty hinges and heavy duty lockable latch hardware.

B. Related Requirements:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)” for concrete bases for gate operators, drives, and controls and post concrete fill as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for excavation for installing concrete footings.
   3. General Contractor shall coordinate access control devices installed at gates and provided as part of a security system with the Owner.
   4. Section 32 31 00 “SELF-LATCHING GATE LATCHES AND LOCKS” for gates at playgrounds or children’s play areas.
   5. Section 08 71 00 “DOOR HARDWARE” for panic hardware accessories including the mortise cylinder and the removable core at gates.

1.03 QUALITY ASSURANCE

A. The General Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.04 REFERENCES

A. The following Standards shall apply to the Work of this Section:
   1. ASTM: American Society for Testing and Materials:
      ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
      ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
      ASTM D523 - Test Method for Specular Gloss
      ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
      ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
      ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
      ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

2. International Building Code: IBC 2018 1607.8.1 Handrails and Guards

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For fences and gates. Include plans, elevations, sections, details, and attachments to other work.
C. Samples: For each fence material and for each color specified.
   1. Provide Samples 12 inches (300 millimeters) in length for linear materials.
   2. Provide Samples 12 inches (300 millimeters) square for bar grating and sheet or plate materials.
   3. Provide Samples: Eight by 10 inches (203 by 254 millimeters) minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.
D. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
B. Product Test Reports: For decorative metallic-coated-steel picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.07 CLOSEOUT SUBMITTALS

A. Maintenance Date: For gate operators to include in maintenance manuals.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.
B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Include 10-foot (three-meters) length of fence complying with requirements.
   2. Subject to compliance with requirements, accepted mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.09 PRODUCT HANDLING AND STORAGE

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.10 PRODUCT WARRANTY

A. All structural fence components (i.e., rails, pickets, and posts) shall be warranted within specified limitations, by the Manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures' warranty shall be guaranteed for five years from date of original purchase.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. Ameristar Fence Products, Inc., 1555 N. Mingo Road, Tulsa, OK 74116; Telephone: 888.333.3422; Website: www.ameristarfence.com.
   2. Ametco Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, OH 44096; Telephone: 440.951.4300; Fax: 440.951.2542; E-mail: ametco@ametco.com; Website: www.ametco.com.
   3. Ultra Aluminum Manufacturing Inc., 2124 Grand Commerce Drive, Howell, MI 48855; Telephone: 517.548.6755; Fax: 517.548.6756; Website: www.ultrafence.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers shall have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer's products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 "SUBSTITUTION PROCEDURES".

2.02 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.03 DECORATIVE METALLIC-COATED-STEEL PICKET FENCES & GATES

A. Basis-of-Design Project: The fence system shall conform to Montage Plus standard picket space Welded and Rackable (ATF – All Terrain Flexibility) Ornamental Steel, for standard picket space, specify Majestic, for three-inch air space, Majestic design, flush bottom rail treatment, Three-Rail style manufactured by Ameristar Fence Products, Inc., in Tulsa, Oklahoma, or approved equal.

B. Decorative Metallic-Coated-Steel Picket Fences: "Montage Plus Pool, Per & Play Three-Inch Air Space Fence".
   1. Comply with ASTM F2408 for light industrial (commercial) application unless otherwise indicated.
   2. Model: Majestic Design.
   3. Style: Three-Rail; 14 Gauge Rails; 18 Gauge Pickets; 16 Gauge Posts.
   4. Height: Four-foot high
   5. Color: Black

C. Decorative Metallic-Coated-Steel Picket Gates: "Montage Plus Pool, Pet & Play Three-Inch Air Space Double Gate".
   1. Comply with ASTM F2408 for light industrial (commercial) application unless otherwise indicated.
   2. Model: Majestic Design.
   3. Style: Double; 14 Gauge Rails; 18 Gauge Pickets; 14 Gauge. Uprights; Post size varies with height (see Table 1 for minimum size requirements).

4. Height: Four-foot high.
5. Hinges:
   a. Standard Gate: Heavy Duty TruClose Hinges, or approved equal.
   b. Gate with Panic Bar Accessories: Sureclose Hinges (Part Number 74108325T) with Gate Stop (Part Number 7403), or approved equal.
6. Gate Widths:
   a. Double-Swing Five Foot and Eight Inch Leaves (12 Foot Wide) with heavy duty hinges, and lockable latch hardware.
      1) Lockable latch Hardware Bases of Design: Heavy Duty LokkLatch Deluxe (Part Number LLDAB-KSA), or approved equal.
   b. Double-Swing Three Foot and Four-Inch Leaves (Seven Foot Wide) with heavy duty hinges, and Self-Closing Latch Hardware; See Specification Section 32 31 00 “SELF-LATCHING GATE LATCHES AND LOCKS”.
   c. Single-Swing Four-Foot Leaf with heavy duty hinges, and Self-Closing Latch Hardware; See Specification Section 32 31 00 “SELF-LATCHING GATE LATCHES AND LOCKS”.
   d. Single-Swing Four-Foot Leaf with panic bar gate hinges with gate stop, 12-inch panic plate, Panic Hardware and Accessories including the mortise cylinder and the removable core; See Specification Section 08 71 00 “DOOR HARDWARE”; or approved equal.
   e. Vehicular Double Gate 12 Foot Leaves (24 Feet Wide) with a drop rod for each gate led, heavy duty hinges, and heavy-duty lockable latch hardware, or approved equal.
      1) Heavy-Duty Lockable Latch Hardware Bases of Desing: Strong Arm Double Gate Latch (Part Number DSX200), or approved equal.
7. Color: Black.

D. Fasteners: Manufacturer’s standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

2.04 MATERIAL

A. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 pounds per square inch (310 Megapascals) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 ounce per square foot (184 gallons per square meter), Coating Designation G-60.

B. Material for pickets shall be 3/4-inch square by 18 Gauge tubing. The rails shall be steel channel, 1.5-inch by 1.4375-inch by 14 Gauge. Picket holes in the rail shall be spaced 4.675-inch on-center for standard picket space. Fence posts and gate posts shall meet the minimum size requirements of Table 1.

Table 1 – Minimum Sizes for Montage Plus Posts

Fence Posts	Panel Height	
2-1/2” x 16 Ga.	Up to & Including 6’ Height	
Gate Leaf	Gate Height	
	Up to & Including 4’	Over 4’ Up to & Including 6’
Up to 4’	2-1/2” x 16 Ga.	2-1/2” x 14 Ga.
4’1” to 6’	3” x 12 Ga.	3” x 12 Ga.
6’1” to 10’	4” x 11 Ga.	4” x 11 Ga.
10’1” to 16’	6” x 3/16” wall	6” x 3/16” wall

C. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than five feet (1.52 meters) wide. As noted within details, provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for

padlocking, padlock accessible from both sides of gate. Final latching and locking operation and associated mechanisms to be coordination with Owner before submitting SHOP DRAWINGS.

2.05 FABRICATION

A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.

B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly (Note: The process produces a virtually seamless, spatter-free good-neighbor appearance, equally attractive from either side of the panel).

C. The manufactured panels and posts shall be subjected to an inline electrode position coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be two mils (0.058 millimeters). The color shall be Black. The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2 (Note: The requirements in Table 2 meet or exceed the coating performance criteria of ASTM F2408).

Table 2 – Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60-inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60˚ Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

D. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Commercial weight fences under ASTM F2408.

E. Classic, Majestic, Genesis & Invincible styles with three and four-rail configurations shall meet IBC compliance. Panel, post and bracket assemblies shall be subjected to structural performance testing according to Chapter 17 – Structural Tests and Special Inspections – International Building Code (IBC) 2018. Physical testing to be completed by accredited third party testing facility. Completed assembly shall demonstrate loading capacity of 2.5 times prescribed design loads found in section 1607.8.1, 1607.8.1.1 and 1607.8.1.2 of IBC 2018 for Handrails and Guards. IBC compliant fence system requirements detailed within Table 3.

Table 3 – Montage Plus – IBC Compliant System Requirements				
Panel Options		**Post Options**		**Brackets Options**
Styles	Rail Configuration	Steel Post Options	Post Plate Options (Anchorage by other trades)	Line Boulevard Brackets
Classic	3-Rail & 4-Rail	2.5” SQ x 14 Ga.	8” x 8” x 3/8” – for 2.5” posts	End Boulevard Brackets
Majestic		3” SQ x 12 Ga.	10” x 10” x 3/8” – for 3” posts	Corner Boulevard Brackets
Genesis		4” SQ x 12 Ga.		*Flat Mount Brackets
Warrior				**Note: Flat Mount Brackets require a thru-bolt installation*
Panel, post, and bracket assemblies shall be subjected to structural performance testing according to Chapter 17 - Structural Tests and Special Inspections - International Building Code (IBC) 2018. Physical testing to be completed by accredited third party testing facility. Completed assembly shall demonstrate loading capacity of 2.5 times prescribed design loads found in section 1607.8.1, 1607.8.1.1 and 1607.8.1.2 of IBC 2018 for Handrails and Guards.				

F. Gates with an out-to-out leaf dimension less than and including 72 inches shall be fabricated using Montage Plus ornamental panel material and 1-3/4-inch square by 14 Gauge gate ends. Gate leaves greater than 72 inches shall be fabricated using ForeRunner rails, 17-gauge pickets, intermediate uprights, gussets and 1-3/4-inch square by 14 Gauge gate ends. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding.

2.06 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2).

B. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M and specifically recommended by manufacturer for exterior applications.

2.07 GROUNDING MATERIALS

A. Grounding Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   1. Material above Finished Grade: Copper.
   2. Material on or below Finished Grade: Copper.
   3. Bonding Jumpers: Braided copper tape, one inch (25 millimeters) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Grounding Connectors and Grounding Rods: Comply with UL 467.
   1. Connectors for Below-Grade Use: Exothermic-welded type.
   2. Grounding Rods: Copper-clad steel.
      a. Size: 5/8 by 96 inches (16 by 2440 millimeters).

2.08 FINISHES

A. This article references AAMA standard for pigmented organic coating on extrusions and panels.

B. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of two mils (0.05 millimeters). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
   1. Color: Black.

PART 3 EXECUTION

3.01 PREPARATION

A. All new installation shall be laid out by the Installation Contractor in accordance with the construction plans.

3.02 INSTALLATION

A. Fence post shall be spaced according to Table 4, plus or minus 1/4-inch. For installations that shall be raked to follow sloping grades, the post spacing dimension shall be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the Manufacturer. Posts shall be set in concrete footers having a minimum depth of 36-inches (Note: In some cases, local restrictions of freezing weather conditions may require a greater depth).

Table 4 – Montage Plus – Post Spacing By Bracket Type

Span	For CLASSIC, GENESIS, MAJESTIC, & WARRIOR 8' Nominal (91.95" Rail)					
Post Size	2-1/2"	2-1/2"	2-1/2"	3"	2-1/2"	3"
Bracket Type	Montage Plus Universal (BB112)	Montage Plus Line Blvd. (BB114)	Montage Plus Flat Mount (BB111)		Montage Plus Swivel (BB113)*	
Post Set-tings ± 1/4" O.C.	95"	95"	95"	95-1/2"	*95"	*95-1/2"
*Note: When using BB113 swivel brackets on either or both ends of a panel installation, care shall be taken to ensure the spacing between post and adjoining pickets meets applicable codes. This shall re-quire trimming one or both ends of the panel.						

B. The "Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) and Section 31 00 00 "EARTH MOVING" sections of this specification shall govern material requirements for the concrete footer.

C. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

3.03 FENCE INSTALLATION MAINTENANCE

A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces:
   1. Remove all metal shavings from cut area.
   2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
   3. Apply two coats of custom finish paint matching fence color.

B. Failure to seal exposed surfaces per steps one to three above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufactures' warranty.

3.04 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

B. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application, weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.

3.05 GATE OPERATOR INSTALLATION

A. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.

B. Excavation for Concrete Bases: Hand-excavate holes for bases in firm, undisturbed soil to dimensions and depths and at locations according to gate operator component manufacturer's written instructions and as indicated.

C. Concrete Bases: Cast-in-place or precast concrete, depth not less than 12 inches (300 millimeters), dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

3.06 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet (450 millimeters) except as follows:
   1. Fences within 100 Feet (30 meters) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 meters).
      a. Gates and Other Fence Openings: Ground fence on each side of opening.
         1) Bond metal gates to gate posts.
         2) Bond across openings, with and without gates, except at openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 millimeters) below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 meters) on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground if required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is six inches (150 millimeters) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections so the possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
   4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

G. Bonding to Lightning-Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning-protection down conductor or lightning-protection grounding conductor, complying with NFPA 780.

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance not less than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.

2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports of grounding resistance at each test location certified by a testing agency. Include observations of the weather and other phenomena that may affect test results.

3.08 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware, gate operators, and other moving parts.

3.09 DEMONSTRATION

A. Train Owner's personnel to adjust, operate, and maintain gates.

3.10 CLEANING

A. The General Contractor shall clean the jobsite of excess materials; post-hole excavations shall be scattered uniformly away from posts.

END OF SECTION

SECTION 32 31 19.11
ANTI-RAM METAL FENCES AND GATES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Anti-Ram Barrier and Gates– PU30/P2 Engineered Cable System; or Approved Equal.

B. Related Requirements:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for concrete bases for gate operators, drives, and controls and post concrete fill.
   2. Section 31 00 00 "EARTH MOVING" for excavation for installing concrete footings.
   3. General Contractor shall coordinate access control devices installed at gates and provided as part of a security system with the Owner.
   4. Section 32 31 10 "SELF-LATCHING GATE LATCHES AND LOCKS" for gates at playgrounds or children's play areas.

1.03 REFERENCES

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
C. ASTM D523 - Test Method for Specular Gloss.
D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
E. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
F. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
G. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
H. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
I. ASTM F2656 – Standard Test Method for Vehicle Crash Testing of Perimeter Barriers
J. Federal Specification RR-W-410E / Wire Rope and Strand.
K. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For fences and gates. Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, and operational clearances.
C. Samples: For each fence material and for each color specified.
   1. Provide Samples: eight inches by 10 inches (203 by 254 millimeters) minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.
D. Delegated-Design Submittal: For anti-ram fence and gates framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer registered in Massachusetts responsible for their preparation.
E. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.

a. Include statement indicating costs for each product having recycled content.

2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
   a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
3. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 INFORMATION SUBMITTALS

A. Field quality-control reports.

B. Product Test Reports: For decorative metallic-coated-steel picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

Product Test Reports: For decorative metallic-coated-steel picket fences, including finish, indicating compliance with referenced standard and other specified requirements.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Date.

1.07 QUALITY ASSURANCE

A. The Installation Contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified. Installation Contractor used for this scope of work shall provide documentation from the manufacturer showing completion of core training on anti-ram barrier systems.

B. Installer Qualifications: Fabricator of products.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
   1. Include 10-foot (three-meter) length of fence complying with requirements.
   2. Subject to compliance with requirements, accepted mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 DELIVERY, STORAGE AND HANDLING

A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.09 PRODUCT WARRANTY

A. All structural fence components (i.e., rails, pickets, and posts) shall be warranted within specified limitations, by the Manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.

B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufactures' warranty shall be guaranteed for five years from date of original purchase.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. Ameristar Fence Products, Inc., 1555 N. Mingo Road, Tulsa, OK 74116; Telephone: 888.333.3422; Website: www.ameristarfence.com.
   2. Ametco Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, OH 44096; Telephone: 440.951.4300; Fax: 440.951.2542; E-mail: ametco@ametco.com; Website: www.ametco.com.

3. Ultra Aluminum Manufacturing Inc., 2124 Grand Commerce Drive, Howell, MI 48855; Telephone: 517.548.6755; Fax: 517.548.6756; Website: www.ultrafence.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations will not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer's products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 012500 "SUBSTITUTION PROCEDURES".

2.02 ANTI-RAM METAL FENCES AND GATES

A. The anti-ram cable barrier system shall conform to the Stalwart II Majestic PU30/P2 Engineered design, manufactured by Ameristar Perimeter Security USA Inc., in Tulsa, Oklahoma. This system shall be PU30/P2 Engineered based on test results of similar design. Engineering analysis shall be based upon ASTM F2656, Impact Condition Designation PU30, Penetration Rating P2, with capability of stopping a 5,070 pound vehicle traveling at speeds up to 30 miles-per-hour.

B. Basis-of-Design Project: The integrated steel fence panel system shall conform to Montage Plus Ornamental Steel ornamental fencing, Majestic Design, 3-rail, manufactured by Ameristar Perimeter Security USA Inc. in Tulsa, Oklahoma, or approved equal.

C. Decorative Anti-Ram Steel Fences: "Montage Plus Ornamental Steel" manufactured by Ameristar Fence Products, Inc.
   1. Model: Majestic Design
   2. Style: Three-Rail; 1-1/4-inch by 1-7/16-inch rails (0.110-inch side wall/0.090-inch top wall/0.060-inch internal web); 3/4-inch square by 0.045-inch-thick pickets; 2-1/2-inch by 2-1/2-inch by 0.060-inch posts with reinforced web
   3. Height: Four feet high
   4. Color: Black

D. The entire anti-ram barrier system, and all associated panels, gates, accessories, fittings, and fasteners shall be obtained from a single source.

2.03 PERFORMANCE REQUIREMENTS

A. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.04 MATERIAL

A. Steel material for cable-supporting framework (i.e., rails and I-beam posts) shall be galvanized prior to forming and shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 pounds per square inch (310 Megapascal). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 ounces per square foot (276 grams per square meter), Coating Designation G-90. Steel material for fence panels shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 pounds per square inch (310 Megapascal) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 ounces per square foot (184 grams per square meter), Coating Designation G-60.

B. The fence panel rails shall be steel channel, 1.5 inch by 1.4375 inch by 14 Gauge. Picket holes in the rail shall be spaced 4.675 inch on-center Material for pickets shall be 3/4 inch square by 18 Guage tubing. The cross-sectional shape of the anti-ram rails shall conform to the

manufacturer's Stalwart II rail design a nominal two inch by two inch by 11 Gauge. Tamperproof fasteners shall be used to fasten each fence panel to post bracket and rail to post connections. Posts shall conform to the manufacturer's Stalwart II I-Beam design with a nominal three inch by 2.75 inch by 12 Gauge.

C. The cable material shall be Independent Wire-Rope Core (IWRC) wire rope conforming to Federal Specification RR-W-410E, six by 36 Warrington Seale, preformed, right regular lay, medium lubrication, Extra Improved Plow Steel (EIPS), with a breaking strength of 103,400 pounds (51.7 tons). Cable diameter shall be one inch.

2.05 FABRICATION

A. Stalwart II rails and posts shall be pre-cut to specified lengths. Post flange shall be pre-punched to accept rail to post and fence panel to post bracket attachment. Post web shall be punched providing a clear opening for interior of rails to align throughout the entire system for affixing conduit, video cabling, IDS wiring, and other components for a complete systems integration. Stalwart II rails shall be attached to I-beam post flange providing a bracket-less design at each intermediate post.

B. Fence panel pickets and rails shall be precut to specified lengths. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by Ameristar's proprietary fusion welding process, thus completing the rigid panel assembly.

C. The manufactured galvanized anti-ram framework and fence panels shall be subjected to the PermaCoat® thermal stratification coating process (high-temperature, in-line, multi-stage, multi-layer) including, as a minimum, a six-stage pretreatment/wash, an electrostatic spray application of an epoxy base, and a separate electrostatic spray application of a polyester finish. The base coat shall be a thermosetting epoxy powder coating (gray in color) with a minimum thickness of two mils (0.0508 millimeters). The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508 millimeters). The color shall be black. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

Table 1 – Coating Performance Requirements

Quality Character-istics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90 percent of test area (Tape and knife test).
Corrosion Re-sistance	B117, D714 & D1654	Corrosion Resistance over 3,500 hours (Scribed per D1654; failure mode is accumulation of 1/8-inch coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inches per pound. (For-ward impact using 0.625-inch ball).
Weathering Re-sistance	D2244, D523 (60˚ Method)	Weathering Resistance over 1,000 hours (Failure mode is 60 percent loss of gloss or color variance of more than three delta-E color units).

D. The manufactured fence panel shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for commercial weight fences under ASTM F2408.

PART 3 EXECUTION

3.01 PREPARATION

A. The purchaser shall indicate the location of barrier line with suitable stakes. Stake intervals shall not exceed 500 feet or line of sight.

B. The purchaser shall indicate all underground utility locations, USC&G benchmarks, property monuments, and other underground structures.

C. Before installing the Stalwart II Daycare Anti-Ram Cable System, all necessary site clearing and grading shall be performed by the purchaser. An adequate clearance on both sides of the cable barrier line is required.
D. An Installation Contractor for this scope of work shall be capable of bonding projects up to three million and shall demonstrate such with a letter from a reputable bonding entity with the bid documents.
E. The Installation Contractor for this scope of work shall provide documentation from the product manufacturer indicating they have been trained on installation practices for Stalwart anti-ram systems by the product manufacturer, documentation shall be provided with bid documents.
F. The Installation Contractor for this scope of work shall provide documentation with bid indicating that the company currently has in place a minimum two million in general liability coverage as well as a minimum one million in commercial vehicle insurance, documentation shall be provided with bid documents.

3.02 INSTALLATION

A. The Stalwart II barrier shall be installed per Ameristar's System Drawings. Fence panels, brackets, cabling, and fasteners shall be installed according to installation instructions and drawings. Posts and bollards shall be installed per product drawings and installation instructions. The "Earthwork" and "Concrete" sections of this specification shall govern material requirements for the concrete footer unless otherwise specified by the product drawings or installation instructions.
B. The "Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" and 31 00 00 "EARTH MOVING" sections of this specification shall govern material requirements for the concrete footer.
C. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.

3.03 FENCE INSTALLATION MAINTENANCE

A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces:
    1. Remove all metal shavings from cut area.
    2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry.
    3. Apply two coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps one through three above shall negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components shall negate the manufactures' warranty.

3.04 GATE INSTALLATION

A. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary child-safe gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

3.05 CLEANING

A. The Installation Contractor shall clean the jobsite thoroughly to ensure it is left neat and free of any debris caused by the installation of the cable system.

END OF SECTION

SECTION 32 31 21
ENCLOSURE FENCES AND GATES METAL LOUVER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ornamental fixed louver modular fencing panels fabricated with extruded aluminum louvers and flat aluminum bars, including extruded aluminum fence posts and aluminum louver gates.

B. Related sections:
   1. Section 03 30 00.13 “CAST-IN-PLACE CONCRETE (SITE)” for concrete footings for support of fence posts as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING” for excavation for installing concrete footings.
   3. General Contractor shall coordinate access control devices installed at gates and provided as part of a security system with the Owner.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. ASTM B117 - Operating Salt Spray (Fog) Apparatus.
   2. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
   3. ASTM B221 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   4. ASTM D822 - Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
   5. ASTM D2794 - Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   6. ASTM D3363 - Test Method for Film Hardness by Pencil Test.

1.03 SUBMITTALS

A. Provide in accordance with Section 01 30 00 “ADMINISTRATIVE REQUIREMENTS”.

B. Product Data: For each type of product.

C. Shop Drawings: For fences and gates. Include plans, elevations, sections, details, and attachments to other work.
   1. Include diagrams for power, signal, and control wiring.

D. Samples: For each fence material and for each color specified.
   1. Provide Samples: Eight inches by 10 inches (203 by 254 millimeters) minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.

E. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.04 WARRANTY

A. Provide in accordance with Section 01 78 00 “CLOSEOUT PROCEDURES”.

1. 10-year warranty for factory finish against cracking, peeling, and blistering under normal use.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:
   1. Ametco Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby, OH 44096; Telephone: 440.951.4300; Fax: 440.951.2542; E-mail: ametco@ametco.com; Website: www.ametco.com.
   2. Omega II Fence Systems, 1735 St-Elzear Blvd. West; Laval (Quebec) Canada H7L 3N6; Telephone:1.800.836.6342; Fax:450.681.7905; E-mail: customerservice@omegatwo.com; Website: www.omegatwo.com; Massachusetts Sales Representative John Rocco Sales NG; Telephone: 732.431.2089.
   3. Palm Shield, 12330 Cary Circle, La Vista, NE 68128; Telephone: 531.329.4406; E-mail: info@palmsheildlouvers.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer’s products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and appearance. Submit as substitutions: see Section 01 25 00 “SUBSTITUTION PROCEDURES”.

2.02 MATERIALS

A. Extruded aluminum: ASTM B221, Alloy 6063, Temper T-6.

B. Sheet aluminum: ASTM B209, Alloy 6063, Temper T-6.

C. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, and water-reducing and plasticizing additives.

2.03 FENCE SYSTEM

A. Basis-of-Design Project: Subject to compliance with requirements, provide product indicated on Drawings by Ameristar Fence Products, Inc. or approved equal.

B. Type: Ornamental fencing system consisting of horizontal**,** fixed louver, modular fence panels fabricated with extruded aluminum framing bars and supported by extruded aluminum fence posts; 80 Shadow Eclipse Aluminum Fixed Louver Fencing as manufactured by Ametco Manufacturing Corporation.

C. Fence panel:
   1. Fixed louver bars: Extruded aluminum louver bars, 1-31/32-inches (50-millimeters) wide, spaced at 2-1/16-inches (52-millimeters). Extend louver flange to allow 80-percent direct visual screening.
   2. Cross bars: 1/2 by 1/8-inch (13 by three-millimeters) flat bars welded perpendicular to back side of louver bars and spaced at 18-inches (457-millimeters).
   1. Panel height: 72 inches (1828.8 millimeters).
   1. Panel width: As indicated on Drawings.

D. Posts:
   1. Type: three by three-inch (76 by 76-millimeters) extruded tubular aluminum sections with solid aluminum caps.

2. Length: As indicated on Drawings.

2.04 GATES

A. Provide gates of type and size indicated on Drawings. Equip gates with manufacturer's standard hardware for complete functional operation.

B. Type: Hinged swinging double gate.

1. Construction: Welded frame fabricated from 5 inches by 5 inches (127 millimeters by 127 millimeters) extruded aluminum tubing with aluminum fixed louver panels to match fencing material.
2. Nominal size: five feet wide by six feet high.
3. Hardware:
   a. Hinges: Size and type as determined by manufacturer. Provide two hinges for each leaf up to six-foot (1829 millimeters) high and one additional hinge for each additional 24-inches (610 millimeters) in height or fraction thereof.
   b. Latch: 3/4-inch (19 millimeters) diameter slide bolt to accommodate padlock.
   c. For double gates provide padlock, 5/8-inch (16 millimeters) diameter center cane bolt assembly and strike.

2.05 ACCESSORIES

A. Fasteners: Stainless steel bolts of type, size, and spacing as recommended by fence manufacturer for specific condition.

B. For exposed locations, provide anti-intruder bolts consisting of cup-head bolt and nut with clamping hexagon such that tightening shears hexagon and render bolt impossible to release.

2.06 FACTORY FINISH

A. Aluminum fence panels and posts shall receive polyester powder coating.

B. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.

1. Minimum hardness measured in accordance with ASTM D3363: 2H.
2. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.
3. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in five percent salt spray at 95 degrees Fahrenheit and 95 percent relative humidity and after 1000 hours less than 3/16 inch (five millimeters) undercutting.
4. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after one year exposure in South Florida with test panels tilted at 45 degrees.

C. Color: Black Velvet as manufactured by Ametco Manufacturing Company. Selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to fabrication, field verify required dimensions.

B. Cast concrete footings in accordance with 03 30 00.13 “CAST-IN-PLACE CONCRETE (SITE)” as released in Early Release Package 2 (ERP2) as detailed on Drawings and accepted shop drawings.

1. Minimum footing diameter:
   a. Terminal and gate posts: 12 inches (305 millimeters).
   b. Intermediate line posts: 10 inches (254 millimeters).
2. Allow eight inches (203 millimeters) minimum embedment of posts.
3. Allow six inches (152 millimeters) minimum concrete beneath post bottom.

C. Provide setting holes for embedment of the fence posts. The hole shall be two inches (51 millimeteres) minimum greater than post width.

3.02 INSTALLATION

A. Install fencing in accordance with manufacturer's installation instructions and accepted shop drawings.

B. Install fence posts plumb and level by embedding post directly in concrete footing. Temporarily brace fence posts with two by four wood supports until concrete is set.

C. Do not install bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

D. Secure fence panels with standard stainless-steel bolts to fence posts after posts have been set in footings.

E. Gates:

1. Install gates and adjust hardware for smooth operation.
2. Provide concrete center foundation depth and drop rod retainers at center of double swinging gate openings.
3. After installation, test gate. Open and close a minimum of five times. Correct deficiencies and adjust.

F. Touch-up damaged finish with paint supplied by manufacturer and matching original coating.

END OF SECTION

SECTION 32 31 29
WOOD PRIVACY FENCES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Wood Screen Fence.

B. Related Sections: The following items of related Work are specified and included in other Sections of the Specifications:
   1. Section 03 30 00.13 “CAST-IN-PLACE CONCRETE (SITE)“ for cast-in-place footings and pads as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING” for excavation for installing concrete footings.

1.03 ACTION SUBMITTALS

A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following
   1. Fence posts, rails, and fittings

B. Shop Drawings: Show locations of fence, posts, rails, and details of extended posts, extension arms, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, and other required installation and operational clearances, and details of post anchorage and attachment and bracing.

C. Samples for Initial Selection: Manufacturer’s color charts or six-inch (150-millimeters) lengths of actual units showing the full range of colors available for components with factory-applied color finishes

D. Samples for Verification: For the following products, in sizes indicated, showing the full range of color, texture, and pattern variations expected. Prepare Samples from the same material to be used for the Work
   1. Wood sample in six-inch lengths.
   2. Paint and stain coatings in six-inch lengths on shapes for posts, and rails.

E. Product Certificates: Signed by manufacturers of wood fences certifying that products furnished comply with requirements.

F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owners, and other information specified.

G. Maintenance Data: For the following to include in maintenance manuals specified in Division 1:
   1. Polymer finishes.
   2. Paints and stains.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed wood screen fences similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

C. Source Limitations for Wood Fences: Obtain each color, grade, finish, type, and variety of component for wood fences from one source with resources to provide wood fences of consistent quality in appearance and physical properties.

1.05 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others.

B. Field Measurements: Verify layout information for wood fences shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of wood fences that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Deterioration of wood, metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

1.07 DELIVERY, STORAGE AND HANDLING

A. Fence panels, posts and accessories shall be delivered to the construction site in packaged cartons.

B. Each package shall be identified and shall bear the name of the manufacturer.

C. All fence materials shall be adequately protected from damage during transit and shall not be dropped.

D. All fence and other appurtenances shall be inspected before placement in the work and any found to be rusted, damaged or defective from any cause, including damage caused by handling, and determined by the Engineer to be unrepairable, shall be replaced at no cost to the Owner.

E. Storage and handling of fence and other system appurtenances shall be in accordance with the manufacturer's recommendations and in a manner to prevent wracking or stress of components, and to prevent mechanical damage or damage by the elements. All stored materials and items shall be protected from weather, careless handling and vandalism.

1.08 REFERENCE STANDARDS

A. References herein are made in accordance with the following abbreviations and all work shall conform to the latest editions, as applicable.

1. Screen Fence:

American Society for Testing and Materials (ASTM)	
ASTM A36	Structural Steel
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM F537	Standard Specification for Design, Fabrication, and Installation of Fences Constructed of Wood and Related Materials

PART 2 PRODUCTS

2.01 WOOD SCREEN FENCE ENCLOSURE

A. All wood for fence shall be 100 percent top grade Northern White Cedar, dimensioned as noted on the accepted Shop Drawings.

B. All wood materials to be stained with two coats of transparent oil-based stain prior to installation. Touch-up stain shall be applied in the field. Stain shall be suitable for exterior application.

1. Manufacturers, or approved equal:
   a. Penofin Ultra-Premium Transparent Clear Oil-Based Penetrating Wood Stain.
   b. Benjamin Moore Woodluxe C591 Translucent Oil-Based Stain.

c. ProLuxe Cetol SRD RE Transparent Matte Cedar Oil-Based All-in-One Stain and Finish

C. Nails, latch and other hardware shall be hot-dipped galvanized (ASTM A153) steel or stainless steel to the dimensions and type noted on the accepted Shop Drawings.

2.02 CAST-IN-PLACE CONCRETE

A. General: Comply with ACI 301 for Section – 03 30 00.13 “CAST-IN-PLACE CONCRETE (SITE)” as released in Early Release Package 2 (ERP2) of these specifications.

2.03 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

PART 3 PRODUCTS

3.01 EXAMINATION

A. General Contractor shall inspect the job site conditions prior to commencing Work of this Section. Examine conditions for compliance with requirements for installation tolerances and other specific conditions, and other conditions affecting performance of unit masonry.

B. Examine existing conditions for coordination with other trades and other sections of this Specification.

C. Do not proceed until any unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Stake locations of fence lines, and terminal posts. Do not exceed intervals of 500 feet (152.5 meters) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, property monuments, and other features which may affect the Work.

B. Discard timbers that are warped, twisted, bowed, crooked or otherwise defective.

3.03 INSTALLATION

A. General:

1. Install fencing to comply with ASTM537 or ASTM F567, as applicable, and more stringent requirements specified.
2. Installation shall be performed in accordance with manufacturer’s recommendations, Contract Documents, accepted Shop Drawings.
3. Fencing shall be erected as indicated on the Drawings, plum, level, snug, and free from rocking. Make final adjustments.
4. Fencing installed prior to paving operations shall be covered with plastic and all care shall be provided to ensure paving materials do not collect on or stain the steel. Plastic shall be removed after paving operation is completed.

B. Post Excavation:

1. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.

C. Post Setting:

1. Hand-excavate holes for post foundations in firm, undisturbed or compacted soil. Set posts in concrete footing. Protect portion of posts aboveground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set

plumb, aligned, and at correct height and spacing, and hold in position during placement and finishing operations until concrete is sufficiently cured.

a. Dimensions and Profile: As indicated on Drawings.
b. Exposed Concrete Footings: Extend concrete two inches (50 millimeters) above grade, smooth, and shape to shed water.
c. Concealed Concrete Footings: Stop footings below grade as indicated on Drawings to allow covering with surface material.
d. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
e. Posts Set into Concrete in Voids: Form or core drill holes not less than five inches (125 millimeters) deep and 3/4 inch (20 millimeters) larger than outside diameter of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

3.04 SCREEN FENCE, ENCLOSURES

A. Install fence as shown on the Contract Documents and accepted Shop Drawings. Caps and top rails shall be installed in place.
B. All posts shall be set plumb.
    1. Rails of the wood fence shall be held level. Nails shall be aligned.

END OF SECTION

SECTION 32 33 00
SITE FURNISHINGS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section consists of providing all labor, equipment, materials, incidental work and construction methods necessary to furnish and install designated Site Improvements and related items as indicated on the Drawings, as specified in this Section, and includes, but is not limited to, the following:
   1. Benches; backed with armrests; surface mount.
   2. Benches; backless with armrests; surface mount.
   3. Buddy Bench; backed; surface mount.
   4. Free-Form Bench; free-standing.
   5. Sculptural Bench; surface mount.
   6. Curved Bench; backed with armrests; surface mount.
   7. Curved Bench; backless; surface mount.
   8. Movable Cube Seats Backed with Armrest and Locking Wheels; free-standing.
   9. Circular Bench; surface mount.
   10. Table with integral seats.
   11. Table with integral seats; ADA-compliant model.
   12. Litter and recycling receptacle.
   13. Bicycle rack.
   14. Shed; prefabricated; 10’-0” x 20’-0” set on cast-in-place concrete pad.
   15. Raised garden bed; ADA-compliant model.
   16. Shade structure; leaf shape.
   17. Shade structure; triangle shape.
   18. Tree grate.
   19. Collapsible Security Bollard.
   20. Vehicular barrier swing gate; 26 feet wide, 28 feet wide and 40 feet wide.
   21. No Snow Storage Signage and Post: 12 inches by 18 inches (304.8 millimeters by 457.2 millimeters).

B. Related Sections:
   1. Section 03 30 00.13 "SITE CAST-IN-PLACE CONCRETE (SITE)" as released in Early Release Package 2 (ERP2) for concrete slabs, footings, and installing pipe sleeves cast in concrete footings.
   2. Section 31 00 00 "EARTH MOVING” for excavation for installing concrete footings.
   3. General Contractor shall verify model numbers, drawings and manufacturer’s specifications are accurate before proceeding with the installation of site furnishings. Any discrepancies shall be reported to the Owner’s Representative for review and final acceptance.
   4. General Contractor shall verify the location of all site furnishings with the Landscape Architect prior to installation or attachment to surfaces.

1.03 REFERENCES

A. The following Standards shall apply to the work of this Section:
   1. Commonwealth of Massachusetts Department of Transportation (MassDOT) Highway Division Specifications: Standard Specifications for Highways and Bridges.

2. ASTM: American Society for Testing and Materials:
   Steel Plate: ASTM A 36.
   Alloy-Steel and Stainless-Steel Bolting Materials for High Temperature Service: A 193/A 193M-99a.
   Stainless Steel Bars and Shapes: A 276-98b.
   Seamless and Welded Austenitic Stainless-Steel Pipes: A 312.
   Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes: ASTM A 500.
   Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing: ASTM A 513.
   Standard Practice for Operating Salt Spray (Fog) Apparatus: ASTM B 117.
   Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings: ASTM D 522.
   Standard Test Method for Specular Gloss: ASTM D 523.
   Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity: ASTM D 2247.
   Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact): ASTM D 2794.
   Standard Test Methods for Measuring Adhesion by Tape Test: ASTM D 3359.
   Standard Test Method for Film Hardness by Pencil Test: ASTM D 3363.
   Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials: ASTM G 155.
3. AISI: American Iron and Steel Institute:
   Stainless Steel Alloy Designation: AISI 304.
   Stainless Steel Alloy Designation: AISI 316.
4. AWS: American Welding Society:
   Structural Welding Code – Stainless Steel: D1.6-99.
5. ISO Testing Standards:
   Paints and Varnishes – Cupping Test: ISO 1520.
   Paints and Varnishes – Buchholz Indentation Test: ISO 2815.

1.04 ACTION SUBMITTALS

A. Shop Drawings: Prior to ordering the below listed materials, submit Shop Drawings to the Owner's Representative for acceptance as follows:
   1. Provide shop drawings for the concrete footings of each site item specified herein.
   2. Provide shop drawings for each Bench installation and plan locations.
   3. Provide shop drawings for each Table with Integral Seats installation and plan locations.
   4. Provide shop drawings for each Litter Receptacle installation and plan locations.
   5. Provide shop drawings for Bicycle Rack installation and plan locations.
   6. Provide shop drawings for each Prefabricated Shed, for full details, installation and plan location; reviewed and stamped by Massachusetts Licensed Structural Engineer.
   7. Provide shop drawings for Raised Garden Bed for installation and plan locations.
   8. Provide shop drawings for each Leaf Shape Shade Structure, for full details, installation and plan location; reviewed and stamped by Massachusetts Licensed Structural Engineer.
   9. Provide shop drawings for each Triangle Shape Shade Structure, for full details, installation and plan location; reviewed and stamped by Massachusetts Licensed Structural Engineer.
   10. Provide shop drawings for Tree Grate typical installation and plan locations.
   11. Provide shop drawings for Collapsible Security Bollard installation and plan locations.
   12. Provide shop drawings for Vehicular Barrier Swing Gate installation and plan locations.
   13. Provide shop drawings for No Snow Storage Signage and Post installation and plan locations.

B. Manufacturer's Literature: Submit copies of each of the manufacturer's material descriptions and installation instructions for the following. Do not order materials until Owner Representative's acceptance has been obtained. Delivered materials shall closely match the accepted samples:
   1. Benches; backed with armrest; surface mount.
   2. Benches; backless with armrest; surface mount.
   3. Buddy Bench; backed; surface mount.
   4. Free-Form Benches; free standing.
   5. Sculptural Bench; surface mount.
   6. Curved Bench; backed with armrests; surface mount.
   7. Curved Bench; backless; surface mount.
   8. Moveable Cube Seats Backed with Armrest and Locking Wheels; free-standing.
   9. Circular Bench; surface mount.
   10. Table with Integral Seats.
   11. Table with Integral Seats; ADA-compliant model.
   12. Litter and recycling receptacle.
   13. Bicycle rack.
   14. Shed; prefabricated; 10'-0" x 20'-0" set on cast-in-place concrete pad.
   15. Raised garden bed; ADA-compliant model.
   16. Shade structure; leaf shape.
   17. Shade structure; triangle shape.
   18. Tree grate.
   19. Collapsible security bollard; 30-inches high; external pad lock.
   20. Vehicular barrier swing gate; 26 feet wide, 28 feet wide and 40 feet wide vehicular barrier swing gate.
   21. No Snow Storage Signage and Post: 12 inches by 18 inches.
   22. Non-shrink grout.
   23. Sealant.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For units with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish, not less than six-inch-long linear components and four-inch square sheet components.
   1. Include full-size Samples of bench, litter receptacle and bicycle rack.

F. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

G. LEED
   1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
      a. Include statement indicating costs for each product having recycled content.
   2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
      a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
   3. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.05 INFORMATIONAL SUBMITTALS

A. Material Certificates: For site furnishings.

1. Wood Preservative Treatment: Include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards and with manufacturer's recommendations.

1.06 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful site furnishing installations.
   1. Experience: Three years' experience in site furnishing installation of similar quality, schedule requirement and construction detailing.
   2. Installer's Field Supervision: Require Installer to maintain an experienced full-time foreman or crew leader on Project site when work is in progress.

1.08 GUARANTEE

A. All site improvements' parts shall be guaranteed against workmanship and material defects for one-year from time of delivery, or as noted herein.

1.09 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Bench Replacement Slats: No fewer than two full-size units for each size indicated.
   2. Table Replacement Slats: No fewer than two full-size units for each size indicated.
   3. Litter Receptacle Inner Containers: five full-size units for each size indicated, but no fewer than two units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers will have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturer's products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 "SUBSTITUTION PROCEDURES".

2.02 SITE FURNITURE

A. Manufacturers:
   1. Forms+Surfaces, 30 Pine Street, Pittsburgh, PA 15223; Telephone: 800.451-0410; Fax: 412.781.7840; E-mail: sales@forms-surfaces.com.
   2. Vestre Inc., 1740 Broadway, 15th Floor, New York, NY 10019; Dan Delongchamp Massachusetts Sales Representative; Telephone: 617.780.4134; E-mail: dan@vestre.com; Website: www.vestre.com
   3. Landscape Forms, 7800 E. Michigan Avenue, Kalamazoo, MI 49048; Telephone: 800.430.6209; Fax: 269.381.0396; E-mail: comments@landscapeforms.com; Website: www.landscapeforms.com; Nadene Worth Massachusetts Sales Representative; Cell: 978.460.5306; E-mail: nadenew@landscapeforms.com.

4. Nature's Instruments; Telephone: 877.733.7456; E-mail: sales@naturesinstruments.com; Website: www.naturesinstruments.com.
5. Elkay, Regional Distributor Halsey Taylor, 2222 Camden Court, Oak Brook, IL 60523, Telephone: 630.572.3192; Website: www.elkay.com; E-mail: www.halseytaylor.com.
6. GameTime, 150 PlayCore Drive SE, Fort Payne, AL 35967; Telephone 800.235.2440; Email: info@gametime.com; Website: https://www.gametime.com; MRC Local Representative; Erik Walsh, Cell: 978.569.3797; Email: ewalsh@mrcrec.com
7. UltraPlay, 1675 Locust Street, Red Bud, IL 62278; Telephone: 888.403.7684Email: customerservice@ultraplay.com; Website: www.ultraplay.com;
8. The 4 Kids, 4400 Oneal Street, Suite 200, Greenville, TX 75401-7018; Telephone: 903.454.9237; Email: info@the4kids.com; Website: www.the4kids.com
9. Belson Outdoors, 627 Amersale Drive, Naperville, IL 60563; Telephone (630) 897-8489; E-mail: sales@belson.com; Website: www.belson.com.
10. School Outfitters, 3736 Regent Avenue, Cincinnati, OH 45212-3724; Telephone (1-800)260-2776; Website: www.schooloutfitters.com.
11. Willy Goat, PO Box 59278, Birmingham, AL 35259; Telephone: (888) 920-4628; E-mail: fun@willygoat.com; Website: www.willygoat.com.

B. Products: Basis-of-Design: Subject to compliance with requirements, provide the following, or approved equal. See graphic example at end of Specification for use in determining an approved equal.
   1. Backed Bench with Armrests: Model Number SBKNI-072B (Knight Bench) manufactured by Forms+Surfaces.
      a. Design: Backed with Armrests.
      b. Dimension: Six-feet overall length, 21.9-inches overall depth, 15.2-inch seat depth, 31.1-inch overall height, 17.9-inch seat height, 20.8-inch armrest height.
      c. Armrests: Two end armrests, six and half inches tall.
      d. Frame: Solid Aluminum.
      e. Frame Finish: Outer frame edges are polished.
      f. Frame Finish: Inner surfaces have a powder coated finish.
      g. Finish: All surfaces are clear coated.
      h. Slat Materials: FSC 100-percent Cumaru hardwood slats to resist moisture, insects, fire, vandalism and decay.
      i. Color: Aluminum Texture.
      j. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
      k. Number and field location of benches as shown on plans.
   2. Backless Bench with Armrests: Model Number SBKNI-072N-2A-CUSTOM (Knight Bench) manufactured by Forms+Surfaces.
      a. Design: Backless.
      b. Dimension: Six-feet overall length, 20-inches overall depth.
      c. Armrests: Two end armrests, six and half inches tall.
      d. Frame: Solid Aluminum; Powdercoat, Color: Aluminum Texture with polished edges and clear top coat.
      e. Frame Finish: Outer frame edges are polished.
      f. Frame Finish: Inner surfaces have a powder coated finish.
      g. Finish: All surfaces are clear coated.
      h. Slat Materials: FSC 100-percent Cumaru hardwood slats to resist moisture, insects, fire, vandalism and decay with natural oiled finish.
      i. Color: Aluminum Texture.
      j. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.

k. Number and field location of benches as shown on plans.

3. Buddy Bench: Model #940P-P6-BBCL-F-Friends manufactured by Belson Outdoors.
   a. Design: Backed.
   b. Dimension: 72 inches long by 22-5/16 inches wide.
   c. Material: Stainless steel.
   d. Color: Blue Seat and Frame.
   e. Icon: Friends
   f. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
   g. Number and field location of benches as shown on plans.
4. Free-Form Bench: Twig Bench manufactured by Landscape Forms.
   a. Design: Backless.
   b. Dimension: 93-inches overall length, 76-inches seat depth.
   c. Material: Reinforced concrete.
   d. Mount: Freestanding.
   e. Number and field location of benches as shown on plans.
5. Sculptural Bench: Model Numbers 607, 622D4, 630D4 and 650 (VROOM bench modules) manufactured by Vestre.
   a. Design: Backless and backed.
   b. Dimension: 14’-6” long; 1’-9” wide, 2’-7” high.
   c. Material: Hot-Dip Galvanized Steel with Powder Coat; Kebony Clear Wood Slats.
   d. Colors: Light Blue (RAL 5012).
   e. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
   f. Number and field locations of benches as shown on plans.
6. Curved Bench; Backed with Armrests; Model Numbers 1308+1325+1327+930 (VIA Curved Bench) manufactured by Vestre.
   a. Design: Backed.
   b. Dimension: 82.7-inches overall length, 20.1-inches overall depth, 17.7-inches overall height. Inner and outer radii vary, as indicated per plan.
   c. Armrests: Two end armrests.
   d. Material: Hot-Dip Galvanized Steel with Powder Coat; Kebony Clear Wood Slats.
   e. Colors: Pale Green (RAL 6021).
   f. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
   g. Number and field location of curved benches as shown on plans.
7. Curved Bench; Backless: Model Numbers 1308+930 (VIA Curved Bench) manufactured by Vestre.
   a. Design: Backless
   b. Dimension: 82.7-inches overall length, 20.1-inches overall depth, 17.7-inches overall height. Inner and outer radii vary, as indicated per plan.
   c. Material: Hot-Dip Galvanized Steel with Powder Coat; Kebony Clear Wood Slats.
   d. Colors: Pale Green (RAL 6021).
   e. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
   f. Number and field location of curved benches as shown on plans.
8. Movable Cube Seats Backed with Armrest and Locking Wheels: Model Number 5206SxA (STONE + UNITY Movable Bench) by Vestre.
   a. Design: Backed.
   b. Dimension: 52 inches wide, 47.25 inches long, and 17.75 inches seat heigh.
   c. Armrests: 6.25 inches heigh; centrally located on one side of cube seat.
   d. Wheels: four wheels with two locking via keyhole for wheel break.

e. Material: Hot-Dip Galvanized Steel with Powder Coat; Kebony Clear Wood Slats.
f. Color: Pastel Orange (RAL 2003).
g. Mount: Free-Standing.
h. Number and field locations of benches as shown on plans.

9. Circular Bench: Model Number 3611-930M (STRIPES bench) by Vestre.
   a. Design: Circle Bench.
   b. Dimension: 70.1 inch diameter.
   c. Material: Hot-Dip Galvanized Steel with Powder Coat; Kebony Clear Wood Slats.
   d. Colors: Light Blue (RAL 5012).
   e. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
   f. Number and field locations of benches as shown on plans.
10. Table with Integral Seats: Model# STKNI-72NA (Knight Table Ensemble) manufactured by Forms+Surfaces.
    a. Design: Backless.
    b. Dimension: Six-foot-length.
    c. Slat Materials: Aluminum.
    d. Color: Azure Texture.
    e. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
    f. Number and field location of benches as shown on plans.
11. ADA-Compliant Table with Integral Seats: Model# STKNI-72NA-ADA (Knight Table Ensemble with ADA option) manufactured by Forms+Surfaces.
    a. Design: Backless.
    b. Dimension: Six-foot and Three-foot-length ADA benches.
    c. Slats: Aluminum.
    d. Color: Azure Texture.
    e. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
    f. Number and field location of table and bench ensembles as shown on plans.
12. Litter and Recycling Receptacle: Model# SLUNN-36SSR (Universal Litter & Recycling Receptacle) manufactured by Forms+Surfaces.
    a. Size: 36-Gallon.
    b. Lid type: Side openings with one standard opening, one round opening.
    c. Lid tether: Yes.
    d. Lid material: stainless steel; Finish satin.
    e. Body type: Split-Stream; Stainless Steel; final body selection by Owner as confirmed in Shop Drawings.
    f. Color: Aluminum Texture.
    g. Finish: Diamond Finish; final finish selection by Owner as confirmed in Shop Drawings.
    h. Base material: Polyethylene Slate.
    i. Mount: Surface mount with levelers.
    j. Liners (side opening receptacles only): Two half liners (including the internal baffle) bag straps and drain holes.
    k. Graphic message and background color: “Litter” and “Recycling” graphics; Black.
    l. Number and field location of litter and recycling receptacles as shown on plans.
13. Bicycle Rack: Model# SKTRO (Trio Bike Rack) manufactured by Forms+Surfaces.
    a. Finish: Standard powder coat.
    b. Color: Aluminum Texture.
    c. Mount: Surface Mount; Stainless-steel anchors and mounting bolts.
    d. Number and field location of bicycle racks as shown on plans.

2.03 PREFABRICATED SHED

A. The General Contractor shall submit Prefabricated Shed Shop Drawings based on Contract Document details. General Contractor's shop drawings shall be reviewed and stamped by Massachusetts Licensed Professional Structural Engineer (PE) verifying compliance with Massachusetts Building Code prior to submission and review by Owner's Representative.

B. Manufacturers:
   1. Package Steel Systems, Inc., 15 Harback Road, Sutton, MA 01590; Telephone: 508.466.4598; Website: packagesteelsystem.com.
   2. Shelters of New England, 251 West Hollis Street, Nashua, NH 03060; Telephone: 603.886.2701; Website: sheltersofnewengland.com.
   3. Viking Steel Structures, 113 W Main Street, Boonville, NC 27011; Telephone: 877.959.9683; Website: https://www.vikingsteelstructures.com.

C. Products: Basis-of-Design: Subject to compliance with requirements, provide the following by Package Steel Systems, Inc., or approved equal.
   1. Design Load items:
      a. IBC Code 2012 Ground Snow Load 42.5 PSF
      b. Snow Load Factor of .7
      c. Wind Load 105 MPH.
   2. Design load certification including seismic zone, wind loads, and snow loads shall be confirmed in writing with local code authorization by Buyer prior to manufacture of the building by Seller. If the above loads change it could affect the price of the building.
   3. Size:
      a. Building Size: 10 feet wide by 20 feet long by 12 feet high
      b. Eave Height: Left Eave nine feet high; Right Eave 9'-6" high
      c. Roof Pitch 0.5:12; 1/2 inch by 12-inch slope.
      d. Exterior roll-up doors are seven-foot-high by eight-foot and eight-inches wide on one-foot-wide units.
      e. Roof is insulated with ply-foil insulation to help prevent condensation.
   4. Materials:
      a. 24-gauge galvalume plus standing seam roof with 20-year manufacturer's warranty (galvalume color).
      b. 26-gauge rake and eave trim, with 35-year manufacturer's warranty.
      c. 26-gauge "R" panel siding with siliconized polyester finish for walls and blank wall areas (there are 15).
      d. 29-gauge galvalume plus interior partitions designed to provide resistance to smudging, staining and corrosion. Interior structural steel is galvanized.
      e. 26-gauge exterior roll-up doors with corrugated door headers.
      f. Tension control and ball-bearings included for all roll up doors.
      g. Floor: Open floor system that sits on top of cast-in-place concrete pad.
      h. Floor system: consists of two-inch by four-inch and two-inch by six-inch pressure treated joists covered with three-quarter-inch exterior grade plywood with the exterior edges wrapped in a 16-gauge galvanized steel sill.
      i. Standard industry latches.
   5. Exterior Finish:
      a. Shed Building Exterior Wall:
         1) Color: "Saddle Tan" from Signature® 200 Standard colors available.
         2) Final color selection by Owner as confirmed in Shop Drawings.
         3) General Contractor to submit three-inch by three-inch color sample for final acceptance.

b. Trim between Exterior Doors, Walls and Roof:
   1) 16-gauge galvanized structural steel covered with pre-painted 26-gauge jamb covers.
   2) Color: “Harbor Blue”.
   3) Final color selection by Owner as confirmed in Shop Drawings.
c. Roll-up Doors:
   1) Color: “White” from Standard Siliconized Polyester Colors.
   2) Final color selection by Owner as confirmed in Shop Drawings.
   3) The General Contractor shall submit three-inch by three-inch color sample for final acceptance.

6. Prefabricated Shed to sit on top of cast-in-place concrete pad, engineered to support the weight of the structure.

2.04 GARDEN FURNITURE

A. Manufacturers:
1. ShelterWorks Ltd., 427 North 15th Street, PO Box 1311, Philomath, OR 97370; Telephone: 541.368.7935; Website: www.durablegreenbed.com.
2. Eartheasy, 22 E. 5th Avenue #433, Vancouver, BC V5T 1G8 Canada; Telephone: 888.451.6752; E-mail: service@eartheasy.com; Website: www.eartheasy.com.
3. Polymade Planters, 450 South 55th Street, Kansas City, KS, 66106; Telephone: 913.349.7276, E-mail: sales@polymade.com.
4. ADA-Compliant Raised Garden Square Bed; Durable. manufactured by ShelterWorks.
   a. Dimension: four-feet by four-feet by 24-inch height.
   b. Material: Faswall; Nontoxic woodchip/concrete composite; four Aluminum corner brackets.
   c. Finish: Stock; 3.5-inch-wide PVC top trim, Cast Aluminum Trim Cap.
   d. Color: Smokey Gray Wall Panels, and Dark Hickory TimberTech Trim Boards.
   e. Mount: Open Bottom on Grade; install filter fabric between planting soil and finished grade; 10-inch minimum extension up planter wall.
   f. Number and field location of planters as shown on plans.
   g. Approved Equal items can be constructed in Western Red Cedar or Eastern White Cedar at the same Durable Bed dimensions.

2.05 SHADE STRUCTURE; LEAF SHAPE

A. Manufacturers:
1. Poligon: 4240 136th Avenue, Holland, MI 49424; Telephone: (616) 888-3500; Website: www.poligon.com.
2. Landscape Structures, 601 7th Street South, Delano, MN 55328; Telephone: 888.438.6574; Email: info@playlsi.com; Website: www.playlsi.com.
3. Revamp Panels LLC, 1610 W Riverside Avenue, Spokane, WA 99201; Telephone: 509.919.0460 ext. 812; Website: www.revamppanels.com.

B. Product Basis-of-Design: Shade Structure, Leaf Shape; Model Number: LEF-12x33 “Polygon Leaf”; As manufactured by Poligon, or Approved Equal.
1. Style: Leaf Shape.
2. Size: 12 feet by 23 feet.
3. Material: Steel, powder-coated.
4. Frame Color: Surrey Beige.
5. Roof Color: Evergreen.
6. Roof Type: Multi-Rib.

2.06 SHADE STRUCTURE; TRIANGLE SHAPE

A. Manufacturers:

1. Poligon: 4240 136th Avenue, Holland, MI 49424; Telephone: (616) 888-3500; Website: www.poligon.com.
2. Landscape Structures, 601 7th Street South, Delano, MN 55328; Telephone: 888.438.6574; Email: info@playlsi.com; Website: www.playlsi.com.
3. Revamp Panels LLC, 1610 W Riverside Avenue, Spokane, WA 99201; Telephone: 509.919.0460 ext. 812; Website: www.revamppanels.com.

B. Product Basis-of-Design: Shade Structure, Leaf Shape; Model Number: MSL15x30 (Monoslope) with over Multi-Rib; As manufactured by Poligon, or Approved Equal.
1. Style: Triangle Shape.
2. Size: 15 feet by 30 feet.
3. Roof Slope: 1:12.
4. Minimum Clearance Height: Eight-feet minimum clearance height under the structure indicates the lowest height of a member from finish grade for clearance under the structure. This is generally the clearance under roof eave or frame, whichever is lower.
5. Material: Steel, powder-coated.
6. Frame Color: Sea Glass
7. Roof Color: Patina Green.

2.07 TREE GRATE AND FRAME

A. Manufacturers:
1. Ironsmith, 41701 Corporate Way #3, Palm Desert, CA 92260; Telephone: 800.338.4766; E-mail: Sales@ironsmith.biz; Website: www.ironsmith.cc.
2. Neenah Foundry, 2121 Brooks Ave, Neenah, WI 54956; Telephone: 920.725.7000; E-mail: InfrastructureSolutions@groupnei.com or IndustrialSolutions@groupnei.com; Website: www.groupnei.com.
3. Iron Age Designs, 2104 SW 152nd St. Suite #4, Burien, WA 98166, Telephone: 877.418.3568; E-mail: info@ironagegrates.com; Website: www.ironagegrates.com; Dave Catalano; Ideal Grounds, Massachusetts Sales Representative; Telephone: 516.871.7506; E-mail: dm_catalano@yahoo.com.

B. Products: Basis-of-Design: Subject to compliance with requirements, provide the following, or approved equal.
1. Tree Grate: STARBURST-2 60x120-inch RECTANGULAR Model# 12060-2 Tree Grate manufactured by Ironsmith.
   a. Size: 60-inch by 120-inch for pedestrian loads only.
   b. Design: 3/8-inch maximum slot opening for ADA compliance and pedestrian safety.
   c. Material: Cast from 100-percent recycled gray iron.
   d. Finish: Powder-coated.
   e. Color: “Black”; final color selection by Owner as confirmed in Shop Drawings.
   f. Number and field location of tree grates as shown on plans.
2. Tree Grate Frame: Model# 60X120FCS manufactured by Ironsmith.
   a. Size: 60-inch by 120-inch for 60X120TGST2RAFE Starburst 2 Tree Grate.
   b. Material: Cast from 100-percent recycled gray iron.
   c. Finish: Powder-coated.
   d. Color: “Black”; final color selection by Owner as confirmed in Shop Drawings.
   e. Number and field location of tree grates as shown on plans.

2.08 COLLAPSIBLE SECURITY BOLLARD

A. Manufacturers:
1. Traffic Guard, P.O. Box 201, Geneva, IL 60134-9956; Telephone: 877.727.7347, Fax: 800.814.7194; E-mail: sales@trafficguard.net; Website: www.trafficguard.net.

2. OCC Outdoors, 6597 W. 300 North, Boggstown, IN 46110; Telephone: 317.223.8881; E-mail: occcontact@occoutdoors.com; Website: www.occoutdoors.com.
3. Ultra Site, 1675 Locust Street, Red Bud, IL 62278; Telephone: 800.458.5872; E-mail: info@ultra-site.com; Website: www.ultra-site.com.

B. Products: Basis-of Design: Subject to compliance with requirements, provide the following, or approved equal:
   1. Collapsible Security Bollard: Model# LPHDHB Single Post manufactured by Traffic Guard.
      a. Bollard Dimensions: Six-inch by three-inch by 3/8-inch tube; 30-inch-high column.
      b. Base Plate Dimensions: 12-inch by 12-inch.
      c. Hinge Pin Dimensions: 3/4-inch by eight-inch.
      d. Mechanism: Padlock and Removable Lock Pin.
      e. Lock Visibility: External Padlock.
      f. Weight: 49 pounds.
      g. Prime Finish: Zinc rich primer; rust and corrosion resistant; 5,000 hours salt spray performance.
      h. Material:
         1) Body and Base: Carbon Steel; powder-coat.
         2) Hinge Pins and Lock: Stainless Steel
         3) Reflective Labels.
      i. Color: Standard, TGIC Polyester outdoor finish; RAL 1028 Yellow.
      j. Mount: Surface Mount; four-inch clearance when collapsed.
      k. Anchor System: CPAS12 Collapsible Post Anchor System:
         1) Cast-in-Place Dimension: 18-inch diameter by 42-inch-deep concrete footer minimum.
      l. Number and field location of collapsible security bollards as shown on plans.

2.09 VEHICULAR BARRIER SWING GATE

A. Manufacturers:
   1. Hoover Fence Co., 4521 Warren Ravenna Rd., Newton Falls, Ohio 44444; Telephone: 330.358.2335, Web: www.hooverfence.com.
   2. Barrier Gate Brands, provided by the Tiger Teeth Store,10050 Wellman Road, Streetsboro, OH 44241, Representative Brian Livaich; Telephone: 800.878-7829; E-mail: brian@dfsupplyinc.co; Website: www.tigerteethstore.com.
   3. Secure Lane, LLC, 3220 S. Dodge Blvd. #8, Tucson, AZ 85713; Christine Richards, Owner-Operator; Telephone: 520.780.9751; E-mail: christine@secure-lane.com; Website: www.secure-lane.com.

B. Products: Basis-of-Design: Subject to compliance with requirements, provide the following, or approved equal.
   1. Vehicular Barrier Swing Gate: Model# HCG-Z-4X26DB-KIT-A (Z-Series Tubular Barrier Double Gate Kit – Aluminum) manufactured by Hoover Fence.
      a. Size: 26-feet width; four feet tall; Two Gate Leaves; See plans for gate width locations.
      b. Material: Rigid construction of premium two-inch outside diameter (1-7/8 inch) actual Schedule 40 Aluminum.
      c. Joints: Notched and/or Hammered.
      d. Gate Posts Caps: Four two-inch Aluminum Caps for Gate Uprights.
      e. Posts: Two four-inch by eight-inch Schedule 40 Aluminum Gate Posts.
      f. Post Caps: Two four-inch Aluminum Caps for Posts.
      g. Hinges: Four four-inch by two-inch Malleable Butt Hinges.
      h. Latch: One Industrial Fulcrum Double Gate Latch.
      i. Mount: In-ground installation; Bell-shaped Hole.

j. Number and field location of aluminum vehicular gates as shown on plans.
k. Aluminum posts shall be embedded in 4,500 pounds-per-square-inch concrete cement.
l. General Contractor to provide cutsheet and installation drawings per manufacturer for acceptance.

2. Vehicular Barrier Swing Gate: Model# HCG-Z-4X28DB-KIT-A (Z-Series Tubular Barrier Double Gate Kit – Aluminum) manufactured by Hoover Fence.
   a. Size: 28-feet width; four feet tall; Two Gate Leaves; See plans for gate width locations.
   b. Material: Rigid construction of premium two-inch outside diameter (1-7/8 inch) actual Schedule 40 Aluminum.
   c. Joints: Notched and/or Hammered.
   d. Gate Posts Caps: Four two-inch Aluminum Caps for Gate Uprights.
   e. Posts: Two four-inch by eight-inch Schedule 40 Aluminum Gate Posts.
   f. Post Caps: Two four-inch Aluminum Caps for Posts.
   g. Hinges: Four four-inch by two-inch Malleable Butt Hinges.
   h. Latch: One Industrial Fulcrum Double Gate Latch.
   i. Mount: In-ground installation; Bell-shaped Hole.
   j. Number and field location of aluminum vehicular gates as shown on plans.
   k. Aluminum posts shall be embedded in 4,500 pounds-per-square-inch concrete cement.
   l. General Contractor to provide cutsheet and installation drawings per manufacturer for acceptance.
3. Vehicular Barrier Swing Gate: Model# HCG-Z-4X40DB-KIT-A (Z-Series Tubular Barrier Double Gate Kit – Aluminum) manufactured by Hoover Fence.
   a. Size: 40-feet width; four feet tall; Two Gate Leaves; See plans for gate width locations.
   b. Material: Rigid construction of premium two-inch outside diameter (1-7/8 inch) actual Schedule 40 Aluminum.
   c. Joints: Notched and/or Hammered.
   d. Gate Posts Caps: Four two-inch Aluminum Caps for Gate Uprights.
   e. Posts: Two four-inch by eight-inch Schedule 40 Aluminum Gate Posts.
   f. Post Caps: Two four-inch Aluminum Caps for Posts.
   g. Hinges: Four four-inch by two-inch Malleable Butt Hinges.
   h. Latch: One Industrial Fulcrum Double Gate Latch.
   i. Mount: In-ground installation; Bell-shaped Hole.
   j. Number and field location of aluminum vehicular gates as shown on plans.
   k. Aluminum posts shall be embedded in 4,500 pounds-per-square-inch concrete cement.
   l. General Contractor to provide cutsheet and installation drawings per manufacturer for acceptance.

2.10 NO SNOW STORAGE SIGNAGE AND POST

A. General

1. Provide signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes and details of construction as indicated. Produce smooth panel sign surfaces constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 inch measured diagonally.
2. All signs shall be professionally printed. The Owner's Representative will provide the vendor with electronic images of all signage artwork, but it shall be the responsibility of the vendor to convert those images to the proper electronic format. The Vendor shall provide

final proofs of all signs to the Owner and Owner's Representative for approval before manufacture.

3. Painting / Finishes: All Permanent signs, poles, and hardware including nuts, bolts, and welds shall be painted either white or black as noted. Signs shall be painted on front, back, and edges. Paint will include two primer coats, and two coats of paint. Background color shall be Pantone Black 6 C. Lettering and images shall be in white. Directional arrows shall be Pantone 151 C Orange. Final colors to be reviewed by the Owner or Owner's Representative for approval before manufacture.
4. Signage artwork and text may be vinyl or silk screened. If vinyl is used the artwork and text shall have a non-yellowing, UV resistant, urethane clear coat applied to protect the vinyl and provide a graffiti resistant coating. Vendor shall provide color samples and paint color and product specifications to the Owner and Owner's Representative upon request.
5. All signs shall have rounded corners.

B. No Snow Storage Signage

1. No Snow Storage Signage shall be 12 inches by 18 inches (304.8 millimeters by 457.2 millimeters) exterior-grade vinyl or screen-printed sign with painted white background on 1/8-inch aluminum, single-sided, sign finish and lettering to be as 2.1 above.
2. The Contractor shall furnish and install all signage and related posts as shown within the drawings and detail.
3. The sign layout shall be provided to the Contractor by the Owner's Representative during construction. See image below for typical school rules signage dimensions and layout:



4. Signs shall include a backing plate, and tamper proof hardware as necessary to attach the signs to steel post set into a concrete footing, in a location as shown on the Drawings. Metal backing plate shall be painted and will be nonrusting, aluminum, or stainless-steel tamper-proof nuts, bolts, washers as necessary.

2.11 MATERIALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated; free of surface blemishes and complying with the following:
   1. Rolled or Cold-Finished Bars, Rods, and Wire: ASTM B 211.
   2. Extruded Bars, Rods, Wire, Profiles, and Tubes: ASTM B 221.
   3. Structural Pipe and Tube: ASTM B 429/B 429M.
   4. Sheet and Plate: ASTM B 209.
   5. Castings: ASTM B 26/B 26M.

B. Steel and Iron: Free of surface blemishes and complying with the following:
   1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
   2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
   3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
   4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
   5. Sheet: Commercial steel sheet complying with ASTM A 1011/A 1011M.
   6. Perforated Metal: From steel sheet not less than 0.075-inch nominal thickness; manufacturer's standard perforation pattern.
   7. Expanded Metal: Carbon-steel sheets deburred after expansion, and complying with ASTM F 1267.
   8. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
   9. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.

C. Stainless Steel: Free of surface blemishes and complying with the following:
   1. Sheet, Strip, Plate, and Flat Bars: ASTM A 666.
   2. Pipe: Schedule 40 steel pipe complying with ASTM A 312/A 312M.
   3. Tubing: ASTM A 554.

D. Wood: Surfaced smooth on four sides with eased edges; kiln dried, free of knots, solid stock of species indicated.
   1. Wood Species:
      a. Douglas Fir: Clear Grade, vertical grain.
      b. Pine: Southern pine, No. 2 or better.
      c. Nordic Pine: Linseed oil proofed.
      d. Cedar: Select Grade or better.
      e. Redwood: free-of-heart center.
      f. Teak (Tectona Grandis): Clear Grade.
      g. Ipe: Recycled.
      h. Cumaru: Class 1.
      i. Kebony; Clear Grade.
   2. Certified Wood: Fabricate site furnishings with components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, “FSC Principles and Criteria for Forest Stewardship.”
   3. Finish: Manufacturer’s standard.

E. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
   1. Polyethylene: Fabricated from virgin plastic HDPE resin.
   2. Recycled Content of Polyethylene.

F. Anchors, Fasteners, Fittings, and Hardware: commercial quality, tamperproof, vandal and theft resistant
   1. Angle Anchors: For inconspicuously bolting legs of site furnishings to grade substrate.
   2. Antitheft Hold-Down Brackets: For securing site furnishings to substrate.

G. Concrete Footing: Concrete footing shall be 4,500-pounds per square inch (31 megapascals), 28-day strength air entrained, 3/4-inch aggregate cast-in-place concrete as specified in Section 03 30 10.13 “CAST-IN-PLACE CONCRETE (SITE)”. Concrete footings shall be placed as shown on the Drawings.

H. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M; recommended in writing by manufacturer, for exterior applications.

I. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

J. Self-leveling Polyurethane Sealant: Provide two or more part, self-leveling, polyurethane based elastomeric sealant, complying with ASTM C 920, Type 1 Class A, having Shore A hardness of not less than 30 when tested according to ASTM C 920, cured modulus of elasticity at 50 percent elongation of not more than 150 pounds per square inch, when tested according to ASTM D 412, and tear resistance of not less than 50 pounds per inch when tested according to ASTM D 624. Where joint surfaces contain bituminous materials, provide modified sealants which are compatible with bituminous materials encountered.

K. Galvanizing: Where indicated for steel and iron components, provide the following protective zinc coating applied to components after fabrication:
   1. Zinc-Coated Tubing: External, zinc with organic overcoat, consisting of a minimum of 0.9 ounces/square foot of zinc after welding, a chromate conversion coating, and a clear, polymer film. Internal, same as external or consisting of 81 percent zinc pigmented coating, not less than 0.3 mil thick.
   2. Hot-Dip Galvanizing: According to ASTM A 123/A 123M, ASTM A 153/A 153M, or ASTM A 924/A 924M.

2.12 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment: Pressure-treat wood according to AWPA U1 and the following:
   1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
   2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

2.13 FABRICATION

A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections,

finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.

C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.

E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.

F. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.14 GENERAL FINISH REQUIREMENTS

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of accepted Samples and are assembled or installed to minimize contrast.

2.15 ALUMINUM FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer’s standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.16 STEEL AND GALVANIZED-STEEL FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer’s standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

B. PVC Finish: Manufacturer’s standard, UV-light stabilized, mold-resistant, slip-resistant, matte-textured, dipped or sprayed-on, PVC-plastisol finish, with flame retardant added; complying with coating manufacturer's written instructions for pretreatment, application, and minimum dry film thickness.

2.17 IRON FINISHES

A. Baked-Enamel, Powder-Coat Finish: Manufacturer’s standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.18 STAINLESS-STEEL FINISHES

A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.

B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

1. Run directional finishes with long dimension of each piece.
2. Directional Satin Finish: No 4.
3. Dull Satin Finish: No. 6.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
C. Install site furnishings level, plumb, true, and positioned at locations indicated on Drawings.
D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
E. Posts Set into Voids in Concrete: Form or core-drill holes for installing posts in concrete to depth recommended in writing by manufacturer of site furnishings and 3/4 inch larger than outside diameter of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.
F. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.03 GENERAL ACCEPTANCE STANDARDS

A. Site Furnishings items specified within this Section 32 33 00, “SITE FURNISHINGS”, will be rejected by the Owner’s Representative for the following reasons and as determined by the Owner’s Representative:
   1. Upon installation, horizontal or vertical curves do not meet the shapes and profiles shown on the Drawings. Curves that have broken backs, sags, saddles, tangents or kinks will be rejected.
   2. Posts are not plumb. Rails do not follow grade as noted on the Drawings.
   3. Indications of field welding or cutting.
   4. Threaded connections are not drawn up tightly. Threads have not been deformed to prevent loosening.
   5. Anchorage into concrete or masonry is not solid but is perceptibly loose. Anchorage does not meet the requirements in the Drawings.
   6. Finishes that do not meet the Specifications or Drawings, due to damage that occurred onsite, manufacturing error or other causes.

3.04 MISCELLANEOUS METALS ACCEPTANCE STANDARDS

A. Miscellaneous metal items, including handrails, and specialty fencing will be rejected by the Owner’s Representative for the following reasons:
   1. Welders were not qualified under or did not perform work in accordance with AWS “Standard Qualification Procedure.”
   2. Fabricated items show metal pieces that were not accurately saw cut and were not fitted together. Gaps, spaces, voids, breaks and crooks in arriss lines, humps, bumps, sags and saddles are present.
   3. Sections are not well formed and do not meet the shapes and profiles shown in the Drawings.
   4. Horizontal or vertical curves do not meet the shapes and profiles shown in the Drawings. Curves that have broken backs, sags, saddles, tangents or kinks shall be rejected.
   5. Connections are not full seam welded or not ground flush and smooth.
   6. Threaded connections are not drawn up tightly. Threads have not been deformed to prevent loosening.
   7. Exposed surfaces do not have a smooth finish and show surface differentiation and variation. Edges show nicks, grind marks or machine marks.

8. Castings do not have sharp corners and edges and are not clean, smooth and true to pattern.
9. Welds are not continuous extending for the entire length of the joints.
10. Welds are not ground smooth.
11. The presence of flux deposits.
12. Welds are not watertight.

END OF SECTION

SECTION 32 84 00
IRRIGATION

PART 1 - GENERAL

1.01 SUMMARY

A. Provide materials, labor, equipment, technical service, and testing to complete construction of automatic athletic field irrigation system, with two-wire path, weather acquisition, on-site precipitation sensing, in-ground soil moisture sensing, and internet-based irrigation controller as defined in Construction Documents.

B. Irrigation system to operate with multiple zones running simultaneously to minimize overall overnight watering time and to maximize hydraulic efficiency (available flow and pressure).
   1. Do not program Automatic Irrigation Controller for single consecutive zones alone.

C. Work items include:
   1. Submitting qualifications and product cut sheets as specified below.
   2. Procurement of applicable licenses, permits, and fees.
   3. Coordination of utilities and verification of existing and proposed site conditions.
   4. Providing irrigation installation, configuration, factory startup, and programming for optimization of athletic field operations.
   5. Connection of electrical power supply and internet data source to irrigation control system and the irrigation control system to earth ground; coordinating with Electrical Contractor.
   6. Coordination of bonding and grounding irrigation controller to earth, coordinating with Electrical Contractor.
   7. Configuration of irrigation controller to communicate with Building Management System, coordinating with Communications Contractor.
   8. Connection of municipal water supply to irrigation system; coordinating with Civil/Site Contractor.
      a. Testing and confirmation of incoming municipal water pressure to irrigation enclosure prior to construction.
   9. Adherence to safety protocols in place during construction, including:
      a. Occupational Safety and Health Administration (OSHA)
      b. Local and State Plumbing Boards
      c. Local and State Health Departments
   10. Demonstration of completed irrigation installation and irrigation components operating within specified Sequence of Operation as determined by specified Commissioning Procedure prior to request for final payment (see Part 3 – Execution).

D. After date of acceptance of completion by Owner’s Project Manager, guarantee entire system with parts and labor for one year, including first-year winterization and spring startup.

1.02 QUALIFICATIONS

A. Qualified irrigation system installers shall have experience of five years with work and products specified herein, including:
   1. Two-Wire Controller and Valve Installation
   2. Soil Moisture and Weather-Based Smart Controllers
   3. Solvent Weld and/or Gasket Joint PVC Pipe two inches and Greater
   4. Commercial/Municipal/Institutional Irrigation Systems
   5. Athletic Field Irrigation Systems
   6. Building Management System Coordination

B. Attest qualifications below for three recent projects of similar scope and size in previous five years.

1. Contact Name
2. Company Name
3. Contact Phone Number
4. Project Name and Location
5. Project Completion Date
6. Brief Project Description

1.03 UTILITIES

A. Notify Owner's Project Manager in writing of missing prerequisite work outlined below. Failure to do so constitutes acceptance of conditions.

B. Water Service Point of Connection
   1. One new two inch municipal water service provided by Civil/Site Contractor. Approximate Irrigation System point of connection location is noted on Drawings.
   2. Equipment requirements:
      a. Requirements at Irrigation System point of connection:
         1) Type: Municipal Water
         2) Flow: Maximum 50 gallons per minute (gpm)
         3) Pressure (dynamic): 60 pounds per square inch (psi) at point of connection in athletic field downstream of all plumbing equipment
            a) Incoming Pressure: Estimated 80 psi from municipal water service in street
            b) Test incoming dynamic pressure downstream of all plumbing equipment in irrigation enclosure.
            c) Submit dynamic pressure test results prior to constructing irrigation system.

C. Electrical
   1. Power Source to be provided by Electrical Contractor (Refer to Division 26 Electrical).
      a. Power Requirements
         1) 120-Volt, One-Phase, 60-Hz, 20-Amp (Irrigation Controller)
         2) 120-Volt, One-Phase, 60-Hz, 20-Amp (Enclosure Heater)
   2. Conduits from building to point of connection as shown on Drawings to be provided by Electrical Contractor for power and communications as outlined above and below.
   3. Irrigation Contractor to coordinate underground power and data connections from Electrical Contractor and use project licensed electricians provided by Electrical Contractor to connect Irrigation Controller and Enclosure Heater.

D. Communications
   1. Communications to be provided by Electrical (Refer to Division 26 Electrical) and Communications (Refer to Division 27 – Communications). Also cross-reference Division 25 – Integrated Automation (Building Management Systems).
   2. Communications to provide three pairs of multimode fiber optic cables from Site Main Distribution Frame (MDF) to Mechanical Control Space.
      a. MDF Terminals to be labeled by Communications as "Athletic Field Irrigation System".
      b. Ethernet/CAT5 from LAN
      c. 4-6 Strands of Singlemode Fiber Optic to the MDF with Solid State Electronics on each end for network connectivity
      d. Pair of Multimode OM4 Fiber Terminated on each end at the MDF with LC Duplex Connectors
   3. Communications to provide wall mounted fiber optic cable enclosure placed at Mechanical Control Space.

4. Distribute data to Automatic Irrigation Controller and Booster Pump Station via CAT/6 Ethernet cables from fiber optic cable enclosure.

E. Pipe Sleeves
   1. Coordinate pipe sleeves provided by Civil/Site Contractor beneath hardscape, as indicated on Drawings.
      a. Pipe sleeve requirements:
         1) SDR 40 PVC (size noted on plan)
         2) Extend 18 inches beyond edge of hardscape
         3) Minimum cover: 24 inch

1.04 RELATED REQUIREMENTS

A. Plans and general provisions of the Drawings, including but not limited to the Agreement and General Conditions and other Division 01 Specification Sections, apply to this Section.

B. Coordinate with other project trades and refer to overall project Construction Documents, including, but not limited to:
   1. Division 01 – General Requirements
   2. Division 02 – Existing Conditions
   3. Division 03 – Concrete
   4. Division 23 – Building Communication Systems
   5. Division 26 – Electrical
   6. Division 27 – Communications
   7. Division 31 – Earthwork
   8. Division 32 – Exterior Improvements
   9. Division 33 – Utilities
   10. Drawings
      a. Drawings IR-300 - IR-400
      b. Review other Project Construction Documents for coordination.

1.05 APPLICABLE STANDARDS AND CODES

A. Comply with following standards and codes:
   1. American Society for Testing and Materials (ASTM)
   2. National Standard Plumbing Code (NSPC)
   3. National Electric Code (NEC)
   4. National Sanitary Foundation (NSF)
   5. Underwriters Laboratories, Inc. (UL)
   6. Occupational Safety and Health Administration (OSHA)
   7. American Wire Gauge (AWG)

B. Comply with applicable laws, standards, and regulations of local governing authority. Local laws more stringent than those referenced above shall take precedent.

1.06 SUBMITTALS

A. Submit following under provisions of Division 01 – General Conditions:
   1. Literature: Manufacturer's product data sheets, specifications and installation instructions for materials listed in this Specification (Part 2 – Products).
      a. Product submittals shall be concise (no extraneous pages or sections) and clearly marked to show submitted product model, type, and size.
      b. Substitute Product Submittal
         1) Provide specified product submittals for “Or Equal” to Owner’s Project Manager for acceptance.

2) Substitute products are acceptable when products of equal or better quality and performance are submitted and accepted by Owner's Project Manager.
3) Substitute Product Submittals constitute representation that:
   a) Substitute products have been thoroughly investigated and have been determined to be equal or superior in respects to that specified.
   b) Substitute products shall provide identical or better warranties as specified products.
   c) Substitute products are compatible with interfacing items.
   d) Assume responsibility and guarantee of system performance as result of product substitution, including making subsequent changes to meet design specifications.

c. Install new products without defects and of quality and performance as specified.
d. Work shall not commence until all products specified are submitted and accepted by written notification by Owner's Project Manager.
e. Products to be submitted for acceptance include, but not be limited to:
   1) Automatic Irrigation Controller
   2) Communications Connection for Irrigation Controller
   3) BACNet Managers for BMS School Integration and Monitoring
   4) Web-Based Applications for Weather Sensing and Remote Management
   5) Moisture Sensors (Soil and Rain)
   6) Wire and Connectors
   7) Pipe, Conduit, Fittings, and Bedding Materials
   8) Manual, Self-Regulating, and Electric Valves
   9) Valve Boxes and Support Materials
   10) Grounding Equipment
   11) Valves (Isolation, Winterization)
   12) Flow Sensors and Master Valves
   13) Outdoor Enclosure

2. Schedule: Submit Schedule of all products to be furnished hereunder, indicating manufacturer, size, and model.
   a. Ensure that all types/styles of products and installation equipment specified herein can be furnished by manufacturer submitted.
   b. Provide all spare parts as noted here within
   c. Prior to submitting schedule, confirm current site conditions are as provided in Drawings.

1.07 DELIVERY, STORAGE AND HANDLING

A. Do not deliver materials to Site until specified submittals have been accepted by Owner's Project Manager.
B. Coordinate with Owner's Project Manager for temporary storage and staging areas.
C. Protect materials from damage from construction traffic, weather, corrosion, and other causes while stored on-site. Minimize on-site storage as possible.
D. Minimize on-site storage. Coordinate with site supervisors for storage options.
E. Store and handle all products and materials in compliance with manufacturer's instructions and recommendations.
F. Material overages at installation completion to be removed from site.

1.08 GUARANTEE AND REPLACEMENT

A. Guarantee entire irrigation system, parts, and labor, for one year from official written date of substantial completion by Owner's Project Manager.

B. System malfunctions occurring during guarantee period due to defective materials, poor workmanship, or improper adjustment shall be corrected to satisfaction of Owner's Project Manager at no additional cost to Owner.
   1. Repair all defects within ten days of notification from Owner's Project Manager.
   2. Repair defects with accepted products.
C. First-year spring system start-up and winterization shall be included in system guarantee.
D. Manufacturer warranties shall be provided for all products and materials where such warranties are offered in published product data. Copies of manufacturer warranties are to be included in Operations and Maintenance Manual (See Operation and Maintenance).
   1. Provide written warranty showing date of completion and period of warranty prior to request for final payment.

1.09 QUALITY ASSURANCE

A. Owner's Project Managers are responsible for construction contract administration to answer requests for information (RFI), review and approve submitted products, provide limited observation site visit(s) during construction, and final punchlist site visit to observe fully operational system meeting conditions of contract as described in Drawings and Specifications.
B. Duties of Owner's Project Managers do not include supervision or direction of actual Work by installer or their agents. Owner's Project Managers roles are to administer contracts for Work for fulfillment as depicted in Drawings and Specifications, not Work itself.
C. Installer is responsible for providing fully operational Irrigation System as depicted in Drawings and Specifications while communicating with Owner's Project Managers, site tradespersons, manufacturers of products, as well as providing initial startup and training of systems by manufacturer-authorized representatives.
   1. Where responsibilities in trades overlap, furnish and install components required for complete, operational system unless explicitly assigned to another trade. Coordinate with Civil and Electrical.
D. Provide equipment and services not shown on Drawings or outlined in Specifications to achieve fully operational Irrigation System.
E. Owner's Project Manager is not responsible for guaranteeing construction, craftsmanship, or quality of installation and guarantee installation outlined in Paragraph 1.08 for one year from date of Substantial Completion as determined by punchlist site visit.

PART 2 - PRODUCTS

2.01 AUTOMATIC IRRIGATION CONTROLLER

A. Controller
   1. Quantity: One
   2. Size: Approximately 16 inches tall by 12 inches wide by six inches deep
   3. Construction: Electronic with 120-Volt Input and 24-28 Volt Output, Stainless Steel Unistrut-Mounted.
   4. Standards: UL-Listed
   5. Features: Manual and Automatic Control, Water Budgeting, Cycle-Soak, Sensor Input Terminals, Internal Transformer, Flow Monitoring Capability, Lightning Protection, Remote Control, Two-Wire System with Conventional Wire Retrofit Capability.
   6. Manufacturer/Model:
      a. Baseline BL-3200
      b. Rain-Bird ESP-LXD
      c. Hunter ACC2 Decoder
      d. Or Equal

B. External Devices (compatible with approved irrigation controller)
   1. Decoders
      a. Manufacturer/Model:
         1) Baseline BL-5201
         2) Rain-Bird FD-101
         3) Hunter ICD-100
         4) Or Equal
   2. Soil Moisture Sensor
      a. Manufacturer/Model:
         1) Baseline Biosensor BL-5315
         2) Rain-Bird SMRT-Y
         3) Hunter Soil-Clik
         4) Or Equal
   3. Rain Sensor
      a. Manufacturer/Model:
         1) Baseline BLTRB400
         2) Rain-Bird RSDBEX
         3) Hunter Rain-Clik
         4) Or Equal
      b. Coordinate attachment location in the field with Landscape Architect. Rain Sensor to be unobstructed from elements overhead.
   4. Flow Sensor
      a. Quantity: One
      b. Size: One and a half inch
      c. Flow Range one to 90 gallons per minute
      d. Manufacturer/Model:
         1) Baseline BFS150
         2) Rain-Bird FS150B
         3) Hunter Flow-Clik 150
         4) Or Equal
   5. Normally Closed (NC) Master Valve
      a. Quantity: One
      b. Size: Two inch
      c. Construction: Brass Globe Valve
      d. Ratings: 220 psi
      e. Features: Manual Bleed Screw, Flow Control, Pressure Regulation
      f. Manufacturer/Model:
         1) Griswold Controls, 2000 Series, Normally Closed
         2) Superior Controls, 3200NXT Normally Closed
         3) Cla-Val, 136-01 Normally Closed
         4) Or Equal
      g. Note: Demonstrate master valve closing within three minutes by simulating broken pipe through unexpected flows through drain valves or multiple zones operating manually and simultaneously.
   6. Web-Based Management

a. Enroll and configure Irrigation Controller web application for remote management of irrigation system with web-enabled devices.
b. Manufacturer/Model:
1) Baseline BaseManager Plus
2) Rain-Bird IQ
3) Hunter Centralus
4) Or Equal

7. Controller Grounding to Earth
a. Run Solid Bare Copper Wire from Automatic Irrigation Controller Grounding Lug in Conduit to Outdoors to Ground to Earth System.
b. Size:
1) Grounding Wire: Six AWG Bare
2) Grounding Rod: 5/8 inch Diameter ten Feet Long
3) Grounding Plate: Four inch by 96 inch by 1/16 inch thick
c. Construction:
1) Grounding Wire: Copper
2) Grounding Rod: Copper
3) Grounding Plate: Copper with Ground Enhancement Material on All Sides
d. Connections:
1) Grounding Wire to Rod: Cadweld
2) Grounding Wire to Plate: Cadweld with Manufacturer-Provided Plate Connections
3) Install PVC Sleeve Pipe with Grate Cover over Grounding Rod and Grounding Plate to Accept Rainfall and/or Irrigation to Reduce Resistance to Earth.

2.02 WIRE

A. Two-Wire
1. Size: 14/two AWG
2. Construction: Dual Strand Solid Copper Conductors with PE Insulation and Polyethylene Jacket.
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, ASTM B-8
5. Markings: Manufacturer, Rating, Size, and Type
6. Manufacturer/Model:
a. Paige Wire, P7389D
b. Regency Wire, R7534D
c. Service Wire, DEC 14/2
d. Or Equal

B. Conventional Wire
1. Size: 14AWG
2. Construction: Single Strand Solid Copper Conductor with Polyethylene Insulation
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, ASTM B-8
5. Markings: Manufacturer, Rating, Size, and Type
6. Manufacturer/Model:
a. Paige Wire, P7313D
b. Regency Wire, R7079D
c. Service Wire, GOLF14

d. Or Equal

C. Wire Splices
1. Type: Direct Burial Wire Splice Kit (All Components Intact)
2. Construction: Lockable Plastic Tube, Pre-Filled with Insulation Gel
3. Ratings: UL-Listed, NEC, Direct Burial and Submersion, up to 600-Volt Potential
4. Manufacturer/Model:
   a. 3M, Direct Bury Splice Kit (DBR/Y-6)
   b. Rain Bird, WC100 Wire Connectors (DBR/Y-6)
   c. Underhill, Direct Bury Splice Kit (DBR/Y-6)
   d. Or Equal

D. Decoder Cable Fuse Device
1. Type: Direct Burial Quick Disconnect Signal Splitter with Five-Amp Fuses
2. Construction: Waterproof PVC with O-Ring Seal and ACME Threads
3. Provide in-line, two-way split, and three-way split configurations following mainline branch splits.

2.03 ELECTRIC ZONE VALVES

A. Sprinkler Zone Valve
1. Size: One and a half inch
2. Construction: Plastic Globe Valve with Reinforced Nylon or Fiberglass Body
3. Ratings: 200 psi
4. Features: Manual Bleed Screw, Flow Control, Pressure Regulation, and Filter/Scrubber
5. Manufacturer/Model:
   a. Hunter, ICV-G-FS
   b. Rain Bird, PESB
   c. Toro, P-220S
   d. Or Equal

2.04 ISOLATION VALVES

A. Mainline Isolation Valves
1. Sizes: Two inch
2. Construction: Bronze, Gate Valve
3. Ratings: 200 psi
4. Features: Steel Cross Handle, Non-Rising Stem
5. Manufacturer/Model:
   a. Nibco, T-113K
   b. Apollo, 102T-K
   c. Matco-Norca, MN-514XLF
   d. Or Equal

2.05 QUICK COUPLING VALVES

A. Mainline Quick Coupling Valve
1. Size: One inch
2. Construction: Brass, Spring-Loaded Valve Seat, Key Engaged, Brass Swing Joint Assembly
3. Ratings: 125 psi
4. Features: ACME Key with one inch Male ACME and 3/4-inch Female AMCE Top, Vinyl Cover
5. Manufacturer/Model:
   a. Hunter, HQ44 - LRC - AW

b. Rain Bird, 44-RC
c. Toro, 100-2SLVC
d. Or Equal

B. Swing Joint Assembly
1. Size: one inch
2. Construction: PVC, with O-Ring Seals and Brass Threaded Outlet
3. Manufacturer/Model:
a. Hunter, HSJ-1 with Snap-Lok
b. Rain-Bird, TSJ-12
c. Lasco, Male Thread x Snap-Lok
d. Or Equal

2.06 VALVE BOXES

A. Valve Boxes ten feet off out of bounds lines along field perimeter. Coordinate final field locations with Landscape Architect.

B. General
1. Size
a. Six inch Round
1) Wire Splice
2) Decoder Cable Fuse Device
b. Ten inch Round
1) Isolation Valve
2) Quick Coupling Valve
c. 12 inch Standard Valve Box
1) Single two inch Electric Zone Valve
2. Construction: Resin
3. Ratings: Tensile Strength 3,000 to 5,000 psi
4. Lid Color: Green
5. Features: Lockable, Bolt-Down Covers (Provide Bolts and Install), Brick Supported
6. Manufacturer/Model:
a. Carson, Specification Grade NDS Pro
b. Rain Bird, VB Series
c. Dura, Valve Boxes
d. Or Equal

2.07 GROUNDING TO EARTH EQUIPMENT

A. Provide separate grounding system for Automatic Irrigation Controller and Irrigation Two-Wire Decoder Field System.

B. Wire: Six AWG Bare Copper Wire
1. Manufacturer/Model:
a. Paige Wire, Model 160635
b. Approved Equal

C. Grounding Plate
1. Size: Four inch x 96 inch x 1/16 inch thick
2. Construction: Copper with Loresco PowerSet Ground Enhancement Material Above and Below
3. Ratings: UL-Listed

4. Features: Cadweld Connectors from Wire to Plate, Manufacturer provided Plate Connections, PVC or ADS Drain Pipe and Grate Cover over Plate with Metal Detection
5. Standards: NEC 250.52 (7)
6. Manufacturer/Model:
    a. Paige Wire, Model 182199
    b. Approved Equal

D. Grounding Rod
1. Size: eight foot long by 5/8 inch diameter UL-Listed Copper-Clad Ground Rods with Welded, Insulated Conductor and Shrink Tubing
2. Construction: Copper with Loresco PowerSet Ground Enhancement Material Surrounding.
3. UL-Listed exothermic weld to copper ground rod meeting NEC requirements
4. Manufacturer/Model:
    a. Paige Wire, Model 182000 (Grounding Rod)
    b. Paige Wire, Model 182000IC10 (Exothermic Weld)
    c. Approved Equal

2.08 PIPE AND FITTINGS

A. Copper Pipe
1. Size: Two inch
2. Construction: Type K Copper
3. Standards: ASTM B-88
4. Fittings: Wrought Copper, Silver Solder Joint (Per ASTM B-828), Non-Corrosive Flux

B. Irrigation Mainline and Laterals (PVC)
1. Size: Two inch
2. Construction: Polyvinyl Chloride (PVC), Solvent Weld
3. Ratings: Class 200 Pressure Pipe
4. Standards: ASTM D-1785
5. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark.
    a. Manufacturer/Model:
        1) Cresline
        2) Certainteed
        3) JM Eagle
        4) Or Equal

C. Irrigation Mainline and Lateral Fittings (PVC)
1. Size: One and a half inch
    a. For Valves TOE Nipples: Schedule 80 PVC
    b. Other Fittings: Schedule 40 PVC
2. Markings: NSF Designation, Size, Class or Schedule
    a. Manufacturer/Model:
        1) Lasco
        2) Spears
        3) Dura
        4) Or Equal

D. Pipe Sleeves
1. Sizes: Four inch Minimum, Refer to Drawings for Sizes
2. Construction: Polyvinyl Chloride (PVC), Solvent Weld

3. Ratings: Schedule 40
4. Standards: ASTM D-1785
5. Pipe Markings: Manufacturer, Nominal Size, Schedule, Pressure, Extrusion Date, NSF 14, Pipe Insertion Mark.
    a. Manufacturer/Model:
        1) Cresline
        2) Certainteed
        3) JM Eagle
        4) Or Equal

E. Electrical Conduit (through Concrete Pad)
1. Size: One inch Minimum
2. Construction: PVC, Solvent Weld
3. Ratings: Schedule 40
4. Fittings: Long Sweep Elbows
5. Manufacturer:
    a. Cresline
    b. Certainteed
    c. JM Eagle
    d. Or Equal

F. PVC Solvent
1. Type: NSF Type I or Type II PVC
2. Standards: ASTM D-2564
    a. Manufacturer/Model:
        1) IPS Weld-On 711
        2) Oatey HD Cement
        3) Rectorseal Gold
        4) Or Equal

G. PVC Primer
1. Type: NSF for PVC
2. Standards: ASTM F-656
    a. Manufacturer/Model:
        1) IPS Weld-On P-68
        2) Oatey Clear Primer
        3) Rectorseal Jim PR-2
        4) Or Equal

2.09 METALLIC UTILITY TRACER TAPE

A. Irrigation pipe and direct burial wire installations shall also include the installation of metallic underground warning tape

B. Colors:

Color	Utility
Purple	Irrigation Pipe
Red	Direct Burial Wire

C. Size: Four inch to six inch wide

D. Markings: Tape marking shall indicate that a water pipe is buried below by reading " CAUTION IRRIGATION/ELECTRICAL BELOW" or a similar marking

2.10 GEAR-DRIVEN ROTOR SPRINKLERS

A. 3/4-inch Inlet Rotor
   1. Body
      a. Size: six inch Pop-Up
      b. Construction: Gear-Drive, Removable Nozzle, Internal Check Valve, Stainless Steel Retraction Spring, Rubber Cover, Stainless Steel Riser
      c. Features: Adjustable Part and Full Circle
      d. Manufacturer:
         1) Hunter, I-20-SS-06 (Basis of Design on Drawings)
         2) Rain-Bird, 5006-PC/FC-SAM-PRS-SS
         3) Toro, T5PCKSS3.0-RS
         4) Or Equal

B. Swing Joints
   1. Size: 3/4-inch
   2. Construction: PVC, with O-Ring Seals and Brass Threaded Outlet
   3. Manufacturer/Model:
      a. Hunter HSJ
      b. Rain Bird TSJ
      c. Lasco Swing Joint Assemblies
      d. Or Equal

2.11 METER AND METER PIT

A. Meter
   1. Size: One and a half inch
   2. Construction: Bronze
   3. Features: Magnetic Drive with Automatic Meter Register (AMR), Oval Flanges
   4. Manufacturer: Badger, Model Recordall one and a half inch (Basis of Design for Dimensions).
      a. Town of Wilmington Water Department to Approve Final Meter and AMR for Purchase.
      b. Coordinate Account Number and Address with Town of Wilmington Water Department and Configure Account for Owner.

B. Meter Pit Precast Manhole Structure
   1. Precast concrete manhole structures shall be as shown on the Drawings. Provide shop drawings of all proposed structures for approval.
   2. Holes in sections to receive piping may be cast into concrete or drilled.
   3. Diameter of hole shall be two to four inches larger than outside diameter of entering pipe.
   4. Structures shall conform to AASHTO HS-25 loading, as specified in the AASHTO Specifications.
   5. Upon completion of hardscape and paving work, new manhole covers shall be cleared of foreign material. After cleaning the covers to be removed and build-up of material inside the frame cleared to ease future removal of covers.
   6. Manufacturer/Model:
      a. Manhole – 60 inch Diameter by Shea Concrete
      b. Approved Equal

2.12 IRRIGATION ENCLOSURE AND EQUIPMENT

A. Reduced Pressure Zone Backflow Preventer Assembly
   1. Sizes: Two inch

2. Construction: Bronze with Quarter Turn Ball Valves
3. Ratings: 175 psi Maximum
4. Manufacturer/Model:
    a. Watts, Model 009M2-QT-FS
    b. Febco, 825Y
    c. Zurn, 2-975XL
    d. Approved Equal

B. Irrigation Enclosure
1. Size: 62 inch long by 39 inch wide by 46 inch high
2. Concrete Pad: 74 inch long by 51 inch wide by six inch thick, one inch Chamfer on Top Edge
3. Construction: Marine-Grade Aluminum
4. Ratings: Insulated
5. Features: Lockable, Exterior Color to be Confirmed by Owner's Representative
6. Manufacturer:
    a. HotBox, Model HB6000AN
    B. Approved Equal

2.13 EARTH MATERIALS

A. Stone (in Valve Boxes at Grade)
1. Type: 3/4-inch Washed Crushed Stone

B. Clean Sand (Pipe Bedding Material)
1. Gradation: (passing by weight)
    a. No. Four Sieve: 80 percent
    b. No. 200 Sieve: Five percent

C. Concrete (Enclosure Pad)
1. Ratings: 4,000 pounds per square inch 28-day Compressive Strength
2. Standards: ASTM C-33, ASTM C-94, ASTM-C150

2.14 SPARE PARTS

A. Wrenches, Keys, and Tools for Servicing and Adjusting Sprinkler Heads, quantity, four.
B. Quick Coupler Valve Keys, quantity, three.
1. Equipped with Pressure Gauge for testing.

C. Gate Valve, quantity, one.
D. Electric Zone Valves, quantity, two.
E. Assorted Valves and Fittings
F. Sprinkler Heads and Nozzle Racks, quantity, three of each.
G. Rotating Nozzle Pressure Gauge Attachment

PART 3 - EXECUTION

3.01 GENERAL

A. Competent superintendents and assistants shall be on-site at all times during product delivery, installation, testing, and system adjustments.
B. System features shall be laid out as indicated on Drawings, making minor adjustments for variations in planting arrangements or field conditions. Major changes shall be reviewed with Owner's Project Manager before acceptance.
1. Irrigation lines shown on Drawings are diagrammatic only. Location of irrigation equipment is contingent upon and subject to integration with all other underground utilities, tree roots, and hardscape design elements.

3.02 EXAMINATION

A. Review and verify project conditions are as indicated on Drawings prior to starting work, including but not limited to:
   1. Utilities
   2. Site grades and dimensions
   3. Landscaping features and hardscaping
   4. Structures
   5. Pipe Sleeves

B. Report any irregularities of site conditions to Owner's Project Manager prior to beginning work.

C. Beginning of installation connotes acceptance of existing project conditions.

3.03 PROJECT COORDINATION

A. Coordinate with Owner's Project Manager to expeditiously install system.

B. Provide written notifications (electronic is acceptable) to Owner's Project Manager prior to work commencement, weekly for progress report, for any proposed changes to system design, and upon installation completion.

C. Questions of design intent, proposed design changes, field notifications, and product substitution after installation commences shall be in writing to Owner's Project Manager as Request for Information (RFI).

D. Utility Coordination
   1. Maintain six inch clearance between irrigation lines and any utility line. Do not install irrigation mainlines nor lateral lines directly above another utility of any kind.
   2. Exercise care when working near existing utilities.

3.04 SITE PROTECTION

A. Protect landscaping, paving, structures, walls, and footings from damage caused during work. Damage to work of another trade shall be reported at once.

B. Replace or repair any damage with same product or material, to satisfaction of Owner's Project Manager at no additional cost per Guarantee.

3.05 AUTOMATIC IRRIGATION CONTROLLER INSTALLATION

A. Controller
   1. Install controller at location shown on Drawings.
   2. Wire valves and external sensors into controller through conduits and set proper programming.
      a. Program "Cycle-Soak" feature for all zones with sloped or poorly draining soils.
      b. Install and calibrate soil moisture sensors as per manufacturer instructions.
      c. Soil moisture sensors are not required for each irrigation zone. Assign representative soil moisture sensors for similar zones, such as:
         1) Sun vs. Shade
         2) Crown of Field vs. Edge of Field
         3) Use Irrigation Plans provided for Recommended Quantity and Assignment
   3. Using licensed electrical, wire controller to 120-Volt, 20-Amp electrical supply provided by Electrical Contractor.
   4. Provide keys after final walkthrough.

B. Flow Sensor
   1. Install Flow Sensor as shown on Drawings.
   2. Provide straight pipe for Flow Sensor to reduce turbulence.
      a. Upstream: ten times pipe diameter
      b. Downstream: five times pipe diameter

3. Wire Flow Sensor to Automatic Irrigation Controller as specified with waterproof connectors. Do not use splices between Controller and Flow Sensor.

C. Grounding
   1. Coordinate with Electrical Contractor for acceptable earth ground locations.

D. Soil Moisture Sensors
   1. Install Soil Moisture Sensors below grade as per manufacturer recommendations and connect to two-wire path. Use controller to identify connection to soil moisture sensors.
   2. Once installed in field and recognized by controller, set controller to calibrate soil moisture, typically saturating surrounding soil and allow to drain (as per manufacturer instructions).
   3. Once calibrated, set representative irrigation zones (see above) to operate only when soil moisture meets watering criteria.
   4. Coordinate with Owner's Project Manager on how to set irrigation watering criteria; generally:
      a. High-Limit (keep soil moist constantly, generally required for establishment)
      b. Low-Limit (allow soil to dry out)
      c. Combination of High and Low-Limit: (keep at moderate soil moisture level)

3.06 WIRE INSTALLATION

A. Install low-voltage valve two-wire per NEC, state, and local electrical codes for less 30-Volt service.

B. Install valve two-wire in trench alongside mainline at invert elevation. Backfill carefully to avoid any damage to wire insulation on conductors.
   1. In areas of unsuitable material, use clean sand in bottom of trench before placing wire (see Excavation, Trenching, and Backfilling)
   2. Cover over wire: 12 inch

C. Maintain sufficient slack for expansion, contraction and servicing. Do not install wiring tightly.
   1. Provide and install additional eight inches to 12 inches slack for conventional wire from decoder to valve.
   2. Provide 30 inches slack between decoders for two-wire.
   3. Provide sufficient length of wire in valve boxes to allow valve solenoid, splice, decoder wire, and all connections to be brought above grade for servicing.
   4. Coil slack for neatness in valve box.

D. Install Decoder Cable Fuse Device as shown on Drawings; generally, prior to junction points on two-wire path.

E. Provide waterproof splices at in-ground wire connections using accepted splice kits. Splices shall be made in valve boxes and recorded on Record Drawings.

F. Provide complete wiring diagram showing wire routing for connections between controller and valves as specified in Record Documents.

G. Securely store wire when not scheduled for installation.

3.07 GROUND INSTALLATION

A. Decoder Grounding
   1. Provide lightning surge arrestors as shown on Drawings.
   2. Provide grounding per manufacturer's instructions. Where no grounding requirements are specified, provide grounding every six decoders or 500 feet maximum.

B. Lightning/Surge Arrestor
   1. With waterproof splices, connect lightning arrestor red wire to site red wire and lightning arrestor black wire to site black wire. Decoder, lightning arrestor, and site two-wire may be connected in same waterproof splice as per manufacturer.

2. With waterproof splice, connect lightning arrestor ground green wire to eight AWG solid bare copper wire. Bury bare copper wire grounding wire 12 inches (or per local code) and run to accepted building ground location.
3. Place wired lightning arrestor neatly inside valve box.

C. Controller Grounding
1. Connect bare copper six AWG wire to controller ground lug and connect to earth ground.
2. Do not create grounding loop with field decoders (different ground locations outside of influence spheres).

3.08 DECODER INSTALLATION

A. Wiring
1. With waterproof splices, connect decoder red wire to site red wire and decoder black wire to site black wire.
2. With waterproof splices, connect decoder valve leads to electric zone valve solenoid leads.
3. Place wired decoder neatly inside valve box.
4. Connect with irrigation controller and run diagnostic decoder search to link.

B. Provide grounding for decoders per manufacturer's instructions. Refer to Ground Installation section.
1. With waterproof splice, connect lightning arrestor ground green wire to eight AWG solid bare copper wire. Bury bare copper wire grounding wire 12 inches (or per local code) and run to grounding plate.
2. Place wired lightning arrestor neatly inside valve box.
3. Splice all lightning arrestor green wires in series (with eight AWG green jacketed copper wire) and coordinate acceptable earth grounding with Electrical Contractor.

3.09 EXCAVATION, TRENCHING, AND BACKFILLING

A. Pipe Trench
1. Excavate trenches straight and true, minimizing site disturbance as possible.
2. Provide final trench bottom of undisturbed soil, free of rocks and debris larger than one inch or with sharp edges.
3. Prepare trench bases with Clean Sand as Pipe bedding material.

B. Clean Backfill
1. Clean backfill must be free of foreign material, debris, frozen material, and rocks larger than one inch.
2. Carefully place clean backfill minimum depth of ten inches over pipe and wire. Tamp in place.
3. Carefully place material around pipe and wire. Tamp in place.

C. Trench Backfill
1. Re-use excavated material and spoils.
2. Place and compact in maximum six inch lifts to dry density equal to undisturbed soil to ASTM D-698.
    a. Do not compaction by truck or equipment tires.
3. Do not backfill in hot weather.
4. Match adjacent subsurface grades without hills or depressions. Repair settling as required by Guarantee in Paragraph 1.08.
5. Replace disturbed specified soils during trenching to match requirements outlined in Division 32 – Exterior Improvements.

3.10 PIPE INSTALLATION

A. PVC Pipe Installation

1. Cut plastic pipe with handsaw or pipe cutter, removing all burrs at cut ends. Pipe cuts shall be square and true. Bevel cut end to conform to manufacturer instructions.
2. Make solvent-weld joints as per manufacturer's instructions and avoid applying excess primer or solvent. Do not wipe off excess solvent from each connection.
    a. Allow welded joints Five minutes set-up/curing time before moving or handling.
        1) Above 80 degrees Fahrenheit: Allow connections to set 24 hours.
        2) Below 80 degrees Fahrenheit: Follow manufacturer instructions.
        3) Below 40 degrees Fahrenheit: Prohibited.
    b. Maximum deflection per joint shall not exceed manufacturer limits.
    c. Maintain one inch between lines which cross at angels of 45 to 90 degrees.

B. Pipe Protection
1. Prevent foreign material from entering pipe during installation.
2. Open ends of pipe shall be closed by watertight plug or seal when not in use.
3. Securely store pipe when not scheduled for installation.
4. Pipe shall not be installed when water is in trench, during rainstorms, or when temperature is below 40 degrees Fahrenheit.
    a. No additional pipe may be installed or backfilled if water enters trench during pipe installation. Remove all water from trench before resuming installation.
    b. Pipe installed at temperatures below 40 degrees Fahrenheit shall be removed and replaced at no cost to Owner.
5. Trenched PVC pipe shall be snaked to accommodate for expansion and contraction due to changes in temperature.

3.11 PIPE SLEEVE INSTALLATION

A. Coordinate with Owner's Representative for provided Pipe Sleeves and locations installed by Site/Civil.

B. New Pipe Sleeves
1. Install Pipe Sleeves where irrigation pipe runs under hardscape (see Construction Drawings).
2. Extend Pipe Sleeves 18 inches beyond edges of hardscapes.
3. Prior to installation of Pipe Sleeves, field mark pipe sleeve ends with vertical wood stakes extending above grade to allow field location during irrigation system installation.

C. Cutting through or jacking under new pavement is prohibited. Failure to provide sleeves require notification to Owner's Representative for resolution.

3.12 METALLIC UTILITY TRACER TAPE

A. Metallic underground warning tape shall be installed six inches above the crown of the pipe and above direct burial wire.

B. Tape shall be installed in accordance with the manufacturer's recommendations.

C. Any tape damaged during shipment or installation shall be immediately replaced prior to backfilling the trench.

3.13 ELECTRIC ZONE VALVE INSTALLATION

A. Install electric zone valves on level crushed stone base generally where shown on Drawings. Do not pour stone around valves that are already installed.

B. Install Schedule 80 PVC threaded nipples with Teflon tape, isolation valves, and/or union couplings in and out of electric zone valves as shown on details on Drawings.

C. Set valves plumb with adjusting handle and bolts, screws, and wiring accessible through valve box opening.

D. Install at sufficient depth to provide between four inches and six inches of cover from top of valve to finish grade.

E. Install specified valve box over electric zone valves. Set lid is flush with final proposed grade. Coordinate with Landscape and Civil Drawings.

F. Adjust zone valve operation after installation using flow control device on valve.

3.14 ISOLATION VALVE INSTALLATION

A. Install isolation valves per detail, where indicated on Construction Drawings.

B. Install isolation valves and bricks on level crushed stone base for operation ease with appropriate valve wrench. Do not pour stone around valves that are already installed.

C. Install specified valve box over isolation valves. Set lid is flush with final proposed grade.

D. Check and tighten valve bonnet packing before valve box and backfill installation.

3.15 QUICK COUPLING VALVE INSTALLATION

A. Install quick coupling valves where indicated on Drawings; generally, at ends of mainline branches for winterization.

B. Mount mainline quick coupling valves on one inch diameter, 12 inch long brass swing joint assemblies and stabilizers.

C. Test each quick coupling valve for operation with keys as part of Spare Parts (Paragraph 2.13). Test with pressure gauge outlined in Spare Parts (Paragraph 2.13).

3.16 VALVE BOX INSTALLATION

A. Furnish and install valve boxes as per valve schedule above for each valve, splice, or sensor.

B. Install plastic valve boxes on minimum four inches crushed stone base. Pouring stone into valve box after installation is not acceptable.

C. Finish elevation of all boxes shall be at grade, unless otherwise noted in Drawings.

D. Provide level brick supports beneath valve boxes.

1. For square/rectangular boxes, provide four supports - one at each corner.
2. For round boxes, provide three supports equally spaced.

3.17 PRESSURE TESTING OF IRRIGATION PIPE

A. Include pressure testing procedure as specified below in submitted bid price.

B. Initial Pre-Construction Pressure Testing

1. For municipal (city) water systems sourcing irrigation, provide initial static and dynamic pressure testing of tapped service line prior to starting irrigation work.
2. Provide initial test results to Owner’s Project Manager for review and approval of results or to identify design modifications including Booster Pump Station horsepower to system resulting from lower than expected or required pressure from supply.

C. General Post-Construction Pressure Testing

1. After installation and backfilling of mainline and laterals (but prior to connecting sprinkler heads or other emission devices), test completed piping system for leaks and pressure integrity.
2. Preparation
    a. Flush irrigation mainline and lateral pipe network thoroughly with freshwater (municipal city, building domestic water, or water source approved by Owner’s Project Manager) to remove debris or foreign material.
    b. Cap or plug open ends of irrigation mainline and lateral pipe network.
    c. Connect test pump and pressure gauge to irrigation system pipe network at test point at start of irrigation mainline. Pressure gauge to be calibrated and have range of zero to 200 psi with accuracy of +/- two psi.
    d. Completely fill pipe network with water and expel trapped air. Provide air release valves at high points to assist in trapped air removal.
3. Testing Procedures

a. Provide portable power, testing pump, pressure gauges, and safety pressure relief valves to site as part of bid for pressure testing procedure.
b. Gradually increase water pressure via testing pump in pipe network to 150 percent of irrigation system working pressure, as indicated on Construction Drawings or in this specification section.
c. Maintain test pressure for two hours minimum.
d. During test period, review joints, fittings, and pipe sections for leaks.

4. Acceptance Criteria
   a. Irrigation pipe network to be considered acceptable when pressure drop during two hour test period does not drop below three percent of initial test pressure.
   b. Repair leaks detected during test period immediately. Make repairs to pipe using materials and methods approved by manufacturer. Submit locations, extents, and methods employed with pressure test report.
   c. After repairs, retest irrigation mainline and lateral pipe network according to procedure outlined above until acceptance criteria are met.
   d. After testing, clean equipment and site of debris.
5. Documentation
   a. Record date, time, location, and test pressure for each test.
   b. Note leaks detected and repairs made.
   c. Provide signed and dated test report to Owner's Project Manager upon completion of testing. Test report to include pressure gauge calibration certificate.
   d. Include Pressure Testing in Record Documents.

3.18 SPRINKLER INSTALLATION

A. Sprinklers shall not exceed maximum spacing as indicated on Construction Drawings.
B. Install sprinklers flush with grade on PVC swing joints as specified.
C. Flush system before installing internals, flush caps, and nozzles (see Testing and Adjustments)
D. Adjust sprinklers after installation using flow control device on valve. Do not exceed radius reduction recommendations from manufacturer.

3.19 PUNCHLIST SITE VISIT

A. Punchlist Site Visit requirements to be submitted to Owner’s Project Manager for acceptance:
   1. Pressure and Leak Test Results of Pipe Network
   2. Solenoid Valve Resistance Readings
   3. Receipt of Cellular Card, Antenna, and/or Data Service Plan.
B. Verification of Web-Enabled Application with:
   1. Account Information (Login and Password)
   2. Owner’s Project Manager shall Login to verify system setup and programming
   3. Push Notification and Short Messaging Service (SMS) setup to designated landscape managers and irrigation installer to notify of alerts during guarantee period.
   4. Screenshots of Learned Flow, Master Valve Enabling, and Programs.
   5. Connection and operation of pressure sensor, flow sensor, and weather sensing devices.
   6. Demonstrate to Owner’s Project Manager during Commissioning Site Visit
   7. Components of irrigation system including:
      a. Clean and neat layout of all components
      b. Pressure Gauges showing adequate pressure
      c. Secured pipe, wire conduit, and controller
      d. Valve Boxes flush with finish grade

e. Interiors of all Valve Boxes that have neat, clean valves and wiring

8. Normal operation of irrigation watering sequence for two minutes per zone sequentially.
9. Ability to hand water through quick coupling valve with key.
10. Ability of Normally Closed (NC) Master Valve to close within three minutes of abnormal flow using multiple quick coupling valves and multiple solenoid valves manually open.

3.20 TESTING AND ADJUSTMENTS

A. Include testing and adjustments in submitted bid price.

B. System Flushing:
   1. Flush irrigation system after complete installation.

C. Testing
   1. Test pipe and valves for leaks at operating pressure. Repair leaks and retest until leaks are remedied.
   2. Perform coverage test with Owner's Project Manager present. Operate electric zone valves for five minutes during coverage test. Readjust sprinkler nozzles and head locations to attain proper coverage. Replace any equipment that does not meet specified standards.
   3. After testing, clean equipment of debris during installation.

D. Adjust sprinkler heads and valve boxes for mowing and landscaping.

E. Throughout the guarantee period, adjust sprinklers and ensure coverage due to settlement and landscaping operations.

3.21 RECORD DOCUMENTS

A. As-Built Drawings
   1. Maintain and update Record Drawings with red-line markings as project progresses, including locations of:
      a. Sprinklers and descriptions (nozzles, pop-up height, and type)
      b. Valve Boxes and descriptions (valve type, zone numbers, and splice)
      c. Equipment installed with distinct symbols.
      d. Pipe routing and tees.
      e. Wire routing and splices.
      f. Controller Location
   2. Locations of installed equipment (valve, controller, sensors) shall be referenced by two permanent locations (swing ties) or GPS.
   3. Make all notes legible as work progresses, any new equipment added shall use distinct symbols denoting location.
   4. Document any changes from original Drawings.
   5. Prints of original Drawings may be obtained from Owner's Project Manager at cost.
   6. Record Drawings shall be used as basis of payment for work completed. Provide copies of red-lined set to Owner's Project Manager along with payment request.

B. Record Documents
   1. Maintain Record Documents at site. Maintain record of following as project progresses:
      a. Materials accepted and acceptance date.
      b. Materials delivered, Accepted, and Installed by whom and date.
      c. Pressure and Leak Test Results with testing personnel and testing date.
      d. Grounding Resistance Test Results with testing personnel and testing date.
      e. Field Communications and Requests for Information (RFI).

2. Prior to final punchlist, provide complete electronic and hard copy files of Record Drawings and Documents to Owner's Project Manager as part of project completion. All information shall be complete and shall be added to submitted documents prior to acceptance.

3.22 OPERATION AND MAINTENANCE

A. General
   1. Bid price shall include up to four hours of irrigation system overview and instruction with Owner's Project Manager.
   2. Refer to Division 01 – General Requirements for Additional Requirements.
   3. Operation and Maintenance Manual shall include, but not be limited to:
      a. Title Page and Table of Contents
      b. One-Paragraph Written Description of Irrigation System
      c. Manufacturers' Data and Cut Sheets of Equipment, including:
         1) Copies of all accepted submittals
         2) Wire resistance readings to each electric valve at completion (for future troubleshooting)
         3) Recommended operating settings
         4) Recommended maintenance schedule
         5) Name, address, and telephone number of installer (for repairs, spring startup, and winterization during one-year guarantee period)
         6) Irrigation program for periods without rain and recommended settings including, zone run time, days per week, cycle-soak, and rain sensor suspension.
      d. Winterization and Spring Startup Instructions (after one-year guarantee period)
      e. Guarantee Data
      f. Pressure Testing of Irrigation Pipe Documentation
      g. Grounding Testing of Irrigation Pipe Documentation
      h. Program Schedule with Run-Times (including Simultaneous Programs and Zones)
      i. Pockets with Folded Plans of:
         1) Original Design Drawing
         2) Final Record Drawing
         3) Controller Valve and Wiring System Diagram Drawing

3.23 SITE CLEANUP

A. Remove unused materials and equipment from project site safely and efficiently. Dispose of unused materials legally, including construction debris and trash.

B. Adjust ground, compact, and re-plant around irrigation sprinkler heads and trenches for proper angle and elevation.

C. Fill depressions and erosion rills with specified planting soil mix to ensure site drainage.

3.24 FINAL ACCEPTANCE

A. Final Acceptance of Irrigation System is predicated on:
   1. Complete system installation, adjustment, testing, and instructional overview.
   2. Submission of Operation and Maintenance Manuals to Owner's Project Manager.
   3. Proper Programming of Automatic Irrigation Controller.
   4. Completed and accepted punchlist items.

B. Owner's Project Manager shall provide written notice (hard copy and/or electronic) for Final Acceptance. Date of Final Acceptance notice shall serve as start of one-year Guarantee period as described above.

END OF SECTION

SECTION 32 90 00
UNDERDRAIN SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION OF WORK

A. Work Includes:
   1. Provide labor, materials, tools, and equipment required to complete work as indicated on Drawings and as specified within this Section.
   2. Work includes installation of athletic field, synthetic turf, and poured-in-place (PIP) underdrains and conveyance infrastructure as shown on Drawings.
   3. Work includes excavation, aggregate and stone drainage media, backfill, compaction, and stabilization.
   4. Coordinate and complete work with connecting storm drainage improvements as indicated in other specification sections (see Division 33).

1.03 RELATED WORK

A. Related Work: The following items are noted and included in this Section and shall be performed under the designated sections:
   1. Division 01 – General Requirements
   2. Division 02 – Existing Conditions
   3. Division 03 – Concrete
   4. Division 31 – Earthwork
   5. Division 32 – Exterior Improvements
   6. Division 33 – Utilities

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures .
   1. Qualifications: Provide three projects demonstrating successful athletic field, synthetic turf, and poured-in-place (PIP) area underdrain systems installation in previous five years. Qualifications are subject to acceptance of Owner's Project Manager.
      a. Contact Name
      b. Company Name
      c. Contact Phone Number
      d. Project Name and Location
      e. Project Completion Date
      f. Brief Project Description
   2. Shop Drawings: Shop drawings showing dimensions, joint and other details of materials proposed for the work. Submit Shop Drawings for acceptance prior to ordering material.
   3. Sieve Analysis: Provide sieve analysis for aggregate drainage materials for acceptance prior to ordering material.
   4. Products: Provide product cut sheets for pipe, fittings, and geotextiles as specified below.
   5. As-Built Plan: Provide as-built showing pipe locations and invert elevations of Athletic Field, Synthetic Turf, and Poured-In-Place (PIP) Area Underdrain Systems.
   6. Maintenance Instructions: Provide recommended procedures to be established for maintenance of underdrain systems during calendar year. Submit after substantial completion and punchlist site visit prior to start of one year guarantee period.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Qualified landscape installer whose work has resulted in successful athletic field, synthetic turf, and poured-in-place (PIP) area underdrain installation meeting acceptance of qualifications submittal above by Owner's Project Managers. Require Installer to maintain experienced full-time supervisor on Project site when construction is in progress.

B. Mandatory construction milestone reports and observations as specified in the Drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Aggregate materials

1. Coordinate and deliver aggregates and stone to a pre-accepted location in separate piles.
2. Stockpiles left for over 72 hours to be surrounded by containment straw bales and completely covered with an accepted blanket material to prevent invasive seed contamination from mixing with the stockpiled materials.

B. Store pipe and geotextile safely and securely from vandalism, theft, and weather.

1.07 PROJECT CONDITIONS

A. Weather Limitations

1. Do not install Athletic Field, Synthetic Turf, and Poured-In-Place (PIP) Underdrain Systems during any form of precipitation.
2. Do not install Athletic Field, Synthetic Turf, and Poured-In-Place (PIP) Underdrain Systems below 40 degrees Fahrenheit as per manufacturer recommendations.

B. Coordinate with athletic field soils, synthetic turf, and poured-in-place (PIP) area installations and irrigation system installation.

1.08 QUALITY ASSURANCE

A. Owner's Project Managers are responsible for construction contract administration to answer requests for information (RFI), review and approve submitted products, provide limited observation site visit(s) during construction, and final punchlist site visit to observe fully operational systems meeting conditions of contract as described in Drawings and Specifications.

B. Duties of Owner's Project Managers do not include supervision or direction of actual Work by installer or their agents. Owner's Project Managers roles are to administer contracts for Work for fulfillment as depicted in Drawings and Specifications, not Work itself.

C. Installer is responsible for providing fully operational Underdrain Systems as depicted in Drawings and Specifications while communicating with Owner's Project Managers, site tradespersons, and manufacturers of products.

D. Provide equipment and services not shown on Drawings or outlined in Specifications to achieve fully operational Underdrain System.

E. Owner's Project Manager is not responsible for guaranteeing construction, craftsmanship, or quality of installation and guarantee installation for one year from date of Substantial Completion as determined by punchlist site visit.

PART 2 – PRODUCTS

2.01 DOUBLE WASHED CRUSHED STONE

A. Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, collapsible material, and organic material.

B. Double wash crushed stone used within Underdrain pipe bedding prior to installation/placement.

C. Crushed stone to be uniformly blended conforming to the gradation for 3/4 inch, one and a half inch, or one and 3/4 inch crushed stone as specified in Division 31 - Earthwork.

2.02 PLASTIC PIPE

A. Rigid Perforated Underdrain Pipe

1. Size: Three inch and four inch diameter
2. Construction: Corrugated Single Wall HDPE Plastic Pipe with perforations.

3. Standards: AASHTO M252 or AASHTO M294
4. Manufacturer/Model:
    a. ADS, Single Wall Heavy Duty Corrugated, Perforated HDPE Pipe
    b. Timewell, Single Wall Corrugated, Perforated HDPE Pipe
    c. Haviland, Single Wall Corrugated, Perforated HDPE Pipe
    d. Or Equal
5. Rigid Perforated Underdrain Pipe Fittings
    a. Construction: High Density Polyethylene (HDPE)
    b. Cell Classification: 323410C or 333410C
    c. Standards: ASTM D3350, ASTM D1056, ASTM F667
    d. Fittings: Split or Snap Coupling Gasketed Connections
    e. Manufacturer – Matches supplied Rigid Perforated Underdrain Pipe

B. Rigid Underdrain Pipe
1. Size: Four inch and six inch diameter
2. Construction: Corrugated Dual Wall HDPE Plastic Pipe
3. Manufacturer/Model:
    a. ADS N-12 ST IB, Dual Wall Pipe
    b. Eagle Corr PE (Dual Wall) by JM Eagle
    c. Menards
    d. Or Equal
4. Insertion Tee Fittings
    a. Construction:
        1) PVC Hub
        2) Rubber Sleeve
        3) Stainless Steel Band
    b. Standards: ASTM F477, ASTM D3212, ASTM F2946
    c. Manufacturer/Model:
        1) Inserta Tee by ADS
        2) Approved Equal
5. Rigid Underdrain Pipe Fittings
    a. Construction: High Density Polyethylene (HDPE)
    b. Cell Classification: 424420C
    c. Standards: AASHTO M252, Type S or SP
    d. Joints and Fittings:
        1) Bell and Spigot Gasketed Joints
            i. Standards: AASHTO M252, AASHTO M294, or AASHTO F477
        2) Bell and Spigot Fittings
            i. Standards: AASHTO M252, AASHTO M294, or AASHTO F2306
    e. Manufacturer – Matches supplied Rigid Underdrain Pipe

C. Flexible Perforated Underdrain Muck Pipe
1. Size: Four inch and six inch diameter
2. Construction: Corrugated Single Wall HDPE Plastic Pipe with perforations.
3. Standards: ASTM F667
4. Fittings: Self-coupling stubs at ends of pipe sections
5. Pipe Manufacturer/Model:
    a. ADS, Channel Muck Pipe
    b. Hancor, Channel Muck Pipe
    c. Neat Distributing, NUFLO, Muck Pipe
    d. Or Equal

2.03 NON-WOVEN GEOTEXTILE FABRIC

A. Non-woven geotextile (filter) fabric is to be placed as shown on Underdrain Drawings.

B. Filter fabric to conform to Section 31 00 00 – Earth Moving

PART 3 – EXECUTION

3.01 COORDINATION

A. Pre-Installation Examination Required

1. Examine previous work, related work, and conditions under which this work is to be performed and notify Owner's Project Manager in writing of deficiencies and conditions detrimental to completion of this work.
2. Beginning work means acceptance of substrates, previous work, and conditions.

B. Do not place underdrain materials until work in adjacent areas is complete and accepted according to overall construction sequence.

C. Coordinate activities with other trades to prevent soil disturbance from traffic or other construction activities after placement.

D. Excavate and install underdrainage system after downstream storm drainage system has been installed to facilitate ease of subsurface connections.

E. Protect crushed stone and underdrainage perforated piping from construction sediment by temporarily covering crushed stone/piping with filter fabric.

F. Flush underdrain pipe and drainage connection with freshwater supply (coordinate in field).

G. Schedule and coordinate underdrain installation with athletic field, synthetic turf, and poured-in-place (PIP) area installations.

H. Restrict traffic over field prior, during, and after installation.

3.02 EXCAVATION AND COMPACTION

A. Avoid compaction of underdrain installation areas prior to construction. Place barricades to restrict access.

B. Do not excavate underdrain trenches when soil is moist or frozen. Smearing soil is not acceptable to continue work.

C. Provide subgrade with gradient less than 1/2 percent slope.

D. Subsoil compaction at underdrain trench bases to prepare using primary tilling equipment such as chisel plow, ripper, or subsoiler. Tilling operations to refracture subgrade to depth of 12 inches

E. Do not use heavy equipment within underdrain system and trenches. Heavy equipment may be used around underdrain installation areas to supply materials. Use light equipment such as compact loader or loader with marsh tracks.

F. Minimize over-compaction of both base and backfill lifts of underdrain system. When possible, use excavation hoes to remove original soil. Compaction significantly contribute to degradation of infiltration capacity of underdrain subgrades.

3.03 UNDERDRAIN CONSTRUCTION

A. Use filter fabric to temporarily protect layers and lifts of installation of underdrain system work. Remove filter fabric before installing next lifts.

B. Perforated Pipe Installation

1. Collector pipe for underdrain systems shall be constructed with slope as indicated on Drawings. Install pipe with uniform gradient and provide unrestricted flow to outlet.
2. Install perforated pipe with perforations down at four and eight o'clock positions.
3. Cap ends of underdrain pipes without cleanouts.
4. Place crushed stone to depth as shown on Drawings.
5. Cover crushed stone surface with filter fabric to prevent sedimentation of Landscaping Subgrades/Planting Soil Mixes.

C. Crushed Stone Installation
   1. Place crushed stone bedding, install underdrain pipe, and then fill trench around pipe above pipe crown, as indicated on Drawings.

3.04 HDPE PIPE INSTALLATION

A. Rigid Underdrain Pipe
   1. Sections of HDPE pipe should be connected using bell and spigot joints into continuous lengths on-site, above ground, before installation.
   2. HDPE Pipe Joints
      a. HDPE pipe shall be joined using a bell and spigot joint. The joint shall utilize a spun-on or welded bell and valley or saddle gasket meeting the requirements of the manufacturer; including, but not limited to:
         1) Soil-tight
         2) Meet AASHTO M252, AASHTO M294, AASHTO F2306, or AASHTO F477

B. Rigid Perforated Underdrain Pipe
   1. Sections of HDPE pipe should be connected using split or snap coupling gasketed connections into continuous lengths on-site, above ground, before installation.

C. Perforated Underdrain Muck Pipe
   1. Sections of HDPE pipe should be connected using self-coupling stubs at the ends of each pipe section into continuous lengths on-site, above ground, before installation.

3.05 CLEAN UP

A. At completion of work, remove debris, materials, rubbish, and excess dirt from site and legally dispose.

B. Leave premises in clean, safe, and condition.

C. Vacuum sediment and construction debris from structure prior to and during guarantee.

END OF SECTION

SECTION 32 91 31
ATHLETIC FIELDS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Non-irrigated Multiuse Athletic Field turfgrass seeding.
   2. Infield turfgrass sodding.
   3. Maintenance.

B. Related Sections:
   1. Section 31 10 00 "SITE CLEARING" for topsoil stripping and stockpiling.
   2. Section 31 00 00 "EARTH MOVING" for excavation, filling and backfilling, and rough grading.
   3. Section 31 25 00 “EROSION AND SEDIMENTATION CONTROLS” for earthwork stockpiles, cut and fill slopes, constructed and existing swales and ditches, and unestablished lawn and seeded embankments.
   4. Section 32 84 00 “IRRIGATION” for irrigation at the multiuse athletic field.
   5. Section 32 90 00 “UNDERDRAIN SYSTEM” for underdrains at the multiuse athletic field and playgrounds as released in Early Release Package 1 (ERP1).
   6. Section 32 92 00 “TURF AND GRASSES” for border turf.
   7. Section 32 93 00 "PLANTS" for border edgings.
   8. Section 33 41 00 “STORM UTILITY DRAINAGE PIPING” for subsurface drainage.
   9. Section 33 49 23 “STORM DRAINAGE RETENTION STRUCTURES” for structures under multiuse athletic field.

1.03 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Shop Drawings:
   1. Stripping plan; layouts showing any field lines, markings and boundaries, and field logos per project drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.

B. Qualification Data: Submit proof of qualified landscape Installer to the Owner's Representative in accordance with QUALITY ASSURANCE paragraph of this Section.

C. Product Certificates: At least 30 days prior to ordering materials, submit to the Owner's Representative samples, certifications, manufacture's product data and certified test results for materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and approved by the Owner's Representative. Delivered materials shall closely match the approved samples. Approval shall not constitute final acceptance. The Owner's Representative reserves the right to reject, on or after delivery, any materials which does not meet these Specifications:
   1. Fertilizer: Submit product literature of seeding fertilizer and certificates showing composition and analysis.
   2. Soil Additives: Submit product literature on all soil additives to be used on site.
   3. Limestone: Submit supplier's certificate that the limestone being supplied conforms to these Specifications.
   4. Hydroseeding: Submit a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water.
   5. Wood Cellulose Fiber Mulch: Submit one copy of manufacturer's literature and one material sample.

D. Material Test Reports: For sampling and testing of Loam Borrow from Off-Site Sources and from On-Site Sources shall be as specified in QUALITY ASSURANCE paragraph of this Section.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turfgrass during a calendar year including the painting and striping of the fields. Submit before expiration of required initial maintenance periods.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful athletic field establishment.
   1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: Three years' experience in turfgrass installation of similar quality, schedule requirement and construction detailing.
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time foreman or crew leader on Project site when work is in progress.

4. Personnel Certifications: Installer's foreman or crew leader shall be either a certified landscape professional or a certified horticulturalist:

B. Landscape professional shall be a Massachusetts Certified Landscape Professional currently certified by the Associated Landscape Contractors of Massachusetts.
   a. Horticulturalist shall be a Massachusetts Certified Horticulturalist as currently certified by the Massachusetts Nursery and Landscape Association.
   b. Certified Turfgrass Professional, designated CTP.
   c. Pesticide Applicator: State of Massachusetts licensed, commercial.

C. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

D. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; buffer pH, Soluble Salts, and mineral and plant-nutrient content of the soil.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Owner’s Representative. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for turfgrass growth.
      a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
   4. The General Contractor shall notify the Owner’s Representative in writing at least 10 days in advance of the time he intends furnishing Screened Loam Borrow stating the location and amount of such deposit, the name and address of the supplier and also shall furnish such facilities, transportation and assistance as the Owner may require for collecting and forwarding samples.

E. Pre-Construction Walk: Conduct pre-construction site walk at the Project site at a day and time specified by the Owner’s Representative.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Seed, Fertilizer and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable at time of first use. Any packaged materials that become caked or otherwise damaged will not be acceptable.

B. Sod: Harvest, deliver, store, and handle sod in accordance with best horticultural practices. Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turfgrass areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, limestone and soil amendments with appropriate certificates.

1.08 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Seed/Sod Spring Planting: April 1 to May 30.
   2. Seed/Sod Fall Planting: August 15 to October 15.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions. When special conditions warrant a variance to the turfgrass operations, proposed times shall be submitted to the Owner's Representative for approval prior to implementation.

1.09 WARRANTY

A. Warranty: Provide written warranty agreeing to remove and replace work that exhibits defects in materials or workmanship for the specified periods. "Defects" is defined to include, but is not limited to; death, unsatisfactory growth, disease, abnormal foliage density, abnormal size, abnormal color, failure to thrive and other unsatisfactory characteristics.

B. Replacement: Replace each defective plant or work with same species, size, character, and quality of originally accepted work. With each replacement plant or material, provide a new one-year warranty for the replacement work. If a replacement is unacceptable during its one-year warranty, the General Contractor shall provide another replacement or, when approved by Owner, equivalent cash payment.

C. Replacement Planting Season: Planting and reseeding for replacement and warranty work shall comply with the planting season contained herein.

D. Owner's Responsibilities and Warranty Exclusions: After completion of the Installation Contractor's maintenance responsibilities, the Owner is responsible for maintaining the work in reasonable compliance with the Installation Contractor's maintenance instructions. The Installation Contractor's warranty shall exclude problems due to improper or inadequate maintenance after the maintenance period or vandalism.

E. General Contractor Responsibilities: During the warranty period the General Contractor shall visit the site at one-month intervals to review the conditions of the accepted work. The General Contractor shall submit in writing his/her concerns regarding the Owner's maintenance practices and/or any vandalism. The Owner shall make reasonable efforts to correct the problems cited by the General Contractor, but the Owner shall not be held responsible for the Installation Contractor's defects in materials or workmanship that result in decline or death to plants and lawns.

F. Failure of the General Contractor to make the required monthly review of the site during the warranty period and submit written notice to the Owner of maintenance defects shall negate the General Contractor's ability to make claim against the Owner for negligence of maintenance.

G. Warranty Period for Multi-Use Fields: One Year from date of final acceptance.

H. Warranty Period for Soccer Fields: One Year from date of final acceptance.

1.10 MAINTENANCE SERVICE

A. Initial Turfgrass Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain according to Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turfgrass is established but for not less than the following periods:

1. Seeded Infield Turfgrass: 120 days from date of final acceptance of lawn areas.
    a. When initial maintenance period has not elapsed before end of planting season, or if turfgrass is not fully established, continue maintenance during next planting season.
2. Sodded Infield Turfgrass: 120 days from date of final acceptance of lawn areas.

PART 2 PRODUCTS

2.01 TURFGRASS SEED

A. Turfgrass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances. Turfgrass seed shall be of the previous year's crop and in no case shall weed seed content exceed one percent by weight. The seed shall be furnished and delivered in the proportion specified below in new, clean and properly labeled containers. All seed shall comply with State and Federal seed laws. Submit manufacturer's Certificate of Compliance. Seed that becomes wet, moldy or otherwise shall not be acceptable. Chewings fescue, hard fescue, tall fescue and ryegrass shall contain *Acromonium* endophytes. Seed containing endophyte shall be kept cool and dry at all times; do not stockpile in the sun.

B. All seed mixes and blends must consist of seed varieties which are highly rated in the most recent NTEP (National Turfgrass Evaluation Program) trial report. Highly rated is defined as being in the top 70-percent of the "Turfgrass Quality Rating".

C. Non-irrigated turf area seed mixes or blends must include 50-70-percent, by weight, A-LIST (Alliance for Low Input Sustainable Turf) or TWCA (Turfgrass Water Conservation Alliance) approved turfgrass cultivars.

D. A-LIST or TWCA approved turfgrass cultivars are also preferred for irrigated turf areas in all accepted seed mixes or blends.

E. Turfgrass Seed Mixes:
    1. General Seed for Temporary Cover are as follows:
        a. Annual Ryegrass; 40 pounds per acre (one pound per 1000 square feet); Recommended seeding date – April 1st to June 1st.
        b. Foxtail Millet; 30 pounds per acre (0.7 pounds per 1000 square feet); Recommended seeding dates – May 1st to June 30th.
        c. Oats; 80 pounds per acre (two pounds per 1000 square feet); Recommended seeding dates – April 1st to July 1st and August 15th to September 15th.
        d. Winter Rye; 120 pounds per acre (three pounds per 1000 square feet); Recommended seeding dates – August 15th to October 15th.
        e. Seeding rate for winter application shall be three tons per acre (150 pounds per 1000 square feet). Mulch shall not be spread on top of snow. Snow shall be removed down to one inch depth or less prior to application.
        f. Mulching rate shall be 1.5 to two tons per acre (two bales (70-90 pounds) per 1000 square feet). Hay or straw mulch shall be air-dried, free of undesirable seeds and coarse materials. There should be no bare spots showing.
    2. Non-Irrigated Multiuse Athletic Fields including, but not limited to Soccer. Seed Mixture Composition shall be the following seed mixes as supplied by Northeast Nursery, 8 Dearborn Road, Peabody, MA 01960; Northeast Golf & Turf Supply; Turf and Soil Specialist Paul Carey; Telephone: 978.239.6449; Email: pcarey@northeast nursery.com; or approved equal. Proportioned by weight as follows:
        a. 70-80-percent Turf Type Tall Fescue containing three or four drought and heat tolerant cultivars.
        b. 10-20-percent Perennial Ryegrass containing one or two drought and heat tolerant cultivars.
        c. 5-10-percent Kentucky Bluegrass containing one drought and heat tolerant cultivar.

d. Seeding rate for the Non-irrigated Multiuse Athletic Fields shall be six to 10 pounds per 1000 square feet, or seeding rate recommended by the supplier. For field specifications which are greater than 75-percent Turf Type Tall Fescue, the preferred seeding rate is 10-pounds per 1,000 square feet.
e. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on site, each variety shall be delivered in the original containers that bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, then the Contractor shall furnish to the Owner's Representative the dealer's guaranteed statement of the composition of the mixture.

3. Irrigated Multiuse Athletic Fields including, but not limited to Soccer. Seed Mixture Composition shall be the following seed mixes as supplied by Northeast Nursery, 8 Dearborn Road, Peabody, MA 01960; Northeast Golf & Turf Supply; Turf and Soil Specialist Paul Carey; Telephone: 978.239.6449; Email: pcarey@northeast nursery.com; or approved equal. Proportioned by weight as follows:
   a. 50-100-percent Premium, Low-cut Kentucky Bluegrass containing four or five genetically diverse cultivars.
   b. 25-50-percent Premium, Low-cut Perennial Ryegrass containing two or three cultivars.
   c. Seeding rate for the Irrigated Multiuse Athletic Fields shall be three to five pounds per 1000 square feet, or seeding rate recommended by the supplier. For field specifications which are greater than 75-percent Kentucky Bluegrass, the seeding rate shall be no greater than four-pounds per 1,000 square feet.
   d. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on site, each variety shall be delivered in the original containers that bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, furnish to the Owner's Representative the dealer's guaranteed statement of the composition of the mixture.

2.02 TURFGRASS SOD

A. Turfgrass Sod: Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted. Sod shall be well rooted turfgrass free from disease, insect pests, weed and any other harmful matter.
B. Turfgrass Sod shall be grown on a sandy loam or loamy sand substrate that is comparable with the project topsoil. Loams, silt/loams and clayey substrates shall not be accepted. The sod shall be a crop of at least one but not more than two years old (from date of seeding).
C. Turfgrass Sod shall be machine cut at a uniform soil thickness of 3/4 inch, plus or minus 1/4 inch, at time of cutting; measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be five percent. Broken pads and torn or uneven ends shall not be acceptable. Sod shall be at least two years old from the time of seeding.
D. Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.
E. Turfgrass Sod shall be harvested, delivered and installed within a 24-hour period. Sod not transplanted within this period shall be inspected and approved by the Owner's Representative prior to its installation. Soil in sod pads shall be kept moist at all times.
F. Mowing Height: All Turfgrass Sod shall be uniformly mowed to a height of 1 1/2 inches prior to shipment.
G. Turfgrass Sod Species:

1. Turfgrass Sod Mixture Composition; shall be the following species as supplied by either of the following sod growers, or approved equal:
   a. Kingston Turf Farms, Inc., 3720 South County Trail, West Kingston, RI 02892; Telephone: 1.800.556.2466
   b. SODCO; 264 Exeter Road, P.O. Box 2, Slocum, RI 02877; Telephone: 1.800.341.6900.
   c. Tuckahoe Turf Farms, Inc., 486 Church Street, Wood River Junction, RI 02894; Telephone: 1.800.556.6985.
2. Proportioned by weight as follows:
   a. A blend of at least three Kentucky bluegrass cultivars in approximately equal proportions.
   b. At least 70-percent of the turfgrass sod blend shall be at least two of the following varieties: Able I, Aspen, Banff, Blacksburg, Challenger, Classic, Eclipse, Estate, Midnight, Princeton (P-104), Ram I, Touchdown, or Trenton.
   c. Any variety substitutions or deviations from these specifications shall be approved by the Owner's Representative.

2.03 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2.04 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6.5 to 8.0; moisture content 35 to 55 percent by weight; 100 percent passing through 3/8 inch or smaller sieve; soluble salt content of five to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 40 percent dry weight.
   2. Nutrient Content: The material shall contain some nitrogen, phosphorous, potassium, calcium, magnesium, sodium and micronutrients including iron, copper, boron, manganese and molybdenum so that heavy application of fertilizers is not required to sustain plant growth. Also, the nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism.
   3. Heavy Metals: Concentrations of zinc, mercury, cadmium, lead, nickel, chromium, and copper shall be below EPA and State of Massachusetts standards for applications to soils with human activity.
   4. Pesticide Residue: Composted organic materials shall not contain any pesticide residues of any kind.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.05 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of one percent nitrogen and 23 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened

containers that bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients recommended and shall be adjusted per the soil analysis.

1. Composition: one pound per 1000 square feet of actual nitrogen, four percent phosphorous, and two percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers that bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients recommended and shall be adjusted per the soil analysis.

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.06 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt marsh hay or threshed straw of winter wheat, rye, oats, or barley.

B. Fiber Mulch for hydro-seeding: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5. Size Range: 1/4 inch minimum to 3/4 inch maximum. Color: Uniform tan-beige range or green range to allow for easy visual metering during application but shall be non-injurious to plant growth.

C. Nonasphaltic Tackifier for hydro-seeding: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; non-toxic and free of plant-growth or germination inhibitors.

D. Asphalt Emulsion for straw mulching: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

E. Water: Suitable for irrigation and free of substance harmful to plant growth. Hoses, pumps, sprinklers or other methods of transportation shall be furnished by Installation Contractor.

2.07 PESTICIDES AND HERBICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination and replace with new planting soil.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set until required to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURFGRASS AREA PREPARATION

A. Limit turfgrass subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of six inches. Remove stones larger than two inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Apply soil amendments and/or fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil off-site before spreading.
3. Spread planting soil in two equal lifts to a depth of six inches for new lawn and two inches for overseed, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top four inches of subgrade. Spread remainder of planting soil.
b. Reduce elevation of planting soil to allow for soil thickness of sod.

C. Unchanged Subgrades: If turfgrass is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turfgrass. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least six inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top four inches of soil. Till soil to a homogeneous mixture of fine texture.
a. Apply soil amendments and/or fertilizer directly to surface soil before loosening.
3. Remove stones larger than two inches in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turfgrass, off Owner's property.

D. Remediation of Compacted or Poorly Drained Subsoil in Planted Areas: If the soils are deemed to be compacted or poorly draining, the General Contractor shall remedy the condition prior to proceeding with further work. Remove any vegetative growth on the surface of the work area. Remove any extraneous materials. Loosen subgrade with a backhoe bucket to a depth of 18 inches. After gathering subsoil in the bucket, drop soil onto the ground from a height of six feet to break up the soil clumps. Position backhoe during work to prevent re-compaction of soils beginning the work in corners or against walls, or the center of isolated beds, and progressing outward towards the border’s edge. After subgrade has been broken up, rototill entire area to a depth of six inches. Heavy clay soils shall be amended with organic material.

E. Finish Grading: Set sufficient grade stakes for checking finished grades. Stakes shall be set at the top and bottom of slopes. The material should be rough graded with a dual laser-guided blade each time after rolling to ensure consistent depth of installation. Final grading shall be performed

with a dual laser-guided blade and roll. Grades shall be established which are accurate to 1/10th of a foot either way. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/4 inch of finish elevation. Limit finish grading to areas that can be planted in the immediate future.

F. Scarifying: After loam has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter, and stones over one inch in diameter shall be removed from the loam. Loam shall also be free of smaller stones in excessive quantities as determined by the Owner's Representative.

G. Rolling: Roll the entire surface with a hand roller weighing not more than 100 pounds per foot of width. During the rolling, remove all ridges and all depressions caused by settlements or rolling shall be filled with additional loam and the surface shall be regarded and rolled until it presents a smooth and even finish to the required grade or to the shapes and configurations shown on the details.

H. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

I. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds five mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.
   2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
   3. Apply fertilizer to the topsoil at a rate of 25 pounds per 1000 square feet. Work the soil into the top four inches of the topsoil.

B. Spread the seed mixture in two passes at 90 degrees to each other.

C. Sow seed at a total rate of three pounds per 1000 square feet on each pass for a total application of six pounds per 1000 square feet.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

E. Protect seeded areas with slopes exceeding 3:1 with erosion control blankets or erosion control fiber mesh, installed and stapled / anchored according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 6:1 by spreading straw mulch. It is the Installation Contractor's responsibility to place the mulch at its optimum thickness and to add or remove mulch to encourage seed germination, plant growth and to prevent erosion. Spread by hand, blower, or other suitable equipment.
   1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
   2. Or if required by Owner's Representative, bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gallons per 1000 square feet. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Water with a fine spray. Watering shall be started seven days after completing the seeded area. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum depth of one inch. Run-off and puddling shall be prevented.

3.05 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed applications. Continue mixing until it is uniformly blended into homogeneous slurry suitable for hydraulic application.
   1. Mix slurry with non-asphaltic tackifier per manufacturer's recommendation.

2. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500 pounds per acre dry weight, and seed component is deposited at the rate of six pounds per 1000 square feet for lawn areas. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 pounds per acre. Apply fertilizer at the rate of three pounds per1000 square feet.
3. Remove all overspray and repair all surfaces that are rutted or otherwise damaged by the hydroseeding materials or vehicle to a condition satisfactory to the Owner's Representative.
4. Take all necessary precautions to prevent overspray on structures, pavements and plantings adjacent to the seed areas.

3.06 SODDING

A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

B. Mix starter fertilizer into top two inches of root zone at a minimum rate of six pounds per 1000 square feet. Water dry root zone to a depth of four inches at least 48 hours prior to sodding to obtain a loose friable planting bed. The final planting bed shall be smooth and surface free from water holding depressions or pockets.

C. When laying the sod, the Installation Contractor shall take great care so that the finished grades are not disturbed. The Installation Contractor shall make provisions to avoid rutting the root zone mix. Equipment used to lay the sod shall not cause rutting of the root zone due to excessive weight. Equipment used during installation shall not be allowed to drive over laid sod.

D. The first row of sod shall be laid in a straight line with subsequent rows placed parallel and tightly against one another. All joints shall be butted tight in order to prevent voids. Lap ends of sod roll a minimum of six inches and cut a new tight joint. All lateral joints shall be staggered. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

E. Cut out any irregularities in the sod and replace with a new piece. Patches shall be cut and installed such that joints are butted tight. The minimum width for any patch shall be 12 inches wide. Abut pavement and curbs with a full width piece, where possible, and infill the opposite side with cut patches. All netting shall be removed as the sod is laid.
   1. Lay sod across angle of slopes exceeding 3:1.
   2. In all swales, and on slopes greater than 3:1, anchor sod with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than two anchors per sod strip to prevent slippage.

F. The sod shall be watered immediately after installation to prevent drying during the progress of the work. The Contractor shall have adequate equipment available to water the sod as specified herein. As the sod is completed in any one section, the entire area shall be thoroughly irrigated to a depth of one inch below the new sod pad. After a short drying period, the sod shall be rolled to firm the sod pad. During first week after planting, water daily or more frequently to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

G. After the sod has begun to root and shall support the movement of a small self-propelled roller, the sod shall be rolled by the Contractor in a minimum of two directions, opposing one another at an angle of 45 degrees.

H. Rolling to remove irregularities in the grade shall not be permitted. The sod shall be cut, rolled up and the root zone surface smoothed to the proper finished grade. Replace the sod immediately after smoothing.

3.07 PROTECTION

A. Erect warning signs and barricades (consisting of stakes with plastic tape) by the Owner's Representative to protect newly seeded and sodded areas from pedestrian, bicycle and vehicular traffic. Maintain barricades throughout the maintenance period until turfgrass is accepted by the Owner's Representative. If requested by the Owner's Representative, Contractor shall remove the barricades prior to acceptance of the newly planted areas.

3.08 TURFGRASS MAINTENANCE

A. The maintenance period for turfgrass shall begin immediately after the seeding or sodding has occurred and shall continue until final acceptance by the Owner's Representative.

B. Maintain and establish turfgrass by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations to establish healthy, viable turfgrass. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turfgrass. Provide materials and installation the same as those used in the original installation.
   1. Fill in soil subsidence that may occur because of settling or other processes. Replace materials and turfgrass damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor to prevent displacement.
   3. Apply treatments to keep turfgrass and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

C. Watering: Install and maintain temporary piping, hoses, and turfgrass-watering equipment to convey water from sources and to keep turfgrass uniformly moist to a depth of four inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turfgrass with fine spray at a minimum rate of one inch per week unless rainfall precipitation is adequate.

D. Mowing and edging:
   1. Mow turfgrass as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Mow turfgrass areas a minimum of three times before acceptance by the Owner's Representative.
   2. At each mowing, all edges of walks, drives, plant beds and other border conditions shall be edge trimmed by hand or machine to produce a straight and uniform edge condition.
   3. Remove and discard from paved areas only clippings and debris generated by each mowing and edging operation legally off-site. Owner's Representative, if practical and aesthetic, may allow sweeping (not blowing) clippings back into grass. Mowers shall be equipped with mulching blades. Do not remove from grass areas any clippings that have been generated by mowing operations.
   4. Schedule initial and subsequent mowing to maintain the following grass height:
      a. Mow Multi-Use Turfgrass Seed Mixture to a height of two inches.
      b. Mow Turfgrass Sod to a height of two inches.

E. Turfgrass Post-fertilization: Apply fertilizer after initial mowing and when turfgrass is dry.
   1. The first application of fertilizer as specified herein occurs during the initial installation of turfgrass seed or sod.
   2. A second application of fertilizer as specified herein shall be applied to seeded or sodded areas at the time of the first mowing. This second application shall be applied at a rate that ensures a nitrogen application of at least 1/2 pound per 1000 square feet. Phosphorous

and potassium shall be applied proportionally in accordance with the recommendations of the soil tests and the quantities previously integrated into the soil during the first application.

3. A third application of nitrogen fertilizer shall be applied to seeded or sodded areas approximately two months after the second. This third application shall correspond to the following application rates depending upon the month of application.
    a. May 1 through May 15: Use fertilizer that will provide actual nitrogen of at least one pound per 1000 square feet to turfgrass area.
    b. June 15 through June 30: Use fertilizer that will provide actual nitrogen of at least one pound per 1000 square feet to turfgrass area.
    c. August 15 through September 15: Use fertilizer that will provide actual nitrogen of at least one pound per 1000 square feet to turfgrass area.
    d. November 1 through November 15: Use fertilizer that will provide actual nitrogen of at least 1-1/2 pounds per 1000 square feet to turfgrass area.

F. Applying limestone
    1. The Installation Contractor shall return to the site at the beginning of the next seeding or sodding season and spread limestone across all lawn areas installed under this Contract. Limestone shall be spread at rates determined by the soil tests specified.

G. Maintenance Record: Full and complete written records for the maintenance of the athletic fields are to be furnished to the Owner by the General Contractor at least 10 days prior to the end of the contractual maintenance period, to familiarize the Owner with the maintenance requirements for proper care and development of the turfgrass.

3.09 SATISFACTORY TURFGRASS

A. Request for Acceptance: In writing, request Owner’s Representative inspection for acceptance at least 10 days in advance of preferred acceptance date. Do not request inspection for acceptance until work is 100 percent complete (not including maintenance) and in compliance with Contract requirements.

B. Partial Acceptance: Acceptance of partial areas or portions of the total work may be granted, at the Owner’s option, if the area to be inspected is large, well-defined, and easily described. The Owner and Owner’s Representative are not obliged to provide partial acceptance of the work.

C. Turfgrass installations shall meet the following criteria as determined by Owner’s Representative:
    1. Satisfactory Seeded Turfgrass: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds, undesirable grass species, disease, insects and surface irregularities. For the purpose of establishing an acceptable standard for seeded areas, scattered bare spots not larger than one square foot will be permitted up to a maximum of three percent of any lawn area. At least 90 percent of the grass established shall be permanent grass species.
    2. Satisfactory Sodded Turfgrass: At end of maintenance period, a healthy, well-rooted, even-colored, viable turfgrass has been established, free of weeds, undesirable grass species, disease, insects, open joints, bare areas, and surface irregularities. For the purpose of establishing an acceptable standard for sodded areas, scattered bare spots not larger than two inches shall be permitted, with not more than one bare or dead spot per square yard of lawn area. At least 90 percent of the grass established shall be permanent grass species.

D. Use specified materials to reestablish turfgrass that does not comply with requirements and continue maintenance until turfgrass is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 FIELD MARKINGS AND DECORATIONS

A. Markings are to be per the plan and must comply with all Client preferred sport league guidelines.

3.12 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turfgrass work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs to protect newly planted areas from traffic. Maintain fencing and barricades throughout the initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

D. Perform cleaning during the installation and upon completion of the work. Remove from site all debris and equipment. Repair all damage resulting from installation.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes providing all labor, equipment, materials, incidental work and construction methods required to perform all turf and grass installation and fine grading work and related items as indicated on the Contract Documents and/or as specified herein, and includes, but is not limited to, the following:
   1. Fine grading and loaming.
   2. Seeding.
   3. Hydroseeding.
   4. Grasses and wildflowers.
   5. Turf renovation for damaged areas.
   6. Erosion-control material(s).
   7. Maintenance and protection.

B. Related Sections:
   1. Section 31 10 00 "SITE CLEARING" for topsoil stripping and stockpiling.
   2. Section 31 00 00 "EARTH MOVING" for excavation, filling and backfilling, and rough grading.
   3. Section 31 25 00 “EROSION AND SEDIMENTATION CONTROLS” for earthwork stockpiles, cut and fill slopes, constructed and existing swales and ditches, and unestablished lawn and seeded embankments.
   4. Section 32 84 00 “IRRIGATION” for irrigation at the multiuse athletic field.
   5. Section 32 90 00 “UNDERDRAIN SYSTEM” for underdrains at the multiuse athletic field and playgrounds as released in Early Release Package 1 (ERP1).
   6. Section 32 91 31 "ATHLETIC FIELDS" for multi-use turf (seed and sod lawn) planting, hydroseeding.
   7. Section 32 93 00 "PLANTS" for trees, shrubs, perennials, turf, stabilization, and border edgings.
   8. Section 33 41 00 “STORM UTILITY DRAINAGE PIPING” for subsurface drainage.

1.03 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.05 INFORMATIONAL SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
B. Qualification Data: Submit proof of qualified landscape Installer to the Owner’s Representative in accordance with QUALITY ASSURANCE paragraph of this Section.
C. Product Certificates: At least 30 days prior to ordering materials, the General Contractor shall submit to the Owner’s Representative samples, certifications, manufacture’s product data and certified test results for materials as specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and accepted by the Owner’s Representative. Delivered materials shall closely match the accepted samples. Acceptance shall not constitute final acceptance. The Owner’s Representative reserves the right to reject, on or after delivery, any materials which does not meet these Specifications:
   1. Fertilizer: Submit product literature of seeding fertilizer and certificates showing composition and analysis.
   2. Erosion Control Matting: Submit one copy of manufacturer’s literature and one material sample.
   3. Soil Additives: Submit product literature on all soil additives to be used on site.
   4. Limestone: Submit supplier’s certificate that the limestone being supplied conforms to these Specifications.
   5. Hydroseeding: Submit a certified statement for acceptance as to the number of pounds of materials to be used per 100 gallons of water.
   6. Wood Cellulose Fiber Mulch: Submit one copy of manufacturer’s literature and one material sample.
D. Material Test Reports: For sampling and testing of Loam Borrow from Off-Site Sources and from On-Site Sources shall be as specified in QUALITY ASSURANCE paragraph of this Section.
E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf, and Grasses and Wildflowers during a calendar year. Submit before expiration of required initial maintenance periods.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf, and Grasses and Wildflowers establishment.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in turf installation of similar quality, schedule requirement and construction detailing.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time foreman or crew leader on Project site when work is in progress.
4. Personnel Certifications: Installer's foreman or crew leader shall be either a certified landscape professional or a certified horticulturalist:
   a. Landscape professional shall be a Massachusetts Certified Landscape Professional currently certified by the Massachusetts Association of Landscape Professionals (MLP).
   b. Horticulturalist shall be a Massachusetts Certified Horticulturalist as currently certified by the Massachusetts Nursery and Landscape Association.
   c. Certified Turfgrass Professional, designated CTP.
5. Pesticide Applicator: State of Massachusetts licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; buffer pH, Soluble Salts, and mineral and plant-nutrient content of the soil.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Owner's Representative. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for turf growth.
      a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-Construction Walk: Conduct pre-construction site walk at the Project site at a day and time specified by the Owner's Representative.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Seed, Fertilizer and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable at time of first use. Any packaged materials that become caked or otherwise damaged will not be acceptable.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers, limestone and soil amendments with appropriate certificates.

1.08 PROJECT CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from the date of Substantial Completion.
   1. Seed Spring Planting: April 1 to May 30.
   2. Seed Fall Planting: August 15 to October 15.
   3. Seed Grasses and Wildflowers Spring Planting: May 1 to June 30.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions. When special conditions warrant a variance to the turf operations, proposed times shall be submitted to the Owner's Representative for acceptance prior to implementation.

1.09 WARRANTY

A. Warranty: Provide a written warranty agreeing to remove and replace work that exhibits defects in materials or workmanship for the specified periods. "Defects" is defined to include, but is not limited to; death, unsatisfactory growth, disease, abnormal foliage density, abnormal size, abnormal color, failure to thrive and other unsatisfactory characteristics.

B. Replacement: Replace each defective plant or work with same species, size, character, and quality of originally accepted work. With each replacement plant or material, provide a new one-year warranty for the replacement work. If a replacement is unacceptable during its one-year warranty, the General Contractor shall provide another replacement or, when accepted by Owner, equivalent cash payment.

C. Replacement Planting Season: Planting and reseeding for replacement and warranty work shall comply with the planting season contained herein.

D. Owner's Responsibilities and Warranty Exclusions: After completion of the Installation Contractor's maintenance responsibilities, the Owner is responsible for maintaining the work in reasonable compliance with the Installation Contractor's maintenance instructions. The Installation Contractor's warranty shall exclude problems due to improper or inadequate maintenance after the maintenance period or vandalism.

E. General Contractor Responsibilities: During the warranty period the General Contractor shall visit the site at one-month intervals to review the conditions of the accepted work. The General Contractor shall submit in writing his/her concerns regarding the Owner's maintenance practices and/or any vandalism. The Owner will make reasonable efforts to correct the problems cited by the General Contractor, but the Owner will not be held responsible for the General Contractor's defects in materials or workmanship that result in decline or death to plants and lawns.

F. Failure of the General Contractor to make the required monthly review of the site during the warranty period and submit written notice to the Owner of maintenance defects shall negate the General Contractor's ability to make claim against the Owner for negligence of maintenance.

G. Warranty Period for Lawns: One Year from the date of final acceptance.

H. Warranty Period for Grasses and Wildflowers: One Year from the date of final acceptance.

1.10 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as indicated in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
   1. Seeded Turf: 60 days from date of final acceptance of lawn areas.
      a. When the initial maintenance period has not elapsed before the end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Initial Grasses and Wildflowers Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as indicated in Part 3. Begin maintenance immediately after each area is planted and continue for Two Years until acceptable grasses and wildflowers is established, but for not less than the following periods:
   1. Seeded Grasses and Wildflowers: 120-days from the date of final acceptance of grasses and wildflowers areas.
      a. When the initial maintenance period has not elapsed before the end of planting season, or if turf is not fully established, continue maintenance during next planting season.

PART 2 PRODUCTS

2.01 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances. Grass seed shall be of the previous year's crop and in no case shall weed seed content exceed one percent by weight. The seed shall be furnished and delivered in the proportion specified below in new, clean and properly labeled containers. All seed shall comply with State and Federal seed laws. Submit manufacturer's Certificate of Compliance. Seed that becomes wet, moldy or otherwise shall not be acceptable. Chewings fescue, hard fescue, tall fescue and ryegrass shall contain *Acromonium* endophytes. Seed containing endophytes shall be kept cool and dry at all times; do not stockpile in the sun

B. All seed mixes and blends shall consist of seed varieties which are highly rated in the most recent NTEP (National Turfgrass Evaluation Program) trial report. Highly rated is defined as being in the top 70-percent of the "Turfgrass Quality Rating".

C. Non-irrigated turf area seed mixes or blends shall include 50-70-percent, by weight, A-LIST (Alliance for Low Input Sustainable Turf) or TWCA (Turfgrass Water Conservation Alliance) approved turfgrass cultivars.

D. A-LIST or TWCA approved turfgrass cultivars are also preferred for irrigated turf areas in all accepted seed mixes or blends.

E. Grass Seed Mixes:
   1. General Seed for Temporary Cover are as follows:
      a. Annual Ryegrass; 40 pounds per acre (one pound per 1000 square feet); Recommended seeding date – April 1st to June 1st.
      b. Foxtail Millet; 30 pounds per acre (0.7 pounds per 1000 square feet); Recommended seeding dates – May 1st to June 30th.
      c. Oats; 80 pounds per acre (two pounds per 1000 square feet); Recommended seeding dates – April 1st to July 1st and August 15th to September 15th.
      d. Winter Rye; 120 pounds per acre (three pounds per 1000 square feet); Recommended seeding dates – August 15th to October 15th.
      e. Seeding rate for winter application shall be three tons per acre (150 pounds per 1000 square feet). Mulch shall not be spread on top of snow. Snow shall be removed down to one inch depth or less prior to application.

f. Mulching rate shall be 1.5 to two tons per acre (two bales (70-90 pounds) per 1000 square feet). Hay or straw mulch shall be air-dried, free of undesirable seeds and coarse materials. There should be no bare spots showing.

2. Non-irrigated General Lawn Seed Mixture Composition shall be the following seed mixes as supplied by Northeast Nursery, 8 Dearborn Road, Peabody, MA 01960; Northeast Golf & Turf Supply; Turf and Soil Specialist Paul Carey; Telephone: 978.239.6449; E: pcarey@northeast nursery.com; or approved equal. Proportioned by weight as follows:
   a. 70-80-percent Turf Type Tall Fescue containing three or four drought and heat tolerant cultivars.
   b. 10-20-percent Perennial Ryegrass containing one or two drought and heat tolerant cultivars.
   c. 5-10-percent Kentucky Bluegrass containing one drought and heat tolerant cultivar.
   d. Seeding rate for the Non-irrigated General Lawn Seed Mix shall be six pounds per 1000 square feet, or per supplier's recommendation.
   e. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on site, each variety shall be delivered in the original containers that bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, then the General Contractor shall furnish to the Owner's Representative the dealer's guaranteed statement of the composition of the mixture.
3. Non-Irrigated Shade Lawn Seed Mixture Composition shall be the following seed mixes as supplied by Northeast Nursery, 8 Dearborn Road, Peabody, MA 01960; Northeast Golf & Turf Supply; Turf and Soil Specialist Paul Carey; Telephone: 978.239.6449; E: pcarey@northeast nursery.com; or approved equal. Proportioned by weight as follows:
   a. 25-35-percent Creeping Red or Slender Fescue containing one or two shade tolerant cultivars.
   b. 25-35-percent Chewing's Fescue containing one or two shade tolerant cultivars.
   c. 10-15-percent Hard or Sheep Fescue containing one shade tolerant cultivar.
   d. 10-30-percent Perennial Ryegrass containing one shade tolerant cultivar.
      1) For heavy dense shade, Perennial Ryegrass can be substituted with Rough Stock Bluegrass (Poa trivialis).
   e. Seeding rate for the Non-Irrigated Shade Lawn Seed Mix shall be five pounds per 1000 square feet, or per supplier's recommendation.
   f. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on site, each variety shall be delivered in the original containers that bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, then the General Contractor shall furnish to the Owner's Representative the dealer's guaranteed statement of the composition of the mixture.

2.02 GRASSES AND WILDFLOWERS

A. "Low-Growing Wildflower and Grass Mix; ERNMX-156" supplied by: Ernst Seeds, 8884 Mercer Pike, Meadville, PA 16335; Telephone: 800.873.3321; or approved equal. Fresh, clean and dry new seed, of mixed species as follows:
   1. Sheep Fescue (Festuca ovina), Annual Ryegrass (Lolium multiflorum), Sideoats Grama (Bouteloua curtipendula), Perennial Blue Flax (Linum perenne), Blue Bachelor's Button (Centaurea cyanus), Lanceleaf Coreopsis (Coreopsis lanceolata), Perennial Gaillardia (Gaillardia aristata), Blackeyed Susan (Rudbeckia hirta), Annual Gaillardia (Gaillardia pulchella), Shasta Daisy (Chrysanthemum maximum), Golden Alexanders (Ziziaa urea), Aromatic Aster (Aster oblongifolius), Narrowleaf Mountainmint (Pycnathemum tenuifolium), Butterfly Milkweed (Asclepias tuberosa), Red Corn Poppy (Papaver rhoeas), Corn

Poppy/Shirley Mix (Papaver rhoeas), Anise Lavender Hyssop (Agastache foeniculum), Hairy Beardtongue (Penstemon hirsutus), Common Yarrow (Achillea millefolium).

a. Seeding rate for the Low-Growing Wildflower and Grass Mix; ERNMX-156 mix shall be 25 to 40 pounds per acre, or per supplier's recommendation.
b. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on site, each variety shall be delivered in the original containers that bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, then the General Contractor shall furnish to the Owner's Representative the dealer's guaranteed statement of the composition of the mixture.

B. "Right-of-Way Native Woods Mix with Annual Ryegrass; ERNMX-132-1" supplied by: Ernst Seeds, 8884 Mercer Pike, Meadville, PA 16335; Telephone: 800.873.3321; or approved equal. Fresh, clean and dry new seed, of mixed species as follows:
1. Annual Ryegrass (Lolium multiflorum), Tioga Deertongue (Panicum clandestinum), Switchgrass "Habitat" (Panicum virgatum 'Habitat'), Madison Virginia Wildrye (Elymus virginicus), Creeping Red Fescue (Festuca rubra), Albany Pine Buch Autumn Bentgrass (Agrostis perennans), Fox Sedge (Carex vulpinoidea), Heath Aster (Aster pilosus).
   a. Seeding rate for the Right-of-Way Native Woods Mix with Annual Ryegrass; ERNMX-132-1 mix shall be 30 pounds per acre, or per supplier's recommendation.
   b. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on site, each variety shall be delivered in the original containers that bear the dealer's guaranteed analysis. If the seed is mixed by a dealer, then the General Contractor shall furnish to the Owner's Representative the dealer's guaranteed statement of the composition of the mixture.

C. Seed Carrier: Inert material, sharp clean sand or perlite, mixed with seed at a ratio of not less than 2:1; two parts seed carrier to one part seed.

2.03 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

2.04 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6.5 to 8.0; moisture content 35 to 55 percent by weight; 100 percent passing through 3/8 inch or smaller sieve; soluble salt content of five to 10 decisiemens/m; not exceeding one half percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 40 percent of dry weight.
2. Nutrient Content: The material shall contain some nitrogen, phosphorous, potassium, calcium, magnesium, sodium and micronutrients including iron, copper, boron, manganese and molybdenum so that heavy application of fertilizers is not required to sustain plant growth. Also, the nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism.
3. Heavy Metals: Concentrations of zinc, mercury, cadmium, lead, nickel, chromium, and copper shall be below EPA and State of Massachusetts standards for applications to soils with human activity.
4. Pesticide Residue: Composted organic materials shall not contain any pesticide residues of any kind.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.05 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of one percent nitrogen and 23 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers that bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients recommended and shall be adjusted per the soil analysis.
   1. Composition: one pound per 1000 square feet of actual nitrogen, four percent phosphorous, and two percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers that bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients recommended and shall be adjusted per the soil analysis.
   1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.06 PLANTING SOILS

A. Planting Soil for Seeded Lawn: ASTM D 5268 topsoil, screened, sandy loam that is fertile, friable natural loam free from subsoil, clay, brush, litter, roots, stones 3/4 inch or larger and any other foreign materials harmful to plant growth. Loam shall have an acidity range of pH 5.8 to 7.0 and shall contain not less than four percent or more than six percent organic material content as determined by the loss of ignition (LOI) of samples which have been oven-dried to a constant weight at a temperature of 221 degrees Fahrenheit (105 degrees Celsius).
   1. Mix ASTM D 5268 topsoil with the following soil amendments in the following quantities to produce planting soil:
      a. Ratio of soil mixture compositions shall be one part topsoil as specified above, one-part organic matter, and one-part native soil mixed prior to planting installation.
         1) If native soil cannot be stockpiled on site for reuse, a soil mixture matching the existing soil profile present on site prior to disturbance, stockpiling or removal shall be used. See Specification Section 31 10 00 SITE CLEARING for requirements of native soil testing.
      b. Weight of Lime per 1000 square feet: 200 pounds maximum limit.
      c. Weight of Bonemeal per 1000 square feet: as per soil analysis.
      d. Weight of Superphosphate per 1000 square feet: 20 pounds or as specified by soil analysis.
      e. Weight of Commercial Fertilizer per 1000 square feet: as per soil analysis.
      f. Weight of Slow-Release Fertilizer per 1000 square feet: as per soil analysis.

B. Planting Soil for Grasses and Wildflowers: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify

suitability of native surface topsoil to produce viable planting soil. Soil shall consist of one to two percent organic matter with a blend of sand, silt, and minimal clay (dry sandy loam), consist of well-sorted particles less than one inch diameter with continuous pore space and have a pH range from 5.8 to 7.0. Soil shall be free from subsoil, clay, brush, litter, roots, stones 3/4 inch or larger and any other foreign materials harmful to plant growth.

1. Supplement with Seeded and Sodded Lawn planting soil when quantities are insufficient.
2. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
    a. Ratio of soil mixture compositions shall be one part topsoil as specified above, one-part organic matter, and one-part native soil mixed prior to planting installation.
    b. Weight of Lime per 1000 square feet: 200 pounds maximum limit.
    c. Weight of Bonemeal per 1000 square feet: as per soil analysis.
    d. Weight of Superphosphate per 1000 square feet: 20 pounds as specified by soil analysis.
    e. Weight of Slow-Release Fertilizer per 1000 square feet: as per soil analysis.

2.07 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt marsh hay or threshed straw of winter wheat, rye, oats, or barley.

B. Fiber Mulch for hydro-seeding: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5. Size Range: 1/4 inch minimum to 3/4 inch maximum. Color: Uniform tan-beige range or green range to allow for easy visual metering during application but shall be non-injurious to plant growth.

C. No Hydroseed or Hydromulch with Tackifier shall be used on ”Grasses and Wildflowers”. The tackifier will “glue” and “smother” the seed and inhibit the ability for the naturalized seed from germinating. Use a cover crop or salt-marsh hay for mulching.

D. Nonasphaltic Tackifier for turfgrass hydro-seeding: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

E. Asphalt Emulsion for straw mulching: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

F. Water: Suitable for irrigation and free of substance harmful to plant growth. Hoses, pumps, sprinklers or other methods of transportation shall be furnished by General Contractor.

2.08 PESTICIDES AND HERBICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.09 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, six inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 pounds per square yard, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, six inches long.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. North American Green, 5401 St. Wendel-Cynthiana Road, Poseyville, IN 47633, Telephone: 800.772.2040; Website: www.nagreen.com; BioNet Biodegradable Erosion Control Blankets; Short-Term.
   b. North American Green, 5401 St. Wendel-Cynthiana Road, Poseyville, IN 47633, Telephone: 800.772.2040; Website: www.nagreen.com; BioNet Biodegradable Erosion Control Blankets; Extended-Term.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
   3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable, and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination and replace with new planting soil.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
   2. Protect grade stakes set until required to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of six inches. Remove stones larger than two inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply soil amendments and/or fertilizer directly to subgrade before loosening.
   2. Thoroughly blend planting soil off-site before spreading.
   3. Spread planting soil in two equal lifts to a depth of six inches for new lawn and two inches for overseed, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top four inches of subgrade. Spread the remainder of planting soil.

C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least six inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top four inches of soil. Till soil to a homogeneous mixture of fine texture.
      a. Apply soil amendments and/or fertilizer directly to surface soil before loosening.

3. Remove stones larger than two inches in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

D. Remediation of Compacted or Poorly Drained Subsoil in Planted Areas: If the soils are deemed to be compacted or poorly draining, the General Contractor shall remedy the condition prior to proceeding with further work. Remove any vegetative growth on the surface of the work area. Remove any extraneous materials. Loosen subgrade with a backhoe bucket to a depth of 18 inches. After gathering subsoil in the bucket, drop soil onto the ground from a height of six feet to break up the soil clumps. Position backhoe during work to prevent re-compaction of soils beginning the work in corners or against walls, or the center of isolated beds, and progressing outward towards the border's edge. After subgrade has been broken up, rototill entire area to a depth of six inches. Heavy clay soils shall be amended with organic material.

E. Finish Grading: Set sufficient grade stakes for checking finished grades. Stakes shall be set at the top and bottom of slopes. Grades shall be established which are accurate to 1/10th of a foot either way. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/4 inch of finish elevation. Limit finish grading to areas that can be planted in the immediate future.

F. Scarifying: After loam has been spread, it shall be carefully prepared by scarifying or harrowing and hand raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter, and stones over one inch in diameter shall be removed from the loam. Loam shall also be free of smaller stones in excessive quantities as determined by the Owner's Representative.

G. Rolling: Roll the entire surface with a hand roller weighing not more than 100 pounds per foot of width. During the rolling, remove all ridges and all depressions caused by settlements or rolling shall be filled with additional loam and the surface shall be regarded and rolled until it presents a smooth and even finish to the required grade or to the shapes and configurations shown on the details.

H. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

I. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten per manufacturer's recommendation.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, per manufacturer's recommendation for site conditions. Fasten per manufacturer's recommendation.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds five mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

3. Apply fertilizer to the topsoil at a rate of 25 pounds per 1000 square feet. Work the soil into the top four inches of the topsoil.

B. Spread the seed mixture in two passes at 90 degrees to each other.

C. Sow seed at a total rate of three pounds per 1000 square feet on each pass for a total application of six pounds per 1000 square feet.

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

E. Protect seeded areas with slopes exceeding 3:1 with erosion control blankets or erosion control fiber mesh, installed and stapled and/or anchored according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 6:1 by spreading straw mulch. It is the General Contractor's responsibility to place the mulch at its optimum thickness and to add or remove mulch to encourage seed germination, plant growth and to prevent erosion. Spread by hand, blower, or other suitable equipment.

1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Or if required by Owner's Representative, bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gallons per 1000 square feet. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Water with a fine spray. Watering shall be started seven days after completing the seeded area. Water shall be applied at a rate sufficient to ensure moist soil conditions to a minimum depth of one inch. Run-off and puddling shall be prevented.

3.06 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with non-asphaltic tackifier per manufacturer's recommendation.
2. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500 pounds per acre dry weight, and seed component is deposited at the rate of six pounds per 1000 square feet for lawn areas. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 pounds per acre. Apply fertilizer at the rate of three pounds per 1000 square feet.
3. Remove all overspray and repair all surfaces that are rutted or otherwise damaged by the hydroseeding materials or vehicle to a condition satisfactory to the Owner's Representative.
4. Take all necessary precautions to prevent overspray on structures, pavements and plantings adjacent to the seed areas.

3.07 TURF RENOVATION FOR DAMAGED AREAS

A. Renovate existing turf.

B. Renovate existing turf damaged by General Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil.

C. Remove vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from General Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
H. Till stripped, bare, and compacted areas thoroughly to a soil depth of six inches.
I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top four inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
J. Apply seed for new turf.
K. Water newly planted areas and keep moist until new turf is established.

3.08 PROTECTION

A. Erect warning signs and barricades (consisting of stakes with plastic tape) to protect newly seeded areas from pedestrian, bicycle and vehicular traffic. Maintain barricades throughout the maintenance period until turf is accepted by the Owner's Representative. If requested by the Owner's Representative, General Contractor shall remove the barricades prior to acceptance of the newly planted areas.

3.09 TURF MAINTENANCE

A. The maintenance period for turf and grasses shall begin immediately after the seeding has occurred and shall continue until final acceptance by the Owner's Representative.
B. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, edging, replanting dead areas, disease and insect control, erosion repair, and performing other operations and consistent with good horticultural practices to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
    1. Fill in soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
    2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor to prevent displacement.
    3. Apply treatments to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
C. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of four inches.
    1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out a temporary watering system to avoid walking over muddy or newly planted areas.
    2. Water turf with fine spray at a minimum rate of one inch per week unless rainfall precipitation is adequate.
D. Mowing and Edging:
    1. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Mow turf areas a minimum of three times before acceptance by the Owner's Representative.
    2. At each mowing, all edges of walks, drives, plant beds and other border conditions shall be edge trimmed by hand or machine to produce a straight and uniform edge condition.
    3. Remove and discard from paved areas only clippings and debris generated by each mowing and edging operation legally off-site. Owner's Representative, if practical and aesthetic, may allow sweeping (not blowing) clippings back into grass. Mowers shall be equipped with mulching blades. Do not remove from grass areas any clippings that have been generated by mowing operations.

4. Schedule initial and subsequent mowing to maintain the following grass height:
    a. Mow General Lawn Seed Mixture to a height of two inches.
    b. Mow Shade Lawn Seed Mixture to a height of two inches.
    c. Mow Low Maintenance Seed Mixture to a height of three to four inches.
5. All mowing shall be scheduled on a weekly basis, depending on the month and weather, as designated by the Owner's Representative.

E. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.
1. The first application of fertilizer as specified herein occurs during the initial installation of turf seed.
2. A second application of fertilizer as specified herein shall be applied to seeded areas at the time of the first mowing. This second application shall be applied at a rate that ensures a nitrogen application of at least 1/2 pound per 1000 square feet. Phosphorous and potassium shall be applied proportionally in accordance with the recommendations of the soil tests and the quantities previously integrated into the soil during the first application.
3. A third application of nitrogen fertilizer shall be applied to seeded areas approximately two months after the second. This third application shall correspond to the following application rates dependent upon the month of application.
    a. May 1 through May 15: Use fertilizer that will provide actual nitrogen of at least one pound per 1000 square feet to turf area.
    b. June 15 through June 30: Use fertilizer that will provide actual nitrogen of at least one pound per 1000 square feet to turf area.
    c. August 15 through September 15: Use fertilizer that will provide actual nitrogen of at least one pound per 1000 square feet to turf area.
    d. November 1 through November 15: Use fertilizer that will provide actual nitrogen of at least 1 1/2 pounds per 1000 square feet to turf area.

F. Applying limestone
1. The Installation Contractor shall return to the site at the beginning of the next seeding season and spread limestone across all lawn areas installed under this Contract. Limestone shall be spread at rates determined by the soil tests specified.

3.10 SATISFACTORY TURF

A. Request for Acceptance: In writing, request Owner's Representative observation for acceptance at least 10 days in advance of preferred acceptance date. Do not request observation for acceptance until work is 100 percent complete (not including maintenance) and in compliance with Contract requirements.

B. Partial Acceptance: Acceptance of partial areas or portions of the total work may be granted, at the Owner's option, if the area to be inspected is large, well-defined, and easily described. The Owner and Owner's Representative are not obliged to provide partial acceptance of the work.

C. Turf installations shall meet the following criteria as determined by Owner's Representative:
1. Satisfactory Seeded Turf: At end of the one-year warranty period, a healthy, uniform, close stand of grass has been established, free of weeds, undesirable grass species, disease, insects and surface irregularities. For the purpose of establishing an acceptable standard for seeded areas, scattered bare spots not larger than one square foot will be permitted up to a maximum of three percent of any lawn area. At least 90 percent of the grass established shall be permanent grass species.

D. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.11 GRASSES AND WILDFLOWERS SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds five miles per hour. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.
   2. All existing vegetation shall be removed and weeds killed prior to seeding.

B. Sow seed at rate specified by seed supplier as per individual Grasses and Wildflowers mixes.

C. Seeding requires a well-tilled, finely graded surface. The brillion seeders heavy cast iron packing wheels should ensure firm seed to soil contact. The optimum seeding time is from May to June to provide more time for soil preparation and to optimize germination of warm season grasses.

D. Three to four weeks prior to top seeding, mix seed with an equal volume of moist (not wet) sawdust and refrigerate at 34 to 38 degrees Fahrenheit (do not freeze). Seed shall not dry out and shall be planted immediately after moist stratification.

E. Seed all areas as defined on the Drawings with a brillion, double-box agricultural seeder that is equipped with native grass bristle brushes in the larger front box rather than the standard steel wire agitators. Brush seed into top 1/16 inch of soil, roll lightly, and water with fine spray.

F. Protect seeded areas from hot, dry weather or drying winds by applying weed free straw, such as winter wheat or salt marsh hay mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of one inch and roll surface smooth. Do not apply any hydroseeding or hydromulch with tackifier to any Grasses and Wildflowers seeding without Landscape Architect acceptance of method and product(s).

G. Water newly planted areas and keep moist until Grasses and Wildflowers is established.

3.12 GRASSES AND WILDFLOWERS MAINTENANCE

A. Maintain and establish Grasses and Wildflowers by watering, weeding, mowing, trimming, replanting, and performing other operations to establish a healthy, viable Grasses and Wildflowers over two years of maintenance activities. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
   1. Weed control during the first year is essential.
   2. Fill in soil subsidence that may occur because of settling or other processes. Replace materials and Grasses and Wildflowers damaged or lost in areas of subsidence.
   3. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor to prevent displacement.
   4. During the first growing season, mow the entire area back to six-inches each time the seeded/plugged areas reach a height of 12-inches to 16-inches; typically, three-times during the first growing season. Use a flail mower, rotary mower or sickle bar mower. Be sure to mow before any weeds have set seed. Do not pull weeds during the first year.
   5. In the fall of the first growing season, leave the dead vegetation and stubble standing to help insulate the seedlings and reduce winter frost heaving.
   6. In the early spring of the second growing season, mow and rake all seeded areas to the ground. If biannual weeds are present, mow again at approximately 12-inches when the majority of the biannual weeds are in full flower, typically mid-June. Make sure to mow before they set seed.
   7. Apply treatments allowed by conservation regulations to keep Grasses and Wildflowers and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
   8. Fertilizer is typically not required or preferred in the Grasses and Wildflowers areas after establishment.

B. Watering: Install and maintain temporary piping, hoses, and Grasses and Wildflowers-watering equipment to convey water from sources and to keep Grasses and Wildflowers uniformly moist.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out a temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water seeded Grasses and Wildflowers areas two to three times a week for the first four weeks after planting unless rainfall precipitation is adequate. Continue to water one to two times per week through the first growing season. Thorough soakings are better than light sprinklings to encourage deep root growth.
   3. Water plugged Grasses and Wildflowers areas two to three times a week for the first six weeks after planting unless rainfall precipitation is adequate. Continue to water one to two times per week through the first growing season. Thorough soakings are better than light sprinklings to encourage deep root growth.
   4. One day of heavy rain can compensate for one time of watering.
   5. Once plants are established in the second season, watering is typically not required in the Grasses and Wildflowers areas.

3.13 SATISFACTORY GRASSES AND WILDFLOWERS GRASS

A. Request for Acceptance: In writing, request Owner's Representative observation for acceptance at least 10 days in advance of preferred acceptance date. Do not request observation for acceptance until work is 100 percent complete (not including maintenance) and in compliance with Contract requirements.

B. Partial Acceptance: Acceptance of partial areas or portions of the total work may be granted, at the Owner's option, if the area to be inspected is large, well-defined, and easily described. The Owner and Owner's Representative are not obliged to provide partial acceptance of the work.

C. Grasses and Wildflowers installations shall meet the following criteria as determined by Owner's Representative:
   1. Satisfactory Seeded Grasses and Wildflowers: At end of the two-year maintenance period, a healthy, uniform, close stand of Grasses and Wildflowers grass has been established, free of weeds, undesirable grass species, disease, insects and surface irregularities. For the purpose of establishing an acceptable standard for seeded areas, scattered bare spots not larger than one square foot in maximum dimension, with not more than one bare spot for each one square yard of Grasses and Wildflowers area.
   2. Satisfactory Plugged Grasses and Wildflowers: At end of the two-year maintenance period, a healthy, uniform, close stand of Grasses and Wildflowers grass has been established, free of weeds, undesirable grass species, disease, insects and surface irregularities. For the purpose of establishing an acceptable standard for seeded areas, scattered bare spots not larger than one square foot in maximum dimension, with not more than one bare spot for each one square yard of Grasses and Wildflowers area.

D. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.14 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.15 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs to protect newly planted areas from traffic. Maintain fencing and barricades throughout the initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION

SECTION 32 93 00
PLANTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes providing all labor, equipment, materials, incidental work and construction methods required to perform all planting installation and related items as indicated on the Contract Documents and/or as specified herein, and includes, but is not limited to, the following:
   1. Planting trees, shrubs, groundcover, bulbs and perennials.
   2. Planting soils.
   3. Tree stabilization.
   4. Landscape edgings.
   5. Existing tree pruning.
   6. Existing tree transplanting.
   7. Erosion-control material(s).
   8. Maintenance.

B. Related Sections:
   1. Section 01 56 39 "TEMPORARY TREE AND PLANT PROTECTION" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
   2. Section 31 10 00 "SITE CLEARING" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
   3. Section 31 13 00 “SELECTIVE TREE REMOVAL AND TRIMMING” for pruning of existing trees and inspections by Certified Arborist.
   4. Section 31 00 00 "EARTH MOVING” for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   5. Section 31 25 00 “EROSION AND SEDIMENTATION CONTROLS” for earthwork stockpiles, cut and fill slopes, constructed and existing swales and ditches, and unestablished lawn and seeded embankments.
   6. Section 32 33 00 "SITE FURNISHINGS" for exterior unit planters.
   7. Section 32 84 00 “IRRIGATION” for irrigation at the multiuse athletic field.
   8. Section 32 90 00 “UNDERDRAIN SYSTEM” for underdrains at the multiuse athletic field and playgrounds as released in Early Release Package 1 (ERP1).
   9. Section 32 91 31 "ATHLETIC FIELDS" for multi-use turf (seed and sod lawn) planting, hydroseeding.
   10. Section 32 92 00 "TURF AND GRASSES" for turf (lawn), grass and wildflowers planting, hydroseeding, and erosion-control materials.
   11. Section 33 41 00 “STORM UTILITY DRAINAGE PIPING” for below-grade drainage of landscaped areas, paved areas, and wall perimeters.

1.03 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.
E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
H. Finish Grade: Elevation of finished surface of planting soil.
I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
K. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
L. Planting Area: Areas to be planted.
M. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
O. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
P. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
Q. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
R. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
S. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.
   1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
   2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.

3. Plant Photographs: Include color photographs in a digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting the true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

B. Samples for Verification: For each of the following:
   1. Trees and Shrubs: Plant material certificates of inspection by government authorities. Vendor/ grower certification of plants, identifying the zone of origin that the plants were grown in.
   2. Organic Mulch: One quart volume of each organic mulch required, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
   3. Erosion Control Matting: Submit one copy of manufacturer's literature and one material sample.
   4. Antidessiccant: Submit manufacturer's product data.
   5. Mycorrhizal Fungal Inoculant: Submit manufacture's product data certifying that inoculant being supplied conforms to these Specifications. Submit the purchasing receipt showing the total quantity purchased for the Project prior to installation. Submit empty packets of fungal spore inoculant to the Owner's Representative for verification of use.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit proof of qualified landscape Installer to the Owner's Representative in accordance with QUALITY ASSURANCE paragraph of this Section. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

B. Product Certificates: At least 30 days prior to ordering materials, the General Contractor shall submit to the Owner's Representative samples, certifications, manufacturer's product data and certified test results for materials specified below. No materials shall be ordered or delivered until the required submittals have been reviewed and accepted by the Owner's Representative. Delivered materials shall closely match the accepted samples. Acceptance shall not constitute final acceptance. The Owner's Representative reserves the right to reject, on or after delivery, any materials that do not meet these Specifications:
   1. Fertilizer: Submit product literature of seeding fertilizer and certificates showing composition and analysis.
   2. Soil Additives: Submit product literature on all soil additives to be used on site.
   3. Manufacturer's certified analysis of standard products.
   4. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

C. Material Test Reports: For sampling and testing of Loam Borrow from Off-Site Sources and from On-Site Sources shall be as specified in QUALITY ASSURANCE paragraph of this Section.

D. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Three years' experience in landscape installation of similar quality, schedule requirement and construction detailing.
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time foreman or crew leader on Project site when work is in progress.
4. Personnel Certifications: Installer's foreman or crew leader shall be either a certified landscape professional or a certified horticulturalist:
   a. Landscape professional shall be a Massachusetts Certified Landscape Professional currently certified by the Associated Landscape Contractors of Massachusetts.
   b. Horticulturalist shall be a Massachusetts Certified Horticulturalist as currently certified by the Massachusetts Nursery and Landscape Association.
   c. Certified Ornamental Landscape Professional, designated COLP.
5. Pesticide Applicator: State of Massachusetts licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; buffer pH, soluble salts, and mineral and plant-nutrient content of the soil.
   1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
   2. The soil testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Owner's Representative. A minimum of twelve representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
   3. Report suitability of tested soil for plant growth.
      a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
      b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Plants: Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1 "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position. Provide legibly tagged, healthy, vigorous stock, grown in a recognized nursery in accordance with good horticultural practices and free of disease, insect, eggs, larvae and defects such as knots, sunscald, injuries, abrasions or disfigurement.
   1. Plant names indicated with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee on Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged. Plants not legibly tagged will be rejected.
   2. Do not make substitutions. If specified landscape materials are not obtainable, submit proof of non-availability to the Owner's Representative, together with a proposal for use of an

equivalent material. Substitutions or changes on the plant species will not be permitted without prior written acceptance by the Owner's Representative.

E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
   1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements six inches above the root flare for trees up to four-inch caliper size, and 12 inches above the root flare for larger sizes.
   2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

F. Plant Material Observation: Plant material shall be inspected according to State and Federal Laws. Notify the Owner's Representative to perform an inspection of plant materials prior to commencing planting operations. Owner's Representative may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Owner's Representative retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
   1. Notify Owner's Representative of sources of planting materials seven days in advance of delivery to site.

G. Allow Owner's representative option of travelling to Grower's facility to select plant materials from available stock.

H. Allow four weeks, after receipt of list of growers, to finish tagging plant materials.

I. Trees dug prior to tagging by Owner's Representative are subject to rejection.

J. Owner's Representative will confirm the plant materials satisfy the requirements of ANSI Z60.1 and all special conditions stated in Project Specifications and Drawings.

K. Unacceptable plant materials will not be tagged and a different Grower shall be selected by Installation Contractor at no expense to the Owner. A second tagging trip will then be scheduled.

L. Decision by Owner's Representative to forgo tagging trip does not release Installation Contractor from responsibility of obtaining plant materials which meet the standards and conditions stated on the Project Specifications and Drawings.

M. Pre-Construction Walk: Conduct pre-construction site walk at the Project site at a day and time specified by the Owner's Representative.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Fertilizer and Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable at time of first use. Any packaged materials that become caked or otherwise damaged will not be acceptable.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Bare Root Stock: Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

D. Plants: Provide freshly dug plants. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Spray plants with antidessicant and provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Digging and moving of plant materials: Plants required to balled and burlapped (B&B) shall be dug and moved with compact balls of soil encompassing the root system, firmly wrapped with burlap and laced with nursery twine or wire basket. Each root ball should be of sufficient width and depth to encompass the fibrous and feeding roots necessary to ensure the full recovery and development of the plant. Plants having a cracked or broken ball of soil will not be acceptable. All plants, from the time they are dug until they are planted, shall be kept shaded and otherwise protected. After digging, transport the plants immediately to the packing sheds or other cover. Adequately water both the foliage and the ball. Handle planting stock by root ball.

F. Take all precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Summer dug materials will not be accepted. Spring (dormant) dug materials that are shipped “in-leaf” shall be sprayed with antidessicant. Dig, pack, transport and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice order, and upon arrival the certificate shall be filed with the Owner’s Representative. Water to maintain root systems to a moist condition. Handling procedures not conforming to these specifications shall result in rejection of plant material and Installation Contractor shall remove plants from site and provide replacements.

G. Store bulbs, corms, and tubers in a dry place at 60 to 65 degrees Fahrenheit until planting.

H. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist. The planting program shall be arranged that an excessive number of unplanted plants as determined by the Owner’s Representative are not stored on the site.

1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
2. Set balled stock and container grown plants on ground and cover ball with soil, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water to maintain root systems in a moist, but not overly wet condition.
5. All plants that are being stored shall be kept adequately watered at all times.

1.08 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Owner’s Representative no fewer than two days in advance of proposed interruption of each service or utility.

2. Do not proceed with interruption of services or utilities without Owner's Representative written permission.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: April 1 through June 30.
   2. Fall Planting: August 15 through November 15.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements. Plant frost tender trees and shrubs only after the danger of frost is past or sufficiently before frost season to allow for establishment before the first frost. Do not plant in frozen ground.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
   1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

F. Existing Tree Pruning:
   1. Prior to the pruning of any existing trees on the Project site, the General Contractor shall retain the services of a Massachusetts Certified Arborist (MCA) to identify the tree species and evaluate the health, vigor and public safety aspects of the trees identified by the Owner's Representative to receive pruning. Upon the completion of the site visit, the Massachusetts Certified Arborist shall submit an Arborist Report detailing the pruning and management aspects that are required for the identified trees.
   2. Only upon acceptance of the Arborist Report by the Owner's Representative, the pruning of existing tree materials shall be done with Owner's permission and in the presence of the Owner's Representative.

1.09 WARRANTY

A. Warranty: Provide written warranty agreeing to remove and replace work that exhibits defects in materials or workmanship for the specified periods. "Defects" is defined to include but is not limited to; death, unsatisfactory growth, disease, abnormal foliage density, abnormal size, abnormal color, failure to thrive and other unsatisfactory characteristics.

B. Replacement: Replace each defective plant or work with same species, size, character, and quality of originally accepted work. With each replacement plant or material, provide a new one-year warranty for the replacement work. If a replacement is unacceptable during its one-year warranty, the General Contractor shall provide another replacement or, when accepted by Owner, equivalent cash payment.

C. Replacement Planting Season: Planting and reseeding for replacement and warranty work shall comply with the planting season contained herein.

D. Owner's Responsibilities and Warranty Exclusions: After completion of the General Contractor's maintenance responsibilities, the Owner is responsible for maintaining the work in reasonable compliance with the General Contractor's maintenance instructions. The Installation Contractor's warranty shall exclude problems due to improper or inadequate maintenance after the maintenance period or vandalism.

E. General Contractor Responsibilities: During the warranty period the General Contractor shall visit the site at one-month intervals to review the conditions of the accepted work. The General Contractor shall submit in writing his/her concerns regarding the Owner's maintenance practices and/or any vandalism. The Owner shall make reasonable efforts to correct the problems cited by the General Contractor, but the Owner shall not be held responsible for the

Installation Contractor's defects in materials or workmanship that result in decline or death to plants and lawns.

F. Warranty shall not include damage or loss of trees and shrubs caused by fires, floods, freezing rains, lightning storms, winds over 75 miles per hour, winter kill caused by extreme cold, severe winter conditions not typical of planting area, and acts of vandalism, or negligence on the part of the owner.

G. Failure of the General Contractor to make the required monthly review of the site during the warranty period and submit written notice to the Owner of maintenance defects shall negate the General Contractor's ability to make claim against the Owner for negligence of maintenance.

H. Warranty Period for Trees, and Shrubs: One Year from date of final acceptance.

I. Warranty Period for Perennials and Ground Covers: One Year from date of final acceptance.

1.10 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees, and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as indicated in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 60 days from date of final acceptance of trees, and shrubs.

B. Initial Maintenance Service for Perennials, Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as indicated in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: 60 days from date of final acceptance of perennials, ground covers and other plants.

PART 2 PRODUCTS

2.01 PLANT MATERIAL

A. Plants: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1 and the "Standardized Plant Names" by the American Joint Committee on Horticultural Nomenclature. Botanical names take precedence over common names. Plant materials shall be nursery grown, true to the names indicated on the Contract Documents and in accordance with the names adopted by the American Joint Committee on Horticultural Nomenclature. No substitutions shall be permitted, without written acceptance by the Owner's Representative. Plant Materials shall be:

1. Hardy under climactic conditions similar to those in the locality of the Project. Only plant stock grown within Hardiness Zones 1 through 6b, as established by the USDA Plant Hardiness Zone Map, latest edition, will be accepted.
2. Plant materials shall be typical of the species or variety with normal, densely developed branches and vigorous, fibrous root systems densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
3. All plants shall have fully developed form without voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.
4. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
5. If at any time during the performance of the Contract, any plant shows signs of graft incompatibility, as determined by Owner's Representative, then the tree and shrub and all

similarity grafted plants of the same Genus/Species/Variety shall be rejected and removed from the site. Visual symptoms of graft incompatibility as cause for rejection include; development of over-growths by rootstock or scion resulting in the development of shoulders or inverted shoulders, suckering of the rootstock combined with poor growth or dieback of scion, any mechanical weakness between scion and rootstock, and marked difference in bark pattern and structure between scion and rootstock.

6. Pruning wounds and damage from handling with a diameter of more than one inch will not be acceptable. Smaller wounds shall show a vigorous growth of bark on all edges.
7. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated or accepted by the Owner's Representative.

B. Quality: Provide tree and shrub size, genus, species and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock".

C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Owner's Representative. If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.

D. Plant Measurements: Plants shall meet the requirements for spread and height indicated in the Plant Schedule. The measurement for height shall be taken from the crown of the roots to the average height of the top branches of the plant, and not the tallest leader. Poorly stemmed or thin plants will not be accepted. Side branches shall be generous, well twigged and evergreen plants shall be well bushed to the ground. Plants shall be in a moist, vigorous condition, free from deadwood, bruises, or other root or branch injuries. Take caliper measurements for deciduous trees six inches above the ground level up to and including four inches caliper size, and 12 inches above the ground for larger sizes.

E. Deciduous Trees: Provide trees of height and caliper as indicated in the Plant Schedule, single stemmed with straight trunk, well-branched crown and intact single leader, with branching height 1/3 to 1/2 of tree height and with branching configuration recommended by ANSI Z60.1 for type of species required. Multiple leaders shall conform to all standards noted above and in this Section. Shade trees shall have no branching lower than 6.5 feet from finished grade. Flowering trees for use in areas away from pedestrian traffic shall have the first branch of their crowns be no higher than four feet from finished grade. All deciduous trees shall be balled and burlapped (B&B)

F. Evergreen Trees: Provide trees of height as indicated in the Plant Schedule, measured from the trunk flair at the natural ground line of the tree to the midpoint of the terminal leader, single stemmed with no double leaders or twin heads permitted, well-branched to the ground and with branching configuration recommended by ANSI Z60.1 for type of species required. Terminal and top whorl buds of evergreen trees shall be in healthy and whole condition at time of harvest. No evergreen tree shall be pruned after the Owner's Representative or General Contractor has tagged the tree in the nursery. All trees shall have healthy, vigorous needles of normal size, color, shape, texture for the particular species and variety. All evergreen trees shall be balled and burlapped (B&B)

G. Shrubs: Provide plants of the height or spread as indicated in the Plant Schedule, and with not less than the minimum number of canes required by ANSI Z60.1 for type and height of shrub required. Container grown stock shall be grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole. Not plants shall be loose in the container. Container stock shall not be pot bound. Canes, trunk(s) and branches shall be well formed, branching uniformly distributed close to ground. Scars shall be free of rot

and not exceed 1/4 the diameter of the wood beneath in greatest dimension unless completely healed, except pruning scars. Shrubs shall show no signs of frost or winter damage to the foliage. Foliage shall not be in a state of drought stress. Leaves or needles shall show no signs of wilt or desiccation due to weather stress at any season of the year. All shrubs shall be container grown (Cont.).

H. Ground Cover: Provide plants of the size, pot size, age and condition as indicated in the Plant Schedule, and with not less than the minimum number of canes, runners, eyes, or fans required by ANSI Z60.1 for the type and size of ground cover required.

I. Perennials: Provide plants of the size, pot size, age and condition as indicated in the Plant Schedule, and with not less than the minimum number of runners, eyes, or fans required by ANSI Z60.1 for the type and size of perennials required.

J. Root-Ball: All ball and burlapped plants to have firm, natural balls of earth, of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Cracked or mushroomed balls are not acceptable. Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible, and all girdling roots removed before planting. All container grown plants shall have an extensive, symmetrically balanced fibrous root system without curling or spiraling of the roots along the walls of rigid containers. All parts of the fibrous root system for balled and burlapped and container grown plants shall be moist and fresh with a white color when washed of soil. The root systems of all plants shall be free of disease, insect pests, eggs or larvae.

K. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

L. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

M. Perennials, Ground Covers and Other Plants: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. All parts of the fibrous root system for balled and burlapped and container grown plants shall be moist and fresh with a white color when washed of soil. The root systems of all plants shall be free of disease, insect pests, eggs or larvae. Provide only plants that are acclimated to outdoor conditions before delivery.

2.02 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
2. Provide lime in form of ground dolomitic limestone.

2.03 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 6.5 to 8.0; moisture content 35 to 55 percent by weight; 100 percent passing through 3/8 inch or smaller sieve; soluble salt content of five to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 40 percent dry weight.
2. Nutrient Content: The material shall contain some nitrogen, phosphorous, potassium, calcium, magnesium, sodium and micronutrients including iron, copper, boron, manganese and molybdenum so that heavy application of fertilizers is not required to sustain plant

growth. Also, the nutrients shall be present in appropriate agricultural and horticultural proportions to prevent ion antagonism.

3. Heavy Metals: Concentrations of zinc, mercury, cadmium, lead, nickel, chromium, and copper shall be below EPA and State of Massachusetts standards for applications to soils with human activity.
4. Pesticide Residue: Composted organic materials shall not contain any pesticide residues of any kind.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.04 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of four percent nitrogen and 23 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers that bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients recommended and shall be adjusted per the soil analysis.

1. Composition: one pound per 1000 square feet of actual nitrogen, four percent phosphorous, and two percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers that bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients as recommended by the soil analysis.

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

E. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

2.05 PLANTING SOILS

A. Planting Soil for Trees, Shrubs, Ground Covers, and Perennials: ASTM D 5268 topsoil, screened, sandy loam that is fertile, friable natural loam free from subsoil, clay, brush, litter, roots, stones 3/4 inch or larger and any other foreign materials harmful to plant growth. Loam shall have an acidity range of pH 5.8 to 7.0 and shall contain not less than four percent or more than six percent organic material content as determined by the loss of ignition (LOI) of samples which have been oven-dried to a constant weight at a temperature of 221 degrees Fahrenheit (105 degrees Celsius).

1. Mix ASTM D 5268 topsoil with the following soil amendments in the following quantities to produce planting soil:
   a. Ratio of soil mixture compositions shall be one part topsoil as specified above, one-part organic matter, and one-part native soil mixed prior to planting installation.

1) If native soil cannot be stockpiled on site for reuse, a soil mixture matching the existing soil profile present on site prior to disturbance, stockpiling or removal shall be used. See Specification Section 31 10 00 SITE CLEARING for requirements of native soil testing.

b. Weight of Lime per 1000 square feet: 200 pounds maximum limit.
c. Weight of Bonemeal per 1000 square feet: as per soil analysis.
d. Weight of Superphosphate per 1000 square feet: 20 pounds or as specified by soil analysis.
e. Weight of Commercial Fertilizer per 1000 square feet: as per soil analysis.
f. Weight of Slow-Release Fertilizer per 1000 square feet: as per soil analysis.

B. Planting Soil for Naturalized Areas: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Soil shall consist of one to two percent organic matter with a blend of sand, silt, and minimal clay (dry sandy loam), consist of well-sorted particles less than one inch diameter with continuous pore space and have a pH range from 5.8 to 7.0. Soil shall be free from subsoil, clay, brush, litter, roots, stones 3/4 inches or larger and any other foreign materials harmful to plant growth.

1. Supplement with trees, shrubs, perennials and ground covers planting soil when quantities are insufficient.
2. Mix existing, native surface topsoil with the following soil amendments and fertilizers in the following quantities to produce planting soil:
   a. Ratio of soil mixture compositions shall be one part topsoil as specified above, one-part organic matter, and one-part native soil mixed prior to planting installation.
   b. Weight of Lime per 1000 square feet: 200 pounds maximum limit.
   c. Weight of Bonemeal per 1000 square feet: as per soil analysis.
   d. Weight of Superphosphate per 1000 square feet: 20 pounds or as per soil analysis.
   e. Weight of Slow-Release Fertilizer per 1000 square feet: as per soil analysis.

2.06 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded and aged pine bark mulch; aged a minimum of six months. The mulch shall be dark brown in color, between 1/2 inch and 2 1/2 inches in any direction, free from chunks and pieces thicker than 1/4 inch. Mulch shall be free of stringy material, viable, noxious weed seeds and insect life, and shall not contain, in the judgment of the Owner's Representative, an excess of fine particles.
2. Size Range: 2 1/2 inch maximum, 1/2 inch minimum.
3. Color: Natural, Dark Brown.

2.07 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.08 TREE STABILIZATION MATERIALS

A. Stakes and Web Guys (ArborTie®):

1. Upright and Web Guy Stakes: Rough-sawn, sound, new cedar posts, free of knots, holes, cross grain, and other defects, two-by-two-inch nominal by ten-foot length, pointed at one end; three stakes per tree. The top four inches of all stakes shall be taped with WHITE duct tape or painted for identification purposes.
2. Web Guys and Ties: Shall be ArborTie or approved equal, a flat woven polypropylene material; 3/4-inch wide. ArborTie is a product from Deep Root Partners, L.P.; 1-800-458-7668 or fax 1-800-277-7668.
3. Guying material shall be secured by loosely connecting the ArborTie or equivalent around the central leader of tree.
4. Staking systems that are not taped or are improperly anchored will be considered incomplete and will not be paid for.
5. Plant locations in park areas to incorporate tree protection guards at the base of the tree. Guards are to be ARBORGARD+ tree trunk protectors or approved equal. ARBORGARD+ is a product of Deep Root Partners, L.P.; (800) 458-7668 or fax (800) 277-7668.

2.09 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include Manufacturer's recommended steel wire staples, six inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 pounds per square yard, with 50 to 65 percent open area. Include Manufacturer's recommended steel wire staples, six inches long.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. North American Green, 5401 St. Wendel-Cynthiana Road, Poseyville, IN 47633, Telephone: 800.772.2040; Website: www.nagreen.com; BioNet Biodegradable Erosion Control Blankets; Short-Term.
   b. North American Green, 5401 St. Wendel-Cynthiana Road, Poseyville, IN 47633, Telephone: 800.772.2040; Website: www.nagreen.com; BioNet Biodegradable Erosion Control Blankets; Extended-Term.

2.10 MISCELLANEOUS PRODUCTS

A. Mycorrhizal Fungi:

1. Dry, granular inoculant containing at least 5300 spores per pound of vesicular-arbuscular mycorrhizal fungi and 95 million spores per pound of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

B. Slow-Release Watering Bag (Treegator Bag®):

1. 20-gallon bag to be constructed out of UV-treated polyethylene and reinforced with nylon webbing. Sides are to be made watertight with durable 1/4-inch-thick heat seals.
2. Bag is to be secured to the tree with heavy-duty nylon zippers, sewn on to each side.
3. Two water release holes at the bottom of each corner, designed to achieve five to nine-hour release rate.
4. Plant locations throughout site to incorporate Treegator Bags or approved equal. Treegator Bag is a product of Treegator Slow-Release Watering Bag; (866) 873-3428 or fax (919) 556-9852, or approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that the finished grades in the planting areas have been established before starting the planting operation.
3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
4. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
5. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination and replace with new planting soil.

3.02 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways. Protect planting areas with slopes exceeding 3:1 with erosion control blankets or erosion control fiber mesh, installed and stapled / anchored according to manufacturer's written instructions.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner’s Representative's acceptance of layout before excavating or planting. Make minor adjustments.

1. The locations shall be as shown on the Drawings unless otherwise indicated. However, due to underground obstructions or for other reasons, it may be necessary to modify the plant locations, subject to review by the Owner’s Representative before the relocation.
2. The Owner’s Representative reserves the right to interchange the plants or to shift the plant locations if it is possible in his/her judgment to procure a better effect by the changes.

D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.03 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 18 inches. Remove stones larger than 1 1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply soil amendments and /or fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil off-site before spreading.
3. Spread planting soil in two equal lifts to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
    a. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top four inches of subgrade. Spread remainder of planting soil.

B. Remediation of Compacted or Poorly Drained Subsoil in Planted Areas: If the soils are deemed to be compacted or poorly draining, the General Contractor shall remedy the condition prior to proceeding with further work. Remove any vegetative growth on the surface of the work area. Remove any extraneous materials. Loosen subgrade with a backhoe bucket to a depth of 18

inches. After gathering subsoil in the bucket, drop soil onto the ground from a height of six feet to break up the soil clumps. Position backhoe during work to prevent re-compaction of soils beginning the work in corners or against walls, or the center of isolated beds, and progressing outward towards the border's edge. After subgrade has been broken up, rototill entire area to a depth of six inches. Heavy clay soils shall be amended with organic material.

C. Finish Grading: Set sufficient grade stakes for checking finished grades. Stakes shall be set at the top and bottom of slopes. Grades shall be established which are accurate to 1/10th of a foot either way. Grade planting areas to a smooth, uniform surface plane with loose uniformly fine texture. Grade to within plus or minus 1/4 inch of finish elevation. Limit finish grading to areas that can be planted in the immediate future

D. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

E. Application of Mycorrhizal Fungi: Broadcast dry product uniformly over prepared soil at application rate indicated by product manufacturer.

3.04 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected overnight or after working hours.
8. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Subsoil and topsoil removed from excavations may be used as planting soil upon acceptance by Owner's Representative.

C. Obstructions: Notify Owner's Representative if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill six-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Owner's Representative if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow percolating before positioning trees and shrubs.

3.05 TREE AND SHRUB

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare set at such a level that after settlement, they will remain at their natural grade elevation in proper relationship to the finished grade.
   1. Use planting soil for backfill.
   2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Add 10-10-10 fertilizer to the surface of the soil ring under the mulch at a rate of one pound per caliper inch of trees and one pound per square yard of plant bed unless otherwise directed.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil. Thoroughly water all plants within 24 hours after they have been planted.
   6. Create shallow watering basins around all trees and shrubs as detailed to retain and conserve moisture. Maintain the basins until the plants have established themselves or until instructed by the Owner's Representative to remove them.

D. Set container grown stock plumb and in center of planting pit or trench with root flare at such a level that after settlement, they will remain at their natural grade elevation in proper relationship to the finished grade.
   1. Use planting soil for backfill.
   2. Carefully remove root ball from container without damaging root ball or plant.
   3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
   4. Add 10-10-10 fertilizer to the surface of the soil ring under the mulch at a rate of one pound per caliper inch of trees and one pound per square yard of plant bed unless otherwise directed.
   5. Continue backfilling process. Water again after placing and tamping final layer of soil. Thoroughly water all plants within 24 hours after they have been planted.
   6. Create shallow watering basins around all trees and shrubs as detailed to retain and conserve moisture. Maintain the basins until the plants have established themselves or until instructed by the Owner's Representative to remove them.

E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
   1. Protect planted areas with slopes exceeding 3:1 with biodegradable erosion control blankets or erosion control fiber mesh, installed and stapled / anchored according to Manufacturer's written instructions.

3.06 TREE AND SHRUB PRUNING

A. Remove only dead, dying, split or broken branches. Do not prune for shape.

B. Do not prune the terminal leaders of the trees. On multiple leader plants, preserve the leader best promoting the symmetry of the plant. Prune branches at a point beyond a lateral bud, or a distance of not less than 1/2 the diameter of the supporting branch.

C. At the discretion of the Owner's Representative, remove 1/3 of the length of all candles on evergreen plants.
D. Prune, thin, and shape trees, and shrubs according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Owner's Representative, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character. Do not remove more than 10 percent of the foliage on any individual specimen and only after acceptance by the Owner's Representative.
E. All cuts shall be cleanly made with sharp tools as close to the parent trunk or limb as possible. Do not apply pruning paint to wounds.

3.07 TREE STABILIZATION

A. Trees in lawn areas, and in grass strips and in pits with grates shall not be staked and guyed. See Contract Documents for trees to be staked and guyed.
B. Install trunk stabilization immediately after trees have been planted as follows unless otherwise indicated. When high winds or other conditions that may affect tree survival or appearance occur, perform immediate staking.
C. Staking and Wire Guying:
    1. Drive the stakes and posts 120 degrees apart from each other to a minimum depth of three feet below grade in undisturbed earth and to a minimum of four feet below grade in areas of fill. Stakes to extend at least five feet above grade. Set stakes to avoid penetrating root balls or masses
    2. Use three stakes per tree. Space stakes equally around trees.
    3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
    4. Attach flags to each guy wire, 30 inches above grade.
    5. Staking and Guying Wire shall be removed by the General Contractor at the end of the warranty period.

3.08 EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Planting Area Establishment" Article.
B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.
C. Fill cells of erosion-control mat with planting soil and compact before planting.
D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.09 MISCELLANEOUS PRODUCTS

A. Slow-Release Watering Bag.
    1. Watering Bag shall be installed to manufacturer specifications.
    2. Each bag shall be filled according to manufacturer specifications at least one time per week.
    3. Bags are to be kept in working conditions and are to be replaced if missing or damaged for the extent of the establishment and guarantee periods.
    4. Bags to be removed by General Contractor at the end of the warranty period.

3.10 EXISTING TREE PRUNING

A. Pruning shall be done with Owner's permission and in the presence of the Owner's Representative in accordance with the Massachusetts Certified Arborist (MCA) Report and

workmanship requirements of “Pruning Standards” to preserve the natural character of the trees.

3.11 GROUND COVER AND PERENNIAL PLANTING

A. Set out and space ground cover and plants other than trees and shrubs as indicated on Drawings in even rows with triangular spacing.
B. Use planting soil for backfill.
C. Dig holes large enough to allow spreading of roots.
D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.
E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
G. Install and fill slow-release watering bag.
H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.12 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.
    1. Trees and Tree-like Shrubs in Turf Areas:
        a. Apply organic mulch ring of two-inch average thickness, with canopy drip-line radius around trunks or stems. Do not place mulch within two inches of trunks or stems.
        b. Thoroughly water mulched area. Rake to provide a uniform finished surface. Treat plant areas with weed retardant in accordance with manufacturer’s instructions after all planting and mulching is complete.
    2. Organic Mulch in Planting Areas:
        a. Apply two-inch average thickness of organic mulch over whole surface of planting area and finish level with adjacent finish grades. Do not place mulch within two inches of trunks or stems.
        b. Thoroughly water mulched area. Rake to provide a uniform finished surface. Treat plant areas with weed retardant in accordance with manufacturer’s instructions after all planting and mulching is complete.

3.13 EDGING INSTALLATION

A. Shovel-Cut Edging: Separate mulched areas from turf areas with a 45-degree, four inch deep, shovel-cut edge as shown in Drawings.

3.14 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations to establish healthy, viable plantings. Spray or treat to keep trees and shrubs free of insects and disease.
B. Fill in soil subsidence that may occur because of settling or other processes. Restore planting saucer and adjacent material and remove dead material.
C. Replace mulch materials damaged or lost in areas of subsidence.
D. Tighten and repair wires and stakes.
E. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.
F. Apply treatments to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

G. Water trees, plants and seasonal planting beds within the first 24 hours of initial planting, and not less than twice per week until final acceptance. Monitor and fill slow-release watering bags. Coordinate watering by irrigation system with Owner's Representative.
H. Maintenance shall also include follow-up, at the end of the warranty period.
   1. Remove and renew wood mulch saucer.
   2. Remove stakes from trees.
   3. Remove slow-release watering bags from trees.
   4. Fertilize trees and shrubs.

3.15 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.
C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.16 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.
B. Protect plants from damage due to landscape operations and operations of other Site Contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
C. After installation and before mulching of planting beds, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.17 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 32 94 51
SOIL CELLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Soil Cell system for planting and paving, including Soil Cell assemblies and related accessories.
   2. Other materials including, but not limited to, geotextile, geogrid, aggregate, subbase material, backfill, root barrier, and planting soil.

B. Related Sections:
   1. Section 03 30 00.13 "CAST-IN-PLACE CONCRETE (SITE)" for cast-in-place concrete base under unit pavers and curbs that serve as edge restraints for paving as released in Early Release Package 2 (ERP2).
   2. Section 31 00 00 "EARTH MOVING" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
   3. Section 32 12 16 "ASPHALT | BITUMINOUS CONCRETE PAVING" for constructing joints between concrete and asphalt pavement.
   4. Section 32 13 13.13 “CONCRETE PAVING (SITE)” for concrete pavement and walks that edge the pavers as released in Early Release Package 2 (ERP2).
   5. Section 32 13 73 "CONCRETE PAVING JOINT SEALANTS" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt | bituminous concrete paving or adjacent construction as released in Early Release Package 2 (ERP2).
   6. Section 32 14 13 “UNIT PAVING ON BITUMEN SETTING BED” for precast concrete paving units.
   7. Section 32 93 00 "PLANTS" for tree plantings, and border edgings.
   8. Section 32 94 56 “PLANTING SOILS FOR SOIL CELLS” for planting soils.
   9. Section 33 40 00 “STORM DRAINAGE” for piping connections.

1.03 REFERENCES

A. The following Standards shall apply to the Work of this Section:
   1. AASHTO: American Association of State Highway and Transportation Officials, latest edition:
      H-20 Load Rating
   2. ASTM: American Society for testing and Materials, latest edition:
      Standard Classification for Sizes of Aggregate for Road and Bridge Construction; D448-12.
      Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 [600 kN-m/m^3]); D698-12e1.
      Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses; D1241-07.
      Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method; D3786/D3786M-13.
      Standard Test Methods for Water Permeability of Geotextiles by Permittivity; D4491-99a(2014)e1.
      Standard Test Method for Trapezoid Tearing Strength of Geotextiles; D4533-D4533M-15.

Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; D4632-D4632M-15.
Standard Test Method for Determining Apparent Opening Size of a Geotextile; D4751-12.
Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products; D4833/D4833M-07(2013)e1.
Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics; D5262-07(2012).
Standard Test Method for Static Puncture Strength of Geotextile and Geotextile-Related Products Using a 50mm Probe; D6241-14.
Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method; D6637-11.

1.04 DEFINITIONS

A. Aggregate Base Course: Aggregate material between the paving and the top of the Soil Cell deck below, designed to distribute loads across the top of the deck.
B. Aggregate Setting Bed for Pavers: Aggregate material between the aggregate base course and unit surface pavers, designed to act as a setting bed for the pavers.
C. Aggregate Subbase: Aggregate material between the bottom of the Soil Cell base and the compacted subgrade below, designed to distribute loads from the Soil Cell bases to the subgrade.
D. Backfill: The earth used to replace or the act of replacing earth in an excavation beside the Soil Cell system to the excavation extents.
E. Finish Grade: Elevation of finished surface of planting soil or paving.
F. Planting Soil: Soil as defined in Section 32 94 56 “PLANTING SOIL FOR SOIL CELLS”, intended to fill the Soil Cell system and other planting spaces.
G. Soil Cell System:
    1. Soil Cell: One assembled unit made up of one base, six post assemblies, and one Soil Cell deck.
    2. Soil Cell System: Two or more Soil Cells used in combination with each other and with required accessories.
H. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill.
I. Walk-through Compaction: A process for light compaction of soils by walking through the soil following placement.
    1. Walk through compaction shall result in 75-85-percent maximum dry density in accordance with ASTM D698, Standard Proctor Method. Do not exceed root limiting compaction for the given soil type.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Conference: Prior to installation of the Soil Cell system and associated Work, meet with the General Contractor, Soil Cell system installer and their field supervisor, manufacturer's technical representative, the Landscape Architect, the Owner at the Owner's discretion, and other entities concerned with the Soil Cell system performance.
    1. Provide at least 72-hours advance notice to participants prior to convening preinstallation conference.
    2. Introduce and provide a roster of individuals in attendance with contact information.
    3. The preinstallation conference agenda shall include, but is not limited to the review of:
        a. Required submittals both completed and yet to be completed.
        b. The sequence of installation and the construction schedule.
        c. Coordination with other trades.
        d. Details, materials, and methods of installation.

1) Review requirements for substrate conditions, special details, and if any, installation procedures.
2) Installation layout, procedures, means and methods.

e. Mock-up requirements.

B. Sequencing and Scheduling:
1. General: Prior to beginning Work of this Section, prepare a detailed schedule of the Work involved for coordination with other trades.
2. Schedule utility installations prior to beginning Work of this Section.
3. Where possible, schedule the installation of the Soil Cell system after the area is no longer required for use by other trades and Work. Where necessary to prevent damage, protect installed system if Work shall occur over or adjacent to the installed Soil Cell system.

1.06 SUBMITTALS

A. Refer to Section 01 30 00 “ADMINISTRATIVE REQUIREMENTS” for submittal definitions, requirements, and procedures. The following paragraphs supplement the requirements of Section 01 30 00.

B. Action Submittals: Submit these to the Landscape Architect for review and acceptance not less than 45 days prior to start of installation of materials and products specified in this Section.
1. Product Data: For each type of product, submit manufacturer's product literature with technical data sufficient to demonstrate that the product meets these specifications.
2. Test and Evaluation Reports:
a. Submit results of compaction testing required by the Specifications for acceptance.
b. Include analysis of bulk materials including soils and aggregates, by a recognized laboratory that demonstrates that the materials meet the Specification requirements.
3. Samples:
a. One full size sample of an assembled Soil Cell (copy of manufacturers brochure with images of product may be accepted in lieu of product sample).
b. Manufacturer's product data/specification sheet for geogrid.
c. Manufacturer's product data/specification sheet for geotextile.
4. Manufacturer's Report: Submit Soil Cell system manufacturer's letter of review and acceptance of the Project, including Drawings and Specifications, Addenda, Clarifications and Modifications, and for compliance with product installation requirements.
5. Qualification Statements:
a. Manufacturer:
1) Submit list of completed projects demonstrating durability and longevity of in-place systems.
(a) Include project name, location, and date of completion.
2) Submit list of third-party approval for stormwater management projects.
b. Installer:
1) Submit documentation of the qualifications of the Soil Cell system installer and their field supervisor, sufficient to demonstrate that both meet the requirements specified in Article 1.05 Quality Assurance.
2) Submit list of completed projects of similar scope and scale demonstrating capabilities and experience.

C. Closeout Submittals: Submit these to the Landscape Architect at completion of installation.
1. Warranty: Submit manufacturer's warranty, fully executed.

D. LEED
1. LEED Materials and Resources Credit 4, Recycled Materials: Submit letter from manufacturer certifying the products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
a. Include statement indicating costs for each product having recycled content.

2. LEED Materials and Resources Credit 5, Regional Materials: Submit letter from manufacturer certifying products having been extracted, harvested, or recovered, as well as manufactured within 500 miles of the project site.
   a. Include a statement indicating the percentage by weight which is extracted, harvested, or recovered within 500 miles of the project site.
3. Source Limitations: Obtain materials mined or manufactured in Massachusetts first and the United State of America second whenever possible.

1.07 QUALITY ASSURANCE

A. Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State and Municipal authorities having jurisdiction. Obtain necessary permits/approvals from these authorities.

B. Manufacturer Qualifications:
   1. A manufacturer whose product is manufactured in an ISO/TS 16949 compliant and ISO 9001 - 2008 registered factory.
   2. A manufacturer with not less than 100 Soil Cell systems in-place, in the United States. Each system is in use for not less than seven years, confirming durability and longevity of the system.
   3. A manufacturer with documented written approval of their product for use as a stormwater treatment device by a minimum of three governmental jurisdictions.
   4. A manufacturer with an established and demonstrated utility service and repair process, including written procedure and photographs demonstrating work.
   5. A manufacturer with a published operating and maintenance manual

C. Installer Qualifications: A qualified installer with not less than five years of successful experience installing Soil Cell systems or related products and materials, and whose work has resulted in successful installation of underground piping, chambers and vault structures, planting soils, and planter drainage systems of a similar scope and scale in dense urban areas.

D. Installer's Field Supervisor: A full-time supervisor employed by the installer with not less than five years of successful experience similar to that of the installer and present at the Project site when Work is in progress. Utilize the same field supervisor throughout the Project unless a substitution is submitted to and accepted in writing by the Landscape Architect.

E. Mock-Up: Prior to the installation of the Soil Cell system, construct a mock-up of the complete installation at the Project site in the presence of the Landscape Architect.
   1. Size and Extent: Minimum of 100-square feet (10-square meters) in area and including the complete Soil Cell system installation with subbase, aggregate subbase, drainage installation, Soil Cell decks, posts, and bases, base coarse aggregate, geotextile, geogrid, backfill, planting soil, and necessary accessories.
   2. The mock-up area may remain part of the installed Work at the end of the Project if it remains undamaged and meets the requirements of the Drawings and Specifications.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Soil Cell System: Protect Soil Cell system components from damage during delivery, storage, and handling.
   1. Store components on smooth surfaces, free from dirt, mud, and debris. Store under tarp to protect from sunlight when time from delivery to installation exceeds one week.
   2. Perform handling with equipment appropriate to the size (height) of Soil Cells and site conditions; equipment may include, hand, handcart, forklifts, extension lifts, or small cranes, with care given to minimize damage to Soil Cell bases, posts, decks, and adjacent assembled Soil Cells.

B. Packaged Materials: Deliver packaged materials in original, unopened containers indicating weight, certified analysis, name and address of manufacturer, and indication of conformance

with State and Federal laws, if applicable. Protect materials from deterioration during delivery and while on the Project site.

1. Do not deliver or place backfill, soil, or soil amendments in frozen, wet, or muddy conditions.
2. Provide protection including tarps, plastic and/or matting between bulk materials and finished surfaces sufficient to protect the finished material.
3. Bring planting soil to the site using equipment and methods that do not overly mix and further damage soil peds within the soil mix.

C. Provide erosion-control measures to prevent erosion or displacement of bulk materials and discharge of soil-bearing water runoff or airborne dust to adjacent properties, water conveyance systems, and walkways. Provide additional sediment control to retain excavated material, backfill, soil amendments and planting mix within the Project limits.

1.09 FIELD CONDITIONS

A. Existing Conditions: Do not proceed with Work when subgrades, soil and planting soils are in a wet, muddy, or frozen condition.

1.10 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the General Contractor under the requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty executed by the installer agreeing to repair or replace components of stabilized aggregate that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:

1. Premature wear and tear provided the material is maintained in accordance with manufacturer’s written maintenance instructions.
2. Failure of system to meet performance requirements.

1.11 LEED REQUIREMENTS

A. Add any specific requirements necessary for achieving desired credits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following, or approved equal:

1. DeepRoot Green Infrastructure, LLC; 101 Montgomery Street, Suite 2850; San Francisco, CA, 94104; Telephone: 415.781.9700; Toll Free: 800.458.7668; Fax: 415.781.0191; Website: www.deeproot.com.
2. Century Products; 1144 N. Grove Street, Anaheim, CA 92806; Telephone: 714.632.7083; Fax: 714.632.5470; E-mail: info@crbtools.com; Website: centruyrootbarrier.com.
3. Green Blue Urban, 2533 Hoitt Avenue, Knoxville, TN, 37917; Telephone: 866.282.2743; E-mail: inquiries@greenblue.com.

B. Any manufacturer's names and/or model numbers identified herein are intended to assist in establishing a general level of quality, configuration, functionality, and appearance required. This is not a proprietary specification, and it should be noted that "or equivalent" applies to all products denoted herein. It is understood that all manufacturers shall have minor variations in configuration, appearance, and product specifications and such minor variations shall not eliminate such manufacturers as an equivalent. It is the intent of this specification to encourage open and competitive involvement from multiple manufacturers that can supply similar products.

C. Other manufacturers' products accepted by the Awarding Authority as equal to the specified products in terms of construction, quality, durability, performance, and or appearance. Submit as substitutions: see Section 01 25 00 "SUBSTITUTION PROCEDURES".

2.02 DESCRIPTION

A. Basis-of-Design Product: The term Soil Cell shall be used to refer to a single Soil Cell.
B. Soil Cells shall be designed for the purpose of growing healthy trees and providing stormwater management.
C. Soil Cells shall be modular, structural systems.
D. Each Soil Cell shall be structurally independent from all adjacent Soil Cells for incorporating utilities and other site features as well as for future repairs.
E. Soil Cells shall be capable of supporting loads up to and including AASHTO H-20 (United States) or CSA-S6 87.5 kilonewtons (Canada) when used in conjunction with approved pavement profiles.
F. Soil Cells shall be open on all vertical faces and horizontal planes and shall have no interior walls or diaphragms.
G. Soil Cells shall be capable of providing a large, contiguous, continuous volume of planting soil that does not inhibit or prevent the following:
    1. Placement of planting soil
    2. Walk through compaction
    3. Compaction testing of planting soil, once in place
    4. Movement and growth of roots
    5. Movement of water within the provided soil volume, including lateral capillary movement
    6. Installation and maintenance of utilities placed within, adjacent to, or below the Soil Cell.
H. Soil Cells shall be able capable of being filled with a variety of soil types and soils that include peds two-inches (50 millimeters) or larger in diameter as is appropriate for the application, location of the installation, and tree species.

2.03 SOIL CELL MATERIALS AND ACCESSORIES

A. Soil Cell System Components: Each "Soil Cell" soil cell module (hereafter Soil Cell or "cell") is composed of one base, six post assemblies, and one deck.
    1. 2x Soil Cell System:
        a. Components: One base, six 2x Soul Cell posts, and one deck.
        b. Assembled Dimensions (Each Cell): 47.2-inches long by 23.6-inches wide by 30.9-inches high (1200 millimeters long by 600 millimeters wide by 784 millimeters high).
B. Soil Cell Materials and Fabrication:
    1. Bases and Posts: Homopolymer polypropylene.
    2. Decks: Fiberglass reinforced, chemically coupled, impact modified polypropylene.
C. Manufacturer's Related Soil Cell Installation Accessories:
    1. Strongbacks: An accessory designed to stabilize the Soil Cell posts temporarily, during soil placement, and removed for reuse prior to placing decks.
    2. Anchoring Spikes: 10-inch landscape spike for securing assembled Soil Cells to subbase.

2.04 RELATED PRODUCTS

A. Root Barrier: Recyclable, black, injection molded panels manufactured with a minimum 50 percent post-consumer recycled polypropylene plastic with UV inhibitors, and integrated zipper joining system which allows instant assembly by sliding one panel into another; for redirecting tree roots down and away from hardscapes.
    1. Panel Sizes:
        a. No. UB12-2: 24-inches long by 12-inches deep by 0.080-inches thick (61 centimeters long by 30 centimeters deep by 2.03 millimeters thick); for use with 1x systems and for pavement profiles less than 12-inches (30 centimeters) deep.

b. No. UB18-2: 24-inches long by 18-inches deep by 0.080 inches thick (61 centimeters long by 46 centimeters deep by 2.03 millimeters thick); for use with 2x and 3x systems, and for pavement profiles 12-inches or more in depth.

2. Products meeting this specification:
   a. DeepRoot Tree Root Barrier (DeepRoot Green Infrastructure, LLC)

B. Geogrid: Net-shaped woven polyester fabric with PVC coating, uniaxial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, and acids; used to provide a stabilizing force within soil structure as the fill interlocks with the grid.
   1. Tensile strength at ultimate (ASTM D6637):
      a. 1850-pounds per foot (27.0 kilonewton per meter) minimum
   2. Creep reduced strength (ASTM D5262):
      a. 1000-pounds per foot (14.6 kilonewton per meter) minimum
   3. Long term allowable design load (GRI GG-4):
      a. 950-pounds per foot (13.9 kilonewton per meter) minimum
   4. Grid aperture size (MD):
      a. 0.8-inch (20 millimeters) minimum
   5. Grid aperture size (CD):
      a. 1.28-inch (32 millimeters) maximum
   6. Roll size: Six-foot (1.8-meter) width is preferred, up to 18-foot (5.4-meter).
   7. Products meeting this specification:
      a. Stratagrid SG 150; http://www.geogrid.com
      b. Miragrid 2XT; http://www.tencate.com
      c. Fortrac 35 Geogrid; (http://www.hueskerinc.com
      d. SF 20 Biaxial Geogrid; http://www.synteen.com

C. Geotextile: composed of high tenacity polypropylene yarns which are woven into a network such that the yarns retain their relative position and is inert to biological degradation and resistant to naturally encountered chemicals, alkalis, and acids.
   1. Tensile strength at ultimate (ASTM D4595):
      a. 4800-pounds per foot (70.0 kilonewton per meter) MD minimum
      b. 4800-pounds per foot (70.0 kilonewton per meter) CD minimum
   2. Tensile strength at five percent strain (ASTM D4595)
      a. 2400-pounds per foot (35.0 kilonewton per meter) MD minimum
      b. 2700-pounds per foot (43.8 kilonewton per meter) CD minimum
   3. Flow rate (ASTM D4491):
      a. 30-gallon per minute per square foot (2648-liters per minute per square meter) minimum
   4. Apparent opening size (ASTM D4751):
      a. 30-sieve (0.60-millimeters)
   5. UV Resistance (at 500-hours):
      a. 80-percent strength retained
   6. Products meeting this specification:
      a. Mirafi HP570; http://www.tencate.com
      b. Geolon PP40; http://www.tencate.com
      c. Nilex Woven 2044 (Nilex); http://www.nilex.com

D. Plastic Cable Ties: A tensioning device or tool used to tie similar or different materials together with a specific degree of tension.

2.05 OTHER RELATED MATERIALS

A. Wood Blocking: Nominal dimensioned untreated lumber used for spacing assembled Soil Cells.

B. Drain and Distribution Pipes:
   1. Refer to Section 33 40 00 “STORM DRAINAGE”.
C. Aggregate Subbase (Below Soil Cell Base):
   1. Aggregate meeting one of the following specifications:
      a. Complying ASTM D1241, Type I, Gradation B; Type I mixtures shall consist of stone, gravel, or slag with natural or crushed sand and fine mineral particles passing a No. 200 sieve.

U.S. Sieve Size	Percent Passing
1-1/2 inches (37.5 mm)	100
1 inch (25 mm)	75 to 95
3/8 inch (9.5 mm)	40 to75
No 4 (4.75 mm)	30 to 60
No 10 (2.36 mm)	20 to 45
No 40 (.425 mm)	15 to 30
No 200 (.075 mm)	5 to 15

      b. Local Department of Transportation (DOT) virgin aggregate that most closely meets the gradation of ASTM D1241.
D. Aggregate Base Course (Above Soil Cell Deck):
   1. Same as aggregate subbase specified above.
E. Aggregate Base Course for Porous Pavement (Above Soil Cell Deck):
   1. Aggregate complying with ASTM D448, No. 57.

U.S. Sieve Size	Percent Passing
1-1/2 inches (37.5 mm)	100
1 inch (25 mm)	95 to 100
1/2 inch (12.5 mm)	25 to 60
No 4 (4.75 mm)	0 to 10
No 8 (2.36 mm)	0 to 5

F. Setting Bed for Unit Pavers (Above Soil Cell Deck):
   1. Aggregate complying with ASTM D448, No. 8.

U.S. Sieve Size	Percent Passing
1/2 inch (12.5 mm)	100
3/8 inch (9.5 mm)	85 to 100
No 4 (4.75 mm)	10 to 30
No 8 (2.36 mm)	0 to 10
No 16 (1.18 mm)	0 to 5

G. Backfill Material (Adjacent to Soil Cells): Clean, compactable, coarse grained fill soil free of organic material, trash, and other debris, and free of toxic material injurious to plant growth.
H. Planting Soil: Refer to Section 32 94 56 “PLANTING SOILS FOR SOIL CELLS”.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the conditions under which the Soil Cells are to be installed.
   1. Carefully check and verify dimensions, quantities, and grade elevations.
   2. Carefully examine the Drawings to become familiar with the existing underground conditions before digging. Verify the location of aboveground and underground utility lines, infrastructure, other improvements, and existing trees, shrubs, and plants to remain including their root system.

3. Notify the General Contractor and the Landscape Architect in writing in the event of conflict between existing and new improvements, of discrepancies, and other conditions detrimental to proper and timely completion of the installation.
4. Obtain written acceptance of changes to the Work prior to proceeding. Proceed with installation only after changes have been made and unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Take proper precautions to avoid damage to existing improvements and plantings.
B. Prior to the start of Work, layout and stake the limits of excavation and horizontal and vertical control points sufficient to install the complete Soil Cell system.
C. Coordinate installation with other trades that may impact the completion of the Work.

3.03 TEMPORARY PROTECTION

A. Protect open excavations and Soil Cell system from access and damage both when Work is in progress and following completion, with highly visible construction tape, fencing, or other means until related construction is complete.
B. Do not drive vehicles or operate equipment over the Soil Cell system until the final surface material has been installed.

3.04 EXCAVATION

A. General: Excavate to the depths and shapes indicated on the Drawings. Provide smooth and level excavation base free of lumps and debris.
B. Confirm that the depth of the excavation is accurate and includes the full section of materials required to place the subbase aggregate, Soil Cell, and pavement profile as indicated on the Drawings.
C. Over-excavate beyond the perimeter of the Soil Cell to allow for:
    1. The extension of aggregate subbase beyond the Soil Cell layout as shown on the Drawings.
    2. Adequate space for proper compaction of backfill around the Soil Cell system.
D. If unsuitable subgrade soils are encountered, consult the Owner's geotechnical consultants for directions on how to proceed.
E. If conflicts arise during excavation, notify the Landscape Architect in writing, and make recommendations for action. Proceed with Work only when action is accepted in writing.

3.05 SUBGRADE COMPACTION

A. Compact subgrade with a minimum of three passes with a vibratory plate compactor; or per direction of the project geotechnical consultant.
B. Do not exceed 10 percent slope for subgrade profile in any one direction. If the 10 percent slope is exceeded, contact the manufacturer’s representative for directions on how to proceed.

3.06 INSTALLATION OF GEOTEXTILE OVER SUBGRADE

A. Install geotextile over compacted subgrade.
    1. Lay geotextile flat with no folds or creases.
    2. Install the geotextile with a minimum joint overlap of 18 inches (450 millimeters).

3.07 INSTALLATION OF AGGREGATE SUBBASE BELOW SOIL CELL BASES

A. Install aggregate subbase to the depths indicated on the Drawings.
B. Extend subbase aggregate a minimum of six inches (150 millimeters) beyond the base of the Soil Cell layout.
C. Compact aggregate subbase to a minimum of 95 percent of maximum dry density at optimum moisture content in accordance with ASTM D698, Standard Proctor Method.
D. Do not exceed 10 percent slope on the surface of the subbase. Where proposed grades are greater than 10 percent, step the Soil Cells to maintain proper relation to the finished grade.

3.08 INSTALLATION OF SOIL CELL BASE

A. Install the Soil Cell system in strict accordance with the manufacturer's instructions and as specified herein; where requirements conflict or are contradictory, follow the more stringent requirements.

B. Layout and Elevation Control:

1. Provide layout and elevation control during installation of the Soil Cell system to ensure that layout and elevations are in accordance with the Drawings.

C. Establish the location of the tree openings in accordance with the Drawings. Once the trees are located, mark the inside dimensions of the tree openings on the prepared subbase.

D. Locate and mark other Project features located within the Soil Cell layout (e.g. light pole bases, utility pipes). Apply marking to identify the extent of the Soil Cell layout around these features. Follow the layout as shown on the Drawings to ensure proper spacing of the Soil Cell bases. Refer to the Drawings for offsets between these features and the Soil Cells.

E. Check each Soil Cell component for damage prior to placement. Reject cracked or chipped units.

F. Place the Soil Cell bases on the compacted aggregate subbase. Start at the tree opening and place Soil Cell bases around the tree openings as shown on the Drawings.

G. Working from tree opening to tree opening, place Soil Cell bases to fill in the area between tree openings.

1. Maintain spacing no less than one inch (25 millimeters) and no more than six inches (150 millimeters) apart, assuming geotextile covering the decks meets the specifications in section 2.04 paragraph C.

H. Follow the Soil Cell layout plan as shown on the Drawings.

I. Install Soil Cell bases around, over, or under existing or proposed utility lines, as indicated on the Drawings.

J. Level each Soil Cell base to provide full contact with subbase. Adjust subbase material, including larger pieces of aggregate, so each base sits solidly on the surface of the subbase. Soil Cell bases that rock or bend over any stone or other obstruction protruding above the surface of the subbase material are not allowed. Soil Cell bases which bend into dips in the subbase material are not allowed. The maximum tolerance for deviations in the plane of the subbase material under the bottom of the horizontal beams of each Soil Cell base is 1/4 inch in four feet (six millimeters in 1200 millimeters).

K. Anchor Soil Cell base with two anchoring spikes per base.

1. For applications where Soil Cells are installed over waterproofed structures, use wood blocking or similar spacing system consistent with requirements of the waterproofing system to maintain required spacing.

3.09 INSTALLATION OF SOIL CELL POSTS

A. 2x Soil Cell System:

1. Attach 2x posts to the installed Soil Cell base. Each base shall receive six 2x posts. Place the end of the post with tabs into the base. Rotate post clockwise to snap in place.

3.10 INSTALLATION OF STRONGBACKS, GEOGRID, BACKFILL AND PLANTING SOIL

A. For Soil Cell systems that have a perforated drain line located inside or adjacent to the system, consult Drawings for layout and details for requirements.

B. Install strongbacks on top of the Soil Cell posts by snapping into place over installed posts prior to installing planting soil and backfill.

1. Strongbacks are required only during the placement and compaction of the planting soil and backfill.
2. Move strongbacks as the Work progresses across the installation.
3. Remove strongbacks prior to the installation of the Soil Cell decks.

C. Install geogrid around the perimeter of the Soil Cell system where the compacted backfill and planting soil interface.
   1. Do not place geogrid between the edge of the Soil Cells and adjacent planting areas.
   2. Cut the geogrid to allow for a six-inch (150-millimeter) overlap at the Soil Cell base and a 12-inch (300-millimeter) overlap at the Soil Cell deck.
   3. Provide a minimum 12-inch (300-millimeter) overlap between adjacent sheets of geogrid.
   4. Secure geogrid with cable ties below the top of the posts, along the post ridges.

D. Place the first lift of backfill material loosely around the perimeter of the Soil Cell system, between the geogrid and the sides of the excavation. Place backfill to approximately the midpoint of the Soil Cell post. Do not compact.

E. Place the first lift of planting soil in the Soil Cell system to approximately the midpoint of the Soil Cell post.
   1. Level the planting soil throughout the system.
   2. Walk-through the placed planting soil to remove air pockets and settle the soil.
      a. Lightly compact soils by walking through the soil following placement.
      b. Walk through compaction shall result in 75-85 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method. Do not exceed root limiting compaction for the given soil type.

F. Compact the first lift of backfill material, previously spread, to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method or in accordance with Project Specifications for hardscape areas, whichever is greater.

G. Add and compact additional backfill material so that the final finished elevation is at approximately the same level as the placed planting soil within the Soil Cells.
   1. Maintain the geogrid between the Soil Cell system and the backfill material at all times.

H. Place the second lift of backfill material loosely around the perimeter of the Soil Cell system, between the geogrid and the sides of the excavation so that the material is two to three inches below the top of the posts. Do not compact.

I. Place the second lift of planting soil inside of the Soil Cell to the bottom of the strongbacks. Walk through compact.

3.11 INSTALLATION OF SOIL CELL DECK

A. Remove strongbacks, level out the planting soil, and immediately install decks over the posts below. Place deck over the top of the posts. Push decks down until the deck clips lock into the posts, snapping the deck into place.

B. Fold the 12-inches (300 millimeters) of geogrid onto the top of the decks.

3.12 FINAL BACKFILL PLACEMENT AND COMPACTION

A. Place and compact final lift of backfill material to 95 percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method, such that the backfill is flush with the top of the installed deck. Do not allow compacting equipment to come in contact with the decks.

3.13 INSTALLATION OF GEOTEXTILE AND AGGREGATE BASE COURSE OVER THE DECK

A. Ensure geotextile meets the specifications in section 2.04 paragraph C.

B. Place geotextile over the top of the deck and extend to the edge of the excavation. Overlap joints a minimum of 18 inches (450 millimeters). Leave enough slack in the geotextile for the aggregate base course to push the geotextile down in the gaps in between the decks.

C. Install the aggregate base course (including aggregate setting bed if installing unit pavers) over the geotextile immediately after completing the installation of the fabrics. Work the aggregate from one side of the layout to the other so that the fabric and aggregate conform to the Soil Cell deck contours.

D. Maintain equipment used to place aggregate base course completely outside the limits of the Soil Cell excavation area to prevent damage to the installed system.
E. For large or confined areas, where aggregate cannot easily be placed from the edges of the excavated area, obtain acceptance for the installation procedure and types of equipment to be used in the installation from the Soil Cell manufacturer.
F. Compact aggregate base course(s) to 95-percent of maximum dry density in accordance with ASTM D698, Standard Proctor Method. Utilize a vibration or plate compactor with a maximum weight of 800 pounds (362.87 kilograms).
G. Do not drive vehicles or operate equipment over the completed aggregate base course.

3.14 INSTALLATION OF CONCRETE CURBS AT TREE OPENINGS, AGGREGATE SUBBASE AND PAVEMENT ABOVE THE SOIL CELL SYSTEM

A. Place concrete curbs along planting areas and tree openings as shown on the Drawings to retain the aggregate base course from migrating into the planting soil.
B. When staking concrete forms (e.g. curbs around the tree openings), prevent stakes from penetrating the Soil Cell decks.
C. Turn down edge of concrete paving to the Soil Cell deck along the edges of tree openings or planting areas to retain the aggregate base course material.
D. When paving type is a unit paver or other flexible material, provide a concrete curb under the paving at the edge of the Soil Cell deck to retain the aggregate base course material at the tree opening.
E. Place paving material over Soil Cell system in accordance with the Drawings.
    1. The Soil Cell system does not fully meet loading strength until the final paving is installed. Do not operate construction equipment on top of the Soil Cell system until paving installation has been completed.
F. Use care when placing paving or other backfill on top of Soil Cell system to prevent damage to the Soil Cell system or its components.

3.15 INSTALLATION OF ROOT BARRIERS

A. Install root barrier in accordance with manufacturer's installation instructions.

3.16 INSTALLATION OF PLANTING SOIL WITHIN THE TREE PLANTING AREA

A. Remove rubble, debris, dust, and silt from the top of the planting soil within the tree opening that may have accumulated after the initial installation of the planting soil within the Soil Cells.
B. Install additional planting soil within the tree openings, to the depths indicated on the Drawings.
    1. Use the same soil used within the Soil Cells for planting soil within the tree openings.
C. Compact planting soil under the tree root ball to prevent settlement of the root ball.
D. Place trees in accordance with the Drawings.

3.17 PROTECTION

A. Keep construction traffic away from the limits of the Soil Cells until the final pavement profile is in place. The Soil Cell system does not fully meet loading strength until the final paving is installed.
    1. Do not operate equipment directly on top of the Soil Cell system until paving installation has been completed.
    2. Provide fencing and other barriers to prevent vehicles from entering the Soil Cell area.
B. When the Soil Cell installation is completed and the permanent pavement is in place, limit traffic and construction related activities to only loads less than the design loads.

3.18 CLEAN UP

A. Perform clean up during installation and upon completion of the Work. Maintain the site free of soil, sediment, trash, and debris. Remove excess soil materials, debris, and equipment from the site following completion of the Work of this Section.

B. Repair damage to adjacent materials and surfaces resulting from installation of this Work using mechanics skilled in remedial work of the construction type and trades affected.

END OF SECTION

SECTION 32 94 56
SITE PLANTING SOIL FOR SOIL CELLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes:
   1. Planting soils for use within the Soil Cell system.
B. Related Sections:
   1. Section 32 93 00 "PLANTS" for tree plantings, and border edgings.
   2. Section 32 94 51 “SOIL CELLS” for soil cell assemblies related accessories.

1.03 REFERENCES

A. Reference Standards:
   1. ASTM International (ASTM)
      Standard Specification for Concrete Aggregates- Fine Aggregates; C33.
   2. The Soil Science Society of America.
      Methods of Soil Analysis, most current edition.
   3. United States Composting Council www.compostingcouncil.org and http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/LandscapeArch_Specs.pdf.
   4. United States Department of Agriculture, Natural Resources Conservation Service
      a. National Soil Survey Handbook, title 430-VI.

1.04 DEFINITIONS

A. Compaction: The density of soil measured as oven dry weight divided by volume.
B. Existing Soil: Mineral soil existing at the locations of proposed planting of area designated for the installation of Soil Cells after the majority of the construction within and around the planting or Soil Cell site is completed and just prior to the start of Work to excavate the soil
C. Landscape Architect: The person or entity employed by the Owner to represent their interest in the review of the Work.
D. Ped: Clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.
E. Screened Soil: Soil that has been processed through a metal screen to remove or break apart soil peds (clumps /clods), roots, rocks and debris and remove larger physical items in the soil not permitted by the specification.
F. Soil Cells: Structural paving support system defined in Section 32 94 51 “SOIL CELLS”.
G. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of fill or backfill, before placing planting soil.

1.05 SUBMITTALS

A. Refer to Section 01 30 00 “ADMINISTRATIVE REQUIREMENTS” for submittal definitions, requirements, and procedures. The following paragraphs supplement the requirements of Section 01 30 00.
B. Action Submittals: Submit these to the Landscape Architect for review and acceptance not less than 45 days prior to start of installation of materials and products specified in this Section.
   1. Product Data: For each type of product, submit manufacturer's product literature with technical data sufficient to demonstrate that the product meets these specifications.

a. For each compost product submit the manufacturer's certification that the compost meets the requirements for US Compost Council STA/TMECC criteria for "Compost as a Landscape Backfill Mix Component" and other requirements of the Specification.
b. For coarse sand product submit the following analysis by a recognized laboratory:
   1) pH
   2) Manufactures Fines Modulus Index
   3) Particle size distribution (percent passing the following sieve sizes):

U.S. Sieve Size
3/8 inch (9.5 mm)
No 4 (4.75 mm)
No 8 (2.36 mm)
No 16 (1.18 mm)
No 30 (0.60 mm))
No 50 (0.30 mm)
No 100 (0.15 mm)
No 200 (0.075 mm)

2. Test and Evaluation Reports:
   a. Include analysis of bulk materials including soils and aggregates, by a recognized laboratory that demonstrates that the materials meet the Specification requirements.
   b. Submit required soil test analysis report for each sample of imported topsoil, existing site soil, and planting soil mixes from an accepted soil-testing laboratory as follows:
      1) Do not submit planting soil mixes for testing until all topsoil, compost, and coarse sand have been accepted.
      2) If tests fail to meet the Specifications, obtain other sources of material, retest and resubmit until accepted by the Landscape Architect.
      3) All testing shall be performed following the requirements of *Methods of Soil Analysis*, The Soil Science Society of America.
      4) Provide a particle size analysis (percent dry weight) and USDA soil texture analysis. Soil testing of planting soil mixes shall also include USDA gradation distribution of gravel, coarse sand, medium sand, and fine sand in addition to silt and clay. Reports of particle size distribution shall use USDA size nomenclature and analysis protocols.
      5) Provide the following other soil properties:
         (a) pH and buffer pH.
         (b) Percent organic content by oven dried weight.
         (c) Nutrient levels by parts per million including: phosphorus, potassium, magnesium, manganese, iron, zinc, and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the soil for optimum growth of the plantings specified.
         (d) Soluble salt by electrical conductivity of a 1:2 soil water sample measured in Milliohm per cm.
      6) All soil testing shall be at the expense of the General Contractor.
3. Samples:
   a. Each sample shall be double bagged packaged in two plastic zip loc style bags. Each bag shall be clearly marked with the project name, date, General Contractors name and telephone number, and product name.
   b. Samples of all existing site soil, topsoil, coarse sand and compost and planting soil mixes shall be submitted at the same time as the particle size and physical analysis of that material.
   c. Samples of the existing site soil that are under existing pavement to be removed may be submitted as soon as possible after the paving is removed.

d. Samples shall be reviewed for appearance only.
e. Provide samples for the following products.
1) One-gallon (3.79-liter) sample of each type of existing site soil prior to adding amendments.
2) One-gallon (3.79-liter) sample of imported topsoil.
3) One-gallon (3.79-liter) sample of compost.
4) One-gallon (3.79-liter) sample of coarse sand.
5) One-gallon (3.79-liter) sample of unscreened planting soil mix.
6) One-gallon (3.79-liter) sample of screened planting soil mix.

4. Qualification Statements:
a. Soil supplier:
1) Submit documentation of the qualifications of the planting soil supplier and their field supervisor, sufficient to demonstrate that both meet the requirements specified in Article 1.05 Quality Assurance.
2) Submit list of completed projects of similar scope and scale demonstrating capabilities and experience.

1.06 QUALITY ASSURANCE

A. Supplier: Soil mixes shall be supplied by a firm that specializes in the production of mixes of planting soils and have at least five years' experience in providing soil mixes soils to projects of similar size and scope to this Work.
B. Soil Testing Laboratory Qualifications: The testing laboratory shall specialize in agricultural soil testing and be a member of the Soil Science Society of America's, North American Proficiency Testing Program (NAPT). Testing results for soil particle size shall be reported using USDA sizes for sand, silt, and clay.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Weather: Do not mix or deliver soil when frozen or muddy.
B. Protect soil and soil stockpiles, from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Confine delivered materials to neat piles in areas coordinated with the site supervisor. Cover stockpiles with plastic sheeting or fabric at the end of each Workday.
C. All manufactured packaged products and material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations.
1. Biological and chemical additives shall be protected from extreme humidity, cold, or heat. All products shall be freshly manufactured and dated for the year in which the products are to be used. Chemical amendments shall have original labels intact and legible, stating the guaranteed chemical analysis.

PART 2 PRODUCTS

2.01 EXISTING SITE SOIL

A. Existing site soil: Soil at the site including the possibility of subgrade soil under existing paving that is of a texture and chemical composition that can support roots provided that compost and or fertilizer is added, and the soil compaction loosened.
B. Existing site soil shall meet the following criteria:
1. Soil objects larger than 1/4 inch (6.24 millimeters) in diameter: Existing site soil shall contain less than five percent total volume of the combination of all objects one to eight inches (25 millimeters – 200 millimeters) in their largest dimension including clumps/clods of heavy clay, sandy clay or silty clay subsoil, debris, refuse, roots, stones, sticks, brush, and or litter. The soil shall contain less than eight percent by volume total of the above

objects 1/4 inch (6.24 millimeters) to one inch (25 millimeters) in diameter. Remove objects larger than eight inches (200 millimeters) in its longest dimension.

2. Seedlings that germinated from seeds in the soil shall be removed within one month of germination whether during the period the soil is being stored or after installation including during the plant warranty period.
3. The Landscape Architect will verify that the soil in the designated areas is suitable at the beginning of planting bed preparation Work. The decisions to specify the use of existing site soils is based on assumptions made during the design phase about the quality of soil which may have been covered by paving at that time or where construction activity earlier in the Project may have altered this soil.
    a. Areas and depths to which existing site soil can be harvested for use in the Soil Cells is indicated on the soil plan.

C. If the Landscape Architect determines the soil to be unacceptable or the Work of this Project has damaged areas designated for use as existing site soil to the point where the soil is no longer suitable to support the plants specified, the Landscape Architect may require modification of the damaged soil up to and including removal and replacement with soil of equal quality to the soil that existed prior to construction.
    1. Examples of damage include further compaction, contamination, grading, creation of hardpan or drainage problems, or lack of previously assumed O, A and or B-horizon soils.
    2. Do not begin Work on additional modifications or soil replacement until changes, if any, to the Contract price are accepted.
D. Protect existing soil from contamination and degradation during the construction process.
E. Excavation and storage of existing site soil:
    1. Remove existing plants, roots, stumps, paving, and non-soil debris from the surface layers of the soil.
    2. Excavate the soil over the areas and depths indicated on the plan or as advised by the Landscape Architect. Utilize techniques and equipment that retains peds (clumps/clods) of soil.
    3. During the excavation process, soils in the accepted areas and depths of different color and texture should be loosely mixed to create a more uniform single soil while still retaining soil peds (clumps/clods). The Landscape Architect may request that soils encountered that are not in accordance with the soil assumptions not be included in the mixing process. Such soils should be removed from the site or may be used as fill soils if accepted by the Landscape Architect.
    4. Do not screen the soil unless accepted in advance by the Landscape Architect. Encountered volumes of soil that do not meet the requirement for soil objects larger than 1/4 inch (6.24 millimeters) in diameter should be segregated during the excavation process and removed from the site. If accepted, soil may be screened through a two inch (50 millimeters) square or larger opening in order to allow the soil to meet the requirements. Isolated large objects shall be removed from the soil by hand.
    5. Stockpile the soil in locations accepted in advance by the General Contractor.
        a. Store soil in bulk trash dumpsters with rear access doors if no suitable space exists at the site.
F. Amending existing site soil:
    1. Amendments for existing site soil should be calculated for a composite mix of all soils to be used.
    2. Add compost to existing site soil, up to 20 percent by moist volume to bring soil organic matter to a minimum of three percent by dry weight.

a. Each 10 percent moist volume of added compost is assumed to raise the percent dry weight soil organic matter by 1.5 percent.
b. Spread compost over the stockpile in amounts that achieve the required organic matter content. As soil is being scooped from the pile to bring to the Soil Cells, mix the compost loosely into the soil with the loader bucket. Add additional compost to the stockpile as the Work progresses to achieve even compost distribution within the mix.
c. Do not over mix the soil. Maintain as many large soil peds (clumps/clods) as possible in the mix.

3. Add fertilizer of the types and quantity recommended by the soil test at the time of mixing.

G. Submittal Requirements: Provide a one-gallon (3.79-liter) sample of each type of existing site soil prior to adding amendments with testing data that includes recommendations for compost volumes and chemical additives for the types of plants to be grown. Samples and test samples shall represent the composite mixing of the available soils. Samples and testing data shall be submitted at the same time.

2.02 IMPORTED TOPSOIL

A. Imported topsoil: Fertile, friable soil loam topsoil suitable for the germination of seeds and the support of vegetative growth meeting the following criteria:

1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 35 percent; a combined clay/silt content of no more than 60 percent; and sand between 35 and 65 percent.
2. Except where noted, imported topsoil shall not have been screened and shall retain soil peds (clumps/clods) larger than two inches (50 millimeters) in diameter throughout the stockpile after harvesting.
   a. Light screening through a two-inch (50 millimeters) square or larger opening shall be permissible in soils with clay content of 20 percent or greater if required to break up large peds (clumps/clods) or remove coarse roots and stones.
   b. Retained soil peds (clumps/clods) shall be the same color on the inside as is visible on the outside surface of the ped.
3. Soil objects larger than 1/4 inch (6.24 millimeters) in diameter: Imported topsoil shall contain less than five percent total volume of the combination of all objects one to eight inch (25 millimeters to 200 millimeters) in their largest dimension including clumps/clods of heavy clay, sandy clay or silty clay subsoil, debris, refuse, roots, stones, sticks, brush, and or litter. The soil shall contain less than eight percent by volume total of the above objects 1/4 inch to one inch (6.24 millimeters to 25 millimeters) in diameter. Remove all objects larger than eight inches (200 millimeters) in its longest dimension.
   a. Meet the above requirement by utilizing acceptable soils sources rather than soil screening.
4. Imported topsoil may be harvested soil from fields or development sites or purchased from suppliers who collect and process soil. The organic content and particle size distribution shall be the result of natural soil formation. Manufactured soils where sand, composted organic material or other additives have been added to the soil to meet the requirements of imported topsoil shall not be acceptable.
5. pH value shall be between 5.5 and 7.5.
6. Percent Organic Matter (OM): three to five percent, by dry weight.
7. Soluble Salt Level: Less than two millimho per centimeter.
8. Soil nutrient chemistry suitable for growing the plants specified or after modification.
9. Germinating seedlings from seeds in the soil shall be removed within one month of germination whether during the period the soil is being stored or after installation, including during the warranty period of the plants.

B. Stockpiled existing topsoil at the site meeting the above criteria may be acceptable.
C. Submittal Requirements: Provide a one-gallon (3.79-liter) sample from each imported topsoil source with required soil testing results. The sample shall be a mixture of the random samples taken around the source stockpile or field. The soil sample shall be delivered with soil peds (clumps/clods) intact that represent the size and quantity of expected peds (clumps/clods) in the final delivered soil. The sample shall represent the expected number of objects larger than 1/4 inch (6.24 millimeters).

2.03 COMPOST

A. Compost: Blended and ground leaf, wood, and other plant-based material, composted for a minimum of nine months and at temperatures sufficient to break down woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Compost feed stock shall be yard waste trimmings, blended with other plant and or manure feed stock designed to produce compost high in fungal material.
   1. Compost shall be commercially prepared compost and meet US Compost Council STA/TMECC criteria.
   2. Submittal Requirements: Provide one-gallon (3.79-liter) sample with manufacturer's literature and material certification that the product meets the requirements.

2.04 COARSE SAND

A. Clean, washed, natural sand, free of toxic materials.
   1. Coarse concrete sand, ASTM C33 Fine Aggregate, with a Fines Modulus Index of 2.8 and 3.2.
   2. Coarse sand, free of limestone, shale, and slate particles. Manufactured Sand shall not be permitted.
   3. pH shall be lower than 7.4.
   4. Provide coarse sand with the following particle size distribution:

U.S. Sieve Size	Percent Passing
3/8 inch (9.5 mm)	100
No 4 (4.75 mm)	95 to 100
No 8 (2.36 mm)	80 to 100
No 16 (1.18 mm)	50 to 85
No 30 (0.60 mm))	25 to 60
No 50 (0.30 mm)	10 to 30
No 100 (0.15 mm)	2 to 10
No 200 (0.075 mm)	2 to 5

B. Submittal Requirements: Provide a one-gallon (3.79-liter) sample with manufacturer's literature and material certification that the product meets the requirements.

2.05 FERTILIZER

A. If noted by the soil test recommendations, add slow-release, organic fertilizer based on soil test and plant requirements.
B. Fertilizers should not be added to Bio-retention soils.
C. Submittal Requirements: Provide manufacturer's literature so that the product meets the requirements.

2.06 BIOLOGICAL AMENDMENTS

A. Amendments such as Mycorrhizal additives, compost tea or other products intended to change the soil biology.

2.07 UNSCREENED PLANTING SOIL MIX

A. A mixture of imported topsoil, coarse sand, and compost to make a new soil that meets the Project goals for the indicated planting area.

1. The approximate mix ratio of imported topsoil, coarse sand and compost shall be:

Mix component	Percent by moist volume
Imported topsoil unscreened	50 to 60 percent
Coarse sand	30 to 40 percent
Compost	10 percent

2. Final Tested Soil Organic Matter (OM): 2.75 to four percent (by dry weight loss ash burn).

B. Mix the coarse sand and compost together first and then add to the topsoil. Mix with a loader bucket to loosely incorporate the topsoil into the coarse sand/compost Mix. Do not over mix. Do not mix with a soil-blending machine. Do not screen the soil. Peds (clumps/clods) of Soil, and loosely mixed Compost and coarse sand shall be permitted in the overall mix.

C. At the time of soil installation, add fertilizer or biological amendments, if required, to the planting soil mix at rates recommended by the testing results for the plants to be grown.

D. Submittal Requirements: Provide a one-gallon (3.79-liter) sample with testing data that includes recommendations for chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time. The sample shall be a mixture of the random samples taken around the source stockpile or field. The sample shall be delivered with soil peds (clumps/clods) intact that represent the size and quantity of expected peds (clumps/clods) in the final delivered soil mix.

2.08 SCREENED PLANTING SOIL MIX

A. A mixture of imported topsoil, coarse sand, and compost mixed off site to make a new soil that meets the Project goals for the indicated planting area.

1. A mix of imported topsoil, coarse sand and compost. The approximate Mix ratio shall be:

Mix component	Percent by moist volume
Imported topsoil screened	40 to 45 percent
Coarse Sand	40 to 50 percent
Compost	10 to 15 percent

2. Final Tested Organic Matter: three to 4.5 percent (by dry weight loss ash burn).
3. Final mix shall be thoroughly screened, mixed and blended.

B. At the time of soil installation, add fertilizer or biological amendments, if required, to the planting soil mix at rates recommended by the testing results for the plants to be grown.

C. Submittal Requirements: Provide a one-gallon (3.79-liter) sample with testing data that includes recommendations for chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time. The sample shall be a mixture of the random samples taken around the source stockpile or field.

PART 3 EXECUTION

3.01 INSTALLATION OF PLANTING SOIL IN SOIL CELLS

A. Refer to Section 32 94 51 “SOIL CELLS”.

END OF SECTION

SECTION 33 05 13
MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

B. The Construction Manager will either perform the work of this section with its own forces or will subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the Town of Wilmington as the co-oblige. Such bond will be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasure Department circular 570. A copy of such bond will be submitted to the Town of Wilmington's Project Manager for acceptance and will be in place prior to the subcontractor commencing any work on the project.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Install precast concrete manholes, catch basins, frames and covers, grates, manhole rungs, platforms, and appurtenances all as shown on the Drawings and as specified herein.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 31 20 00 - Earth Moving
2. Section 33 41 00 - Storm Utility Drainage Piping
3. Section 33 31 00 - Sanitary Utility Sewerage Piping

1.03 REFERENCES

A. American Concrete Institute:

1. ACI 318 - Building Code Requirements for Structural Concrete.
2. ACI 530/530.1 - Building Code Requirements for Masonry Structures and Specifications for Masonry Structures.

B. ASTM International:

1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. ASTM C32 - Standard Specification for Sewer and Manhole Brick
4. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C55 - Standard Specification for Concrete Brick.

6. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
7. ASTM C150 - Standard Specification for Portland Cement
8. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes
9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
11. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
12. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
13. ASTM D4097 - Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks
14. ASTMD4101 - Standard Specification for Propylene Plastic Injection and Extrusion Materials

C. American Association of State Highway and Transportation Officials (AASHTO)

D. Occupational Safety and Health Administration (OSHA)

1.04 DESIGN REQUIREMENTS

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.

C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.

1.05 SUBMITTALS

A. Section 01 30 00 – Administrative Requirements: Requirements for submittals.

B. Shop Drawings: Indicate manhole locations, elevations, and sizes and elevations of penetrations.

C. Product Data: Submit cover and frame construction, features, configuration, dimensions.

1.06 QUALITY ASSURANCE

A. The quality of all materials, the process of manufacture, and the finished sections will be subject to inspection and acceptance by the Engineer or other representative of the Town of Wilmington. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places and the materials will be subject to rejection at any time on account of failure to meet any of the requirements specified herein; even though samples may have been accepted as satisfactory as the place of manufacture. Material reject after delivery to the job will be marked for identification and will be removed from the job at one. All materials that have been damaged after delivery will be rejected, and if already installed, will be acceptably repaired, if permitted, or removed and replaced, entirely at the Construction Manager’s expense.

B. At the time of inspection, the materials will be carefully examined for compliance with the applicable ASTM standard specification and this Section with the accepted manufacturer's drawings. All manhole sections will be inspected for general appearance, dimension, scratch strength, blisters, cracks, roughness, soundness, and other surface or structural imperfections. The surface will be dense and close-textured.

C. Imperfections in manhole sections may be repaired, subject to the acceptance of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs will be carefully inspected before final acceptance. Cement mortar used for repairs will have a minimum compressive strength of 4,000 psi at seven days and 5,000 psi at 28 days, when tested in three-inch x six-inch cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the acceptance of the Engineer.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.08 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Comply with precast concrete manufacturer's instructions for unloading, storing, and moving precast manholes.

C. Store precast concrete manholes to prevent damage to Town of Wilmington's property or other public or private property. Repair property damaged from materials storage.

D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Maintain materials and surrounding air temperature to minimum 50 degrees Fahrenheit prior to, during, and 48 hours after completion of masonry work.

C. Cold Weather Requirements: ACI 530.

PART 1 - PRODUCTS

2.01 PRECAST CONCRETE MANHOLE SECTIONS

A. Precast concrete barrel sections and transition top sections will conform to ASTM C478 and meet the following requirements:

1. Manholes will have a minimum 48-inch interior diameter with a wall thickness of not less than five inches.
2. Top sections will be eccentric except that barrel sections will be used where shallow pipe cover requires a top section less than four feet.

3. Barrel sections will have tongue and groove joints. Manholes will be manufactured in the configuration shown on the Drawings with the bell of the manhole section pointing down.
4. All sections will be cured by an accepted method and will not be shipped or subjected to loading until the concrete compressive strength has attained 3,000 psi and not before five days after fabrication or repair, whichever is longer.
5. Precast concrete barrel sections with top slabs and precast concrete transition sections will be designed for a minimum of HS-20 loading plus the weight of the soil above at 120 pcf.
6. The date of manufacture and the name and trademark of the manufacturer will be clearly marked on the inside of each precast section.
7. Precast concrete bases will be constructed of and installed as shown on the Drawings. The thickness of the bottom slab of precast bases will not be less than the manhole barrel sections or top slab, whichever is greater.
8. Knockout panels will not be permitted.

2.02 CATCH BASINS

A. Precast reinforced concrete catch basin sections will conform to the applicable requirements of ASTM C478, latest revision.

B. Basin will be precast reinforced concrete four feet in diameter with penetrations cast into the basin for pipe connection; knockout panels will not be permitted. Basins will have a minimum wall thickness of five inches and a minimum bottom thickness of six inches. Basins will have a sump of four feet. Top sections will be a flat slab and have a minimum of eight inches for support of cast iron frame and grate. The hole in the top section will be 24 inches square size to accommodate frame and cover and be eccentric. The hole in the top section will be located over the side opposite to the hooded outlet to facilitate future cleaning operations.

C. All concrete will have a minimum compressive strength of 4,000 psi and a live load design base for all catch basins will be HS-20 loading.

D. All catch basins will be fitted with a hooded outlet. The hoods are to be positioned so they will not interfere with future cleaning operations. The hooded outlet cover will be fabricated from marine grade fiberglass, stainless steel (18-8) attachment hardware, pressure sensitive oil resistant foam rubber gasket, PVC Schedule 40 fittings, and pipe for anti-siphon device.

E. Bedding material under catch basins and drain manholes will conform to the requirements for of the Specifications for pipe bedding. A minimum of 12 inches of 3/4-inch crushed stone is required to provide a uniform base. If the material at the elevation that catch basins are to be set on is not suitable to support them, then this material will be removed to a depth that will support the structure. The material accepted by the Engineer will be used to replace the removed material and be compacted before setting the base.

F. Catch basin frames and grates/covers will be set at a finished elevation one inch below finish pavement elevation.

G. ADA compliant grates are required in pedestrian areas. If gratings have elongated openings, then they will be placed so that the long dimension is perpendicular to the dominant direction of travel. Walking surfaces should be slip resistant.

2.03 BRICK MASONRY.

A. The bricks will be good, sound, hard and uniformly burned, regular and uniform in shape, of compact size and texture and satisfactory to the Engineer. Underburned or salmon brick will not be acceptable and only whole brick will be used unless otherwise permitted. In case bricks are rejected by the Engineer, they will be immediately removed from the site of the work and satisfactory bricks used thereafter.
   1. Bricks for the channels and sleeves will comply with ASTM C32 for sewer brick; Grade SS (from clay or shale) except that the mean of five tests for absorption will not exceed eight percent and no individual brick will exceed 11 percent.
   2. Bricks for building up and leveling the manhole frames will comply with ASTM C62.

B. Mortar used in the brickwork will be composed of one part Type II Portland cement conforming to ASTM C150 and sand to which a small amount of hydrated lime not to exceed 10 lbs. to each bag of cement will be added.

C. The sand used will be washed, cleaned, screened, sharp and well graded as to different sizes and with no grain larger than will pass a No. 4 sieve. It will be free from vegetable matter, loam, organic or other materials of such nature or quantity to render it unsatisfactory.

D. The hydrated lime will also conform to ASTM C207.

2.04 FRAMES, COVERS AND GRATES

A. Manufacturers:
   1. All manufacturers producing such products will be considered.
   2. Substitutions: Section 01 25 00 – Substitution Requirements.

B. Manhole frames and covers will be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind that render them unfit for the service for which they are intended. Manhole covers and frame seats will be machined to a true surface. Castings will be thoroughly cleaned and subject to hammer inspection. Cast iron will conform to ASTM A48, Class 35, H-20 loading.

C. Manhole covers will have a diamond pattern, pick holes, and the word ‘SEWER’, DRAIN', or as appropriate, cast in three-inch letters.

D. Inlet frames and grates will be of good quality, strong, tough, even grained cast iron, smooth, free from scale, lumps, blisters, sand holes and defects of any kind that render them unfit for the service for which they are intended. Catch basin grates and frame seats will be machined to a true surface. Castings will be thoroughly cleaned and subject to hammer inspection. Cast iron will conform to ASTM A48, Class 35, H-20 loading.

E. Grates, if located in a walking area, will have spaces no greater than 1/2-inch-wide in one direction. If gratings have elongated openings, then they will be placed so that the long dimension is perpendicular to the dominant direction of travel.

2.05 JOINTING PRECAST MANHOLE SECTIONS

A. Tongue and groove joints will be sealed with either a round rubber o-ring gasket or a preformed flexible joint sealant. The o-ring will conform to ASTM C443.

B. Joints will be designed and manufactured so that the completed joint will withstand an internal water pressure of 10 psi without leakage or displacement of the gasket or sealant.

2.06 MANHOLE RUNGS

A. Manhole rungs will conform to the requirements of ASTM C478 and be of the following types:

1. Manhole rungs will be steel reinforced copolymer polypropylene plastic. Rungs will be 14 inches wide. Copolymer polypropylene will conform to ASTM D4101. Steel reinforcing will be 1/2-inch diameter, grade 60 conforming to ASTM A615 and will be continuous throughout the rung. The portion of the legs to be embedded in the precast section will have fins and be tapered to insure a secure bond.

2.07 PIPE CONNECTION TO MANHOLE

A. Manhole pipe connections may be accomplished in the following ways:

1. The ‘Lock Joint Flexible Manhole Sleeve’ will be cast in the precast manhole base. The steel strap will be protected from corrosion with a bituminous coat.
2. ‘A-Lok’ will be a rubber like gasket cast in the precast manhole base. The rubber gasket will be case into a formed opening in the manhole.
3. ‘Kor-N-Seal’ joint will be installed as recommended by the manufacturer. The stainless-steel clamp will be protected from corrosion with a bituminous coat.

B. Clear Cover Opening: 24-inch diameter, or as otherwise indicated on Drawings.

C. Steps: 12-inch-wide, 16 inches on center vertically, set into manhole, or as otherwise indicated on Drawings.

2.08 DAMPPROOFING

A. The dampproofing will be Hydrocide 648 by Sonneborn Building Products, Dehydratine by A.C. Horn, Inc., Meadows Trowel Mastic, or accepted equal.

2.9 CONFIGURATION

A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female joints; sleeved to receive pipe sections.

B. Shape: Cylindrical.

C. Clear Inside Dimensions: 48 inches, or as otherwise indicated on Drawings.

D. Design Depth: As indicated on Drawings.

E. Clear Cover Opening: 24-inch diameter, or as otherwise indicated on Drawings.

F. Steps: 12-inch-wide, 16 inches on center vertically, set into manhole, or as otherwise indicated on Drawings.

2.10 BEDDING MATERIALS

A. Bedding and Cover: 3/4-inch Crushed Stone in accordance with Section M2.01.4 of the MHD Standard Specifications.

B. Soil Backfill from Around Manhole: In pavement areas where controlled density fill is not specified, provide Ordinary Fill to the sub-base of the pavement, and then provide the required sub-base material for the pavement section. In grassed areas where controlled density fill is not specified, provide Ordinary Fill to a point six inches below finished grade, then Manufactured Topsoil to finished grade.

PART 2 - EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify built-in items are in proper location, and ready for roughing into Work.

C. Verify correct size of manhole excavation.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.03 INSTALLATION

A. Excavation and Backfill:

1. Excavate for manholes to location and depth shown in accordance with Section 31 20 00 – Earth Moving and as otherwise specified herein. Provide clearance around sidewalls of structure for construction operations.
2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes in dry trench.
3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Place base pad, trowel top surface level.

C. Install manholes supported at proper grade and alignment on crushed stone bedding as shown on Drawings.

D. Backfill and compact excavations for manholes in accordance with Section 31 20 00 – Earth Moving.

E. Form and place manhole cylinder plumb and level, to correct dimensions and elevations.

F. Cut and fit for sleeves.

G. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel, as indicated on Drawings.

H. Set cover frames and covers level without tipping, to correct elevations.

I. Coordinate with other sections of Work to provide correct size, shape, and location.

3.04 PRECAST CONCRETE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering precast structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with State of MHD specifications.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer's plant.

G. Verify installations satisfy required alignment and grade.

H. Cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

I. Cut pipe to finish flush with interior of structure.

J. Shape inverts through manhole as shown on Drawings.

3.05 FRAME AND COVER INSTALLATION

A. Set frames using mortar and masonry. Install radially laid sewer brick with 1/4-inch-thick vertical joints at inside perimeter. Lay sewer brick in full bed of mortar and completely fill joints. Where more than one course of sewer brick is required, stagger vertical joints. No more than three courses of sewer brick will be permitted.

B. Set frame and cover two inches above finished grade for manholes with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.06 FIELD QUALITY CONTROL

A. Sections 01 40 00 - Quality Requirements, 01 60 00 - Product Requirements and 01 70 00 – Execution and Closeout Requirements.

B. Vertical Adjustment of Existing Manholes:

1. Where required, adjust top elevation of existing manholes to finished grades shown on Drawings.
2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.

3.07 LEAKAGE TESTS

A. Leakage tests will be made and observed by the Engineer on each manhole. The test will be as described below:

B. Vacuum Test (required on all new manholes):

1. The test will be made using an inflatable compression band, vacuum pump, and appurtenances specifically designed for testing manholes. Test procedures will be in accordance with the equipment manufacturer's recommendations. Contactor will be fully familiar with the vacuum testing equipment and provide a minimum of four hours of instruction by a factory authorized representative at the outset of the project.
2. Each manhole will be test immediately after assembly including the connection of pipes and prior to backfilling.
3. All lift holes will be plugged with non-shrink grout and all pipes entering the manhole will be plugged and braced to prevent the plug from being drawn into the manhole.
4. After test equipment is in place the test will be run at the following rate and test times:
    a. For four-foot diameter manholes:
        1) Initial test pressure – 10 inches Hg
        2) Test Time – one-inch Hg drop to 9 inches Hg in one minute allowable for 0 feet to 10 feet deep manholes.
    b. If the pressure drop exceeds one-inch Hg in the specified time the manhole will be repaired in accordance with accepted procedures and retested.
    c. If a manhole fails to meet a one-inch Hg drop in the specified time after repairs the unit will be water exfiltration tested as specified below and repaired.

C. Exfiltration Test (required as described above):
1. Assemble manhole in place; fill and point all lifting holes and exterior joints within 6 feet of the ground surface with an accepted non-shrinking mortar. Test prior to placing the shelf and invert before filling and pointing the horizontal joints below 6 feet of depth. Lower groundwater table below bottom of manhole for the duration of the test. Plug all pipes and other openings into the manhole and brace to prevent blowout.
2. Fill manhole with water to the top of the cone section. If the excavation has not been backfilled and no water in observed moving down the surface of the manhole, the manhole is satisfactorily watertight. If the test, as described above is unsatisfactory to the Engineer, or if the manhole excavation has been backfilled, continue the test. A period of time may be permitted to allow for absorption. Following this period, refill manhole to the top of the cone, if necessary, and allow at least eight hours to pass. At the end of the test period, refill the manhole to the top of the cone again, measuring the volume of water added. Extrapolate the refill amount to a 24-hour leakage rate. If the manhole fails this requirement, but the leakage does not exceed three gallons per vertical foot per day, repairs by accepted methods may be as directed by the Engineer. If leakage due to a defective joint exceeds this amount, the manhole will be rejected. Uncover the rejected manhole to disassemble, reconstruct, or

replace it as directed by the Engineer. Retest the manhole, and if satisfactory, fill and point the interior joints.

3. No adjustment in the leakage allowance may be made for unknown causes such as leaking plugs, absorptions, or other. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the entrance.
4. An infiltration test may not be substituted for an exfiltration test if the groundwater table is above the highest joint in the manhole. If there is no leakage into the manhole as determined by the Engineer, the manhole will be considered watertight. If the Engineer is not satisfied, testing will be performed as described herein.

3.08 CLEANING

A. All new manholes will be thoroughly cleaned of all silt, debris, and foreign matter of any kind, prior to final inspection.

END OF SECTION

SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

B. The Construction Manager will either perform the work of this section with its own forces or will subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the Town of Wilmington as the co-oblige. Such bond will be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasure Department circular 570. A copy of such bond will be submitted to the Town of Wilmington's Project Manager for acceptance and will be in place prior to the subcontractor commencing any work on the project.

1.02 SUMMARY

A. Section Includes:
   1. Pipe and fittings for site water line including water mains and laterals.
   2. Valves.
   3. Hydrants.
   4. Backflow preventers.
   5. Underground pipe markers.
   6. Bedding and cover materials.

B. Related Sections:
   1. Section 31 20 00 - Earth Moving.
   2. Section 31 10 00 - Site Clearing.
   3. Section 32 12 16 - Asphalt Paving.

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10 lb. Rammer and an 18 in. Drop.

B. American Society of Mechanical Engineers:
   1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
   2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

C. American Society of Sanitary Engineering:
   1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
   2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

D. ASTM International:
   1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
   2. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
   3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
   4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3).
   5. ASTM D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.

6. ASTM D2241 - Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
7. ASTM D2466 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
8. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
9. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
10. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C111 - American National Standard for Rubber-Gasket
4. Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
6. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
7. AWWA C502 - Dry-Barrel Fire Hydrants.
8. AWWA C504 - Rubber-Sealed Butterfly Valves.
9. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. (50 mm) Through 24in. (600 mm) NPS.
10. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
11. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
12. AWWA C606 - Grooved and Shouldered Joints.
13. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
14. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
15. AWWA C702 - Cold-Water Meters - Compound Type.
16. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
17. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
18. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.
19. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

G. Underwriters Laboratories Inc.:
1. UL 246 - Hydrants for Fire - Protection Service.

1.04 SUBMITTALS

A. 01 30 00 – Administrative Requirements.

B. Product Data: Submit data on pipe materials, pipe fittings, valves, hydrants, and accessories.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements.

B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with MHD and MA DEP standards, including the potable water supply construction permit issued for this project.

B. Maintain one copy of each document on site.

C. Valves: Manufacturer's name and pressure rating marked on valve body.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Deliver and store valves in shipping containers with labeling in place.

PART 2 - PRODUCTS

2.01 WATER PIPING

A. Pipe will be ductile iron push on joint pipe manufactured in accordance with the requirements of ANSI/AWWA C151/A21.51 and will be thickness Class 52 with a minimal wall thickness of 0.31 inch for six-inch pipe, 0.33 inch for eight-inch pipe, 0.35 inch for 10-inch pipe, and 0.37 inch for 12-inch pipe. Pipe thickness will be designated in accordance with ANSI/AWWA C150/A21.50 and will be based on laying connections and internal pressure as specified in the project plans. The rated working pressure will be a minimum of 350 psi. Push on joints for such pipe will be in accordance with ANSI A21.11/AWWA C111. Only in special circumstances will mechanical joints be allowed with the prior acceptance of the Engineer. Pipe will have cement mortar lining twice the normal thickness and tar coating in accordance with ANSI A21.4-90/AWWA C104. Pipe lengths will be standard 18 feet or 20 feet unless otherwise accepted. Bell joint end will have a rubber gasket to assure a permanent seal. The spigot end will have a slight bevel for easy passage through gasket.

B. Ductile iron water pipe will be installed in a flat bottom trench, backfilled lightly with a selected material removed in excavation with nothing larger than two inches in diameter. This material will be consolidated to centerline of pipe; after this is done the same materials will be used to provide a 12-inch cover over the top of the installed main.

C. Ductile iron water pipe will not be laid with a deflection of more than 12 inches.

2.02 HYDRANTS

1. Break flange type hydrants conforming to AWWA C502, latest revision, shall be American Darling B62B or Mueller Super Centurion 250, with one four-inch steamer connection, two 2-1/4-inch side hose connections with national standard threads, positive drain, open left with pentagon operating nut, 6-inch inlet, seven-inch diameter barrel, mechanical joint hub, and 5-1/4-inch valve opening. Hydrants will be restrained back to main, thrust block behind, 3/4-inch stone from bottom of hydrant boot to 8 inches over drain port. All hydrants will be set with steamers facing the street or parking lots with a minimum of 15 inches from finish grade to bottom of steamer connection. All hydrants will be painted red barrels with silver bonnets and caps per the Town of Wilmington Water Department requirements.

B. Hydrants will be designed for 250 psi working pressure and will conform in every respect to the specifications adopted by the AWWA. Hydrants will be given two coats of quality paint after installation.

C. Hydrants will be identical to present Town of Wilmington Fire and/or Water Department requirements.

D. Installation: No hydrant will be located within 20 feet of a driveway curb cut. The maximum allowed distance for hydrant back from face of berm is eight feet with a minimum distance of

two feet. Bury depth will be 5'-6".

E. There will be no plantings such as, but not limited to, shrubs or bushes, planted within 10 feet of any hydrant.

2.03 SERVICE BOXES

A. Plug cover to be in cement or asphalt, the word 'WATER' will be cast into the cover, the box will be of a length in height to accommodate any bury depth with 1-foot adjustment height. The overall height is to be 4-1/2 to 5-1/2 feet unless otherwise accepted by the engineer. The service box will be reinforced at arch and pipe ring area and will accommodate up to a one-inch curb stop. Service box rod will have a heavy ductile iron yoke with a brass copper pin. Service boxes will be identical to present Town of Wilmington Water Department requirements.

2.04 VALVE BOXES

A. Valve boxes will be cast iron, tar coated, two piece adjustable sliding type with a top flange and a minimum inside shaft diameter of 5-1/4 inches. Boxes will have the word 'WATER' clearly cast into the cover. Bell end of the lower sections will in all cases be sufficiently large enough to fit over the stuffing boxes of the valves. Valve boxes will be buried 5 feet or deeper to accommodate installation and have a minimum of 12-inch overlap so there is 1 foot adjustment. A positive centering cap made of high strength plastics should be placed over the valve onto which the valve box will be centered. Valve boxes will be identical to present Town of Wilmington Water Department requirements.

2.05 GATE VALVES

A. Manufacturers: will be A.F.C. Series 2500 Resilient Seat, Mueller Resilient Seat, Metro Seat #5460 and #5860. Gate boxes will be identical to present Town of Wilmington Water Department requirements.

B. 2-1/2 inch and Smaller: Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, extension box and valve key. Open right. Epoxy coated.

C. Three inch and Larger: AWWA C500, Iron body, bronze trim, non-rising stem with square nut, single wedge, flanged ends, control rod, extension box and valve key. Open right. Epoxy coated.

2.06 BACKFLOW PREVENTERS

A. Manufacturers: Any manufacturer whose product meets the requirements of the specifications, and the requirements of the Town of Wilmington Water Department, will be considered.

B. Furnish materials in accordance with MHD and MA DEP standards.

C. Reduced Pressure Backflow Preventers:

1. Comply with ASSE 1013.
2. Bronze body, with bronze internal parts and stainless-steel springs.
3. Two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

D. Double Check Valve Assemblies: Comply with ASSE 1012; Bronze body with corrosion resistant internal parts and stainless-steel springs; two independently operating check valves with intermediate atmospheric vent.

2.07 UNDERGROUND PIPE MARKERS

A. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Water Service" in large letters.

2.08 BEDDING AND COVER MATERIALS

A. Bedding: 1-1/2-inch stone in accordance with Section M2.01.1 of the MHD Standards

B. Cover: 3/4-inch Crushed Stone in accordance with Section M2.01.4 of the MHD Standards
C. Soil Backfill from Above Pipe to Finish Grade: Ordinary Fill as specified in Section 31 00 00 – EARTH MOVING.
D. Bituminous Asphalt Patch: Refer to patching requirements under Section 32 12 16 - ASPHALT PAVING.

2.9 JOINT RESTRAINT PRODUCTS

A. Wedge Action Retaining Joints may be used wherever accepted by the Town of Wilmington and will be manufactured of ductile iron conforming to ASTM A536. The mechanical joint restraint will be Megalug Series 1100 or equal accepted by DPW.
B. Concrete for Thrust Blocks: 4,000 psi concrete in accordance with Section M4.02.00 of the MHD Standards.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

3.02 PREPARATION

A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare pipe connections to equipment with flanges or unions.

3.03 BEDDING

A. Excavate pipe trench in accordance with Section 31 00 00 – EARTH MOVING for Work of this Section.
B. Form and place concrete for pipe thrust restraints at change of pipe direction. Place concrete to permit full access to pipe and pipe accessories. Provide square footage of thrust restraint bearing on subsoil per detail.
C. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 8-inch compacted depth; compact to 95 percent.
D. Backfill around sides and to top of pipe in accordance with Section 31 00 00 – EARTH MOVING.
E. Maintain optimum moisture content of fill material to attain required compaction density.
F. Place fill materials in accordance with Section 31 00 00 – EARTH MOVING and Section 32 12 16 - ASPHALT PAVING.

3.04 INSTALLATION - PIPE

A. Maintain 10-foot horizontal separation of water piping from sewer piping unless site constraints prohibit.
B. Install pipe to indicated elevation to within tolerance of 5/8 inch.
C. Route pipe in straight line.
D. Install pipe to allow for expansion and contraction without stressing pipe or joints.
E. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.
F. Establish elevations of buried piping with not less than 5.5 feet of cover. If cover is less than 5.5 feet, the pipe will be insulated with two inches of extruded polystyrene insulation. The pipe will maintain a minimum of four feet of cover.
G. Install trace wire continuous over top of pipe.
H. Backfill trench in accordance with Section 31 00 00.
I. Install Work in accordance with MHD and MA DEP standards.

3.05 UNDERGROUND PIPE MARKERS

A. Manufacturers:

1. Any manufacturers of such products will be considered.
2. Substitutions: Refer to Section 01 25 00 – Substitution Requirements.

B. Plastic Ribbon Tape: Bright colored, imprinted with "WATER" in large letters, minimum six inches wide by four mil. thick, manufactured for direct burial service.

C. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "WATER SERVICE" in large letters.

3.06 INSTALLATION - VALVES

A. Set valves on compacted soil.

B. Center and plumb valve box over valve. Set box cover flush with finished grade.

C. Install Work in accordance with MHD and MA DEP standards.

3.07 SERVICE CONNECTIONS

A. Install water service in accordance with double check valve backflow preventer.

B. Install water service to the building. Connect to building water service.

C. Install Work in accordance with Mass State Plumbing Code.

3.08 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. CLOSEOUT SUBMITTALS

1. Section 01 70 00 – Execution and Closeout Requirements.
2. Disinfection Report:
    a. Type and form of disinfectant used.
    b. Date and time of disinfectant injection start and time of completion.
    c. Test locations.
    d. Name of person collecting samples.
    e. Initial and 24-hour disinfectant residuals in treated water in ppm for each outlet tested.
    f. Date and time of flushing start and completion. Disinfectant residual after flushing in ppm for each outlet tested.
3. Bacteriological Report:
    a. Date issued, project name, and testing laboratory name, address, and telephone number.
    b. Time and date of water sample collection.
    c. Name of person collecting samples.
    d. Test locations.
    e. Initial and 24-hour disinfectant residuals in ppm. for each outlet tested.
    f. Coliform bacteria test results for each outlet tested.
    g. Certify water conforms, or fails to conform, to bacterial standards of MA DEP standards for drinking water.
    h. Water Quality Certificate: Certify water conforms to quality standards of MA DEP, suitable for human consumption.
4. QUALITY ASSURANCE
    a. Perform Work in accordance with AWWA C651 (equivalent to State standards).
    b. Maintain one copy of each document on site.
5. QUALIFICATIONS
    a. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.
    b. Testing Firm: Company specializing in testing and examining potable water systems, accepted by Commonwealth of Massachusetts.

c. Submit bacteriologist's signature and authority associated with testing.

6. DISINFECTION CHEMICALS
   a. Chemicals: Chlorine solution used for disinfecting springs, wells, and other water systems will consist of a solution of water and liquid chlorine, sodium hypochlorite, calcium hypochlorite, or chloride of lime.
   b. Liquid forms of chlorine or sodium hypochlorite and powder forms of calcium hypochlorite or chloride of lime will be used according to the instructions supplied by the manufacturer and as recommended by the Massachusetts Department of Health.
   c. If sodium hypochlorite is already in solution as a laundry bleach containing 5.25 percent sodium hypochlorite, it will be used at the rate of one part per 12,000 parts of water to be disinfected. The dosage should be sufficient to produce a chlorine taste in the water.
7. EXAMINATION
   a. Verify existing conditions before starting work.
   b. Verify piping system has been cleaned, inspected, and pressure tested.
   c. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting, and balancing, demonstration procedures, including coordination with related systems.
8. INSTALLATION
   a. Provide and attach required equipment to perform the Work of this section.
   b. Perform disinfection of water distribution system and installation of system and pressure testing.
   c. Introduce treatment into piping system at a concentration of 50 mg Cl/L.
   d. Maintain disinfectant in system for 24 hours.
   e. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
   f. Replace permanent system devices removed for disinfection.
9. Disinfection, Flushing, and Sampling:
   a. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted.
   b. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
   c. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
   d. After final flushing and before pipeline is connected to existing system, or placed in service, employ an accepted independent testing laboratory to sample, test and certify water quality suitable for human consumption.

3.09 FIELD QUALITY CONTROL

A. Sections 01 40 00 - QUALITY REQUIREMENTS and 01 70 00 – Execution and Closeout Requirements.

B. Pressure test system. Repair leaks and re-test.
   1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Architect/Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
   2. Provide equipment required to perform leakage and hydrostatic pressure tests.
   3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure,

whichever is greater.

4. Conduct hydrostatic test for at least two-hour duration. Submit FM Global certificate for underground leak pressure test to CM.
5. No pipeline installation will be accepted when pressure varies by more than five psi at completion of hydrostatic pressure test.
6. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, close corporation cocks and apply test pressure. At conclusion of tests, remove corporation cocks removed and plug resulting piping openings.
7. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
8. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
9. When leakage is detected, locate source, and make repairs. Repeat test until specified leakage requirements are met.

C. Compaction Testing for Bedding: In accordance with ASTM D1557.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

E. Frequency of Compaction Tests: As directed by Engineer.

END OF SECTION

SECTION 33 31 00
SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
   1. Install and test polyvinyl chloride (PVC) sewer pipe, complete as shown on the Drawings and as specified herein.
   2. Pipe or piping refers to all pipe, fittings, material, and appurtenances required to construct PVC gravity and pressure sewer pipe complete, in place.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
   1. Section 31 20 00 - Earth Moving: Soil for backfill in trenches.

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10 lb. Rammer and an 18 inch. Drop.

B. ASTM International:
   1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Rigid Poly (Vinyl Chloride) (CPVC) Compounds
   2. ASTM D1785 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   3. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
   4. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   5. ASTM D2466 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
   6. ASTM D2564 - Standard Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems.
   7. ASTM D2729 - Standard Specification for Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
   8. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly Vinyl Chloride (PVC) Pipe and Fittings.
   9. ASTM D6938- Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
   10. ASTM D3034 - Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.
   11. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals

12. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
13. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.04 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.05 SUBMITTALS

A. Section 01 30 00 - Administrative Requirements.
B. Product Data: Submit data indicating pipe material used, pipe accessories, and fittings.
C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.06 CLOSEOUT SUBMITTALS

A. Section 01 70 00 – Execution and Closeout Requirements.
B. Project Record Documents: Record location of pipe runs, connections, manholes, cleanouts, and invert in and invert out elevations.
C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.07 QUALITY ASSURANCE

A. All PVC sewer pipe will be from a single manufacturer. The supplier will be responsible for the provision of all test requirements specified in ASTM D3034 as applicable. In addition, all PVC pipe to be installed under this Contract may be inspected at the plant for compliance with these Specifications by an independent testing laboratory provided by the Town of Wilmington. The Construction Manager will require the manufacturer’s cooperation in these inspections. The cost of plant inspection of all pipe accepted for this Construction Manager, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the Town of Wilmington.
B. Inspections of the pipe may also be made by the Engineer or other representatives of the Town of Wilmington after delivery. The pipe will be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though the sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery will be marked for identification and will be removed from the job at once.

1.08 DELIVERY, STORAGE, AND HANDLING

A. All items will be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment will be replaced as directed by the Engineer.
B. PVC items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care will be taken in loading, transporting, and unloading items to prevent damage to the items. All items will be examined before installation and no piece will be installed which is found to be defective. Handling and installation of pipe and fittings will be in accordance with the manufacturer’s instructions, references standards, and as specified herein.
C. Any pipe or fitting showing a crack, or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, will be marked as rejected and removed at once from the work site.
D. While stored, the pipe will be adequately supported from below at not more than three-foot intervals to prevent deformation. The pipe will not be stacked higher than 6 feet.
E. Pipe and fittings will be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight. Temporary shading to meet this requirement will be provided. Simple covering of the pipe and fittings which allows temperature buildup, or direct or indirect sunlight will not be permitted.

F. If any defective item is discovered after it has been installed, it will be removed and replaced with an exact replacement item in a satisfactory manner by the Construction Manager, at the Construction Manager's own expense. All pipe and fittings will be thoroughly cleaned before installation and the interior will be kept clean until testing.

G. In handling the items, use special devices and methods as to achieve the results specified herein. No un-cushioned devices will be used in handling the item.

1.09 PRE-INSTALLATION MEETINGS

A. Convene a minimum of one week prior to commencing work on this section.

1.010 FIELD MEASUREMENT

A. Verify field measurements and elevations are as indicated.

1.011 COORDINATION

A. Coordinate the Work with abandonment of existing septic tanks and associated piping, and abandonment of existing leaching fields.

PART 2 - PRODUCTS

2.01 SANITARY SEWAGE GRAVITY PIPE

A. Plastic Pipe: ASTM D3034, Type PSM, SDR 35, Poly Vinyl Chloride (PVC) material; inside nominal diameter of 8-inch, bell, and spigot style rubber ring sealed gasket joint.
   1. Fittings: PVC.
   2. Push On Joints: ASTM F477, elastomeric gaskets per ASTM D3212, securely locked into place to prevent displacement during assembly.
   3. All fittings and accessories for sewer will have bell and/or spigot configurations compatible with the pipe.

2.02 UNDERGROUND PIPE MARKERS

A. Manufacturers:
   1. Any manufacturers of such products will be considered.
   2. Substitutions: Refer to Section 01 25 00 – Substitution Requirements.

B. Plastic Ribbon Tape: Bright colored, imprinted with "Sewer Line" in large letters, minimum 6 inches wide by 4 mil. thick, manufactured for direct burial service.

2.03 MANHOLES

A. In accordance with Section 33 05 13 - Manholes and Structures

2.04 BEDDING AND COVER MATERIALS

A. Bedding and Cover: 3/4-inch crushed stone in accordance with Section M2.01.4 of the MHD Standard Specifications.

B. Soil Backfill from Above Pipe: In pavement areas where controlled density fill is not specified, provide Ordinary Fill to the sub-base of the pavement, and then provide the required sub-base material for the pavement section. In grassed areas where controlled density fill is not specified, provide Special Borrow per MassDOT Spec. M1.02.0 to a point 6 inches below finished grade, then Manufactured Topsoil to finished grade.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on the Drawings.

3.02 PREPARATION

A. Correct over excavation with coarse aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.03 BEDDING

A. Excavate pipe trench in accordance with Section 31 20 00 – Earth Moving.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding six inches.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.04 INSTALLATION OF PVC PIPE AND FITTINGS

A. No single piece of pipe will be laid unless it is straight. The centerline of the pipe will not deviate from a straight line drawn between the centers of the opening at the ends of the pip by more than 1/16 inch per foot of length. If a piece of pipe fails to meet this required check for straightness, it will be rejected and removed from the site. Laying instructions of the pipe will be explicitly followed.

B. If any defective pipe is discovered after it has been installed, it will be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Town of Wilmington. All pipe and fittings will be thoroughly cleaned before installation, will be kept clean until they are used in the work, and when laid will conform to the lines and grades required. PVC pipe and fittings will be installed in accordance with requirements of the manufacturer, ASTM D2321 or as otherwise provided herein.

C. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding will be placed, compacted, and graded to provide firm, uniform, and continuous support for the pipe. Bell holes will be excavated so that only the barrel of the pipe bears upon the bedding. The pipe will be lad accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted. Bedding will be placed evenly on each side of the pipe to mid-diameter and hand tools will be used to force the bedding under the haunches of the pipe and into the bell holes to give firm, continuous support for the pipe. The initial three feet of backfill above the bedding will be placed in one-foot layers and carefully compacted, where controlled density fill is not specified. Generally, the compaction will be done evenly on each side of the pipe and compaction equipment will not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial three feet of backfill will be accepted by the pipe manufacturer prior to use.

D. All pipe will be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the pipe will be closed by watertight plug or other accepted means. Good alignment will be preserved during installation. The deflection at joints will not exceed that recommended by the manufacturer. Fittings, in addition to those shown on the plans, will be provided, if required, in crossing utilities which may be encountered upon opening the trench.

E. When cutting pipe is required, the cutting will be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of the pipe to be used with a bell will be beveled to the manufactured spigot end.

F. The Engineer may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces will be rejected, marked as such and immediately removed from the job site.

G. Each length of the pipe will have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints will not be ‘pulled’ or ‘cramped.’

H. Before any joint is made, the pipe will be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe will not be driven down to grade by striking it.

I. Precautions will be taken to prevent flotation of the pipe in the trench.

J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care will be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates will not be allowed to extend below the top of the pipe. If trench boxes, moveable sheeting, shoring or plates have been installed below the top of the pipe, they will be moved slowly taking care not to disturb pipe, bedding,

or backfill. As trench boxes, moveable sheeting, shoring, or plates are moved, pipe bedding will be placed to fill any voids created and the backfill will be re-compacted to provide uniform side support for the pipe.

3.05 JOINTING PVC PIPE (PUSH ON TYPE)

A. Joints will be made in strict accordance with the manufacturer's instructions. Pipe will be laid with bell ends looking ahead (upgradient of the spigot end). A rubber gasket will be inserted in the groove of the belled end and the joint surfaces cleaned and lubricated. The plain edge of the pipe to be entered will then be inserted in alignment with the bell of the pipe to which is it to be jointed and pushed home with a come-along or by other means. Check that the reference mark on the spigot is flush with the end of the bell.

3.06 JOINTING PVC SEWER PIPE AND FITTINGS

A. PVC sewer pipe and fittings will be jointed in accordance with the recommendations of the latest ASTM standards and detailed instructions of the manufacturer. The pipe manufacturer will furnish information and supervise the installation of at least the first five joints.

B. All manhole connections will be as shown on the Drawings except that concrete and mortared connections will be equipped with an integral o-ring or other sealant such that a positive watertight seal is established.

3.07 SERVICE CONNECTIONS

A. Service connections will be installed at a minimum slope of two percent at the locations and to the limits determined by the Engineer in the field. In each case the end will be capped, backed with a #2 reinforcing rod welded to a six-inch x six and a quarter-inch steel plate extending to six inches below the finished ground surface as shown on the Drawings.

B. Service connections will be 8-inch diameter PVC unless otherwise shown on the Drawings.

C. Service connections will be made at a point 10 feet outside the foundation of the building in accordance with the Uniform Plumbing Code. If the existing building surface is in structurally deficient condition or constructed of a material not accepted by the plumbing inspector, the Construction Manager will stop work immediately and contact the Engineer.

3.08 INSTALLATION - MANHOLES

A. In accordance with Section 33 05 13 – Manholes and Structures

3.09 FIELD QUALITY CONTROL

B. Refer to Sections 01 40 00 - Quality RequirementsPerform test on site sanitary sewage system in accordance with municipal standards.

C. Request inspection by Engineer prior to and immediately after placing bedding and piping. Provide minimum 24-hour notice. The Board of Health will inspect all work prior to issuing its acceptance. The Board of Health will be given a minimum of 24 hours advance notice when requesting an inspection. The Construction Manager will comply with all inspection requirements of the Town of Wilmington.

D. Compaction Testing: In accordance with ASTM D1557.

E. When tests indicate Work does not meet specified requirements, remove work, replace, and retest.

F. Frequency of Compaction Tests: As directed by Engineer.

3.10 PROTECTION OF FINISHED WORK

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

3.11 TESTING (GRAVITY PIPELINES)

A. Deflection testing of pipe will be specified as follows:

1. Pipe deflection measured not less than 90 days after the backfill has been completed as specified will not exceed 5 percent. Deflection will be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.
2. Deflection will be measured by a rigid mandrel (Go/No Go) device cylindrical in shape with a minimum of nine or ten evenly spaced arms or prongs. Drawings of the mandrel

with complete dimensions will be submitted to the Engineer for each diameter of pipe to be tested. The mandrel will be hand pulled through all sewer lines.

3. Any section of sewer not passing the mandrel will be uncovered at no additional cost to the Town of Wilmington and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe will be retested at no additional cost to the Town of Wilmington. Retested pipe will not deflect more than 5 percent.

B. Low pressure air testing of pipe will be specified as follows:

1. For making the low-pressure air tests, use equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. The equipment will be provided with an air regulator valve or air safety so set that the internal air pressure in the pipeline cannot exceed 8 psig.
2. The leakage test using low pressure air will be made on each manhole-to-manhole section of pipelines after placement of the backfill.
3. Pneumatic plugs will have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs will resist internal test pressures without requiring external bracing or blocking.
4. All air used will pass through a single control panel.
5. Low-pressure air will be introduced into the sealed line until the internal air pressure reaches four psig greater than the minimum pressure exerted by the groundwater that may be above the invert at the pipe at the time of the test. However, the internal air pressure in the sealed line will not be allowed to exceed eight psig. When the maximum pressure exerted by the groundwater is greater than four psig, conduct only an infiltration test, as specified below.
6. Testing will be in accordance with the requirements of ASTM F1417-11AR19E01. The following italicized text contains selected text from ASTM F1417 (Gravity Sewer Lines).
   - The section of the line to be tested is plugged. Air, at low pressure, is introduced into the plugged line. The line passes the test if the rate of air loss, as measured by pressure drop, does not exceed a specified amount in a specified time.
   - Pressure drop may be determined by using Table 1 or calculated by use of the formulas below.

TABLE 1: Minimum Specified Time Required for a 0.5 psig Pressure Drop for Size and Length of Pipe Indicated for Q = 0.0015 (NOTE-Consult with pipe and appurtenance manufacturer for maximum test pressure for pipe size greater than 30 inch in diameter.)

Pipe Dia	Minimum Time, min:sec	Length for Min. Time, ft	Time for Longer Length, s	Specification Time for Length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3.12
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5.04	5.42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7.54	8.54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11.24	12.50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17.48	20.02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25.38	28.51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	28:11	30:32	34.54	39.16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45.35	51.17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:18	50:30	57.42	64.54

30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71.13	80.07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86.10	96.57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102.34	115.23

- Calculate all test times by the following formula: T= 0.085 DK/Q, where: T = shortest time allowed for the air pressure to drop 1.0 psig, K = 0.000419 DL but not less than 1.0, Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF, D = measured average inside diameter of sewer pipe (see Method D 2122 and Practice D 3567), inch., and L = length of test section, feet.
- Table 1 contains the specified minimum times required for a 1.00 psig pressure drop from a starting pressure of 3.5 psig to a final pressure of 2.5 psig using a leakage rate of 0.0015 ft3/min/ft2 of internal surface.

C. Infiltration testing of pipe will only be carried out when the depth of groundwater is so great that low pressure air testing cannot be adequately performed; otherwise low-pressure air testing will be performed as specified above. The procedure for infiltration testing of pipe is as follows:
   1. For making the infiltration tests, underdrains, if used, will be plugged and other groundwater drainage will be stopped to permit groundwater to return to its normal level insofar as practicable.
   2. Upon completion of a section of the sewer, dewater it and conduct a satisfactory test to measure the infiltration for at least 24 hours. The amount of infiltration, including manholes, tees, and connections, will not exceed 200 gallons per inch diameter per mile of sewer per 24 hours.

END OF SECTION

SECTION 33 41 00
STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The Construction Manager, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section will also be bound by the documents identified in Division 00 Procurement and Contracting Requirements and Division 01 General Requirements.

B. The Construction Manager will either perform the work of this section with its own forces or will subcontract such work to a subcontractor who will furnish a performance and payment bond for the complete scope of work and listing the Town of Wilmington as the co-oblige. Such bond will be procured from a surety that is currently licensed to do business in Massachusetts and is currently listed on the United States Treasure Department circular 570. A copy of such bond will be submitted to the Town of Wilmington's Project Manager for acceptance and will be in place prior to the subcontractor commencing any work on the project.

1.02 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install high density polyethylene pipe, fittings and appurtenances as indicated and as specified herein.

1.03 RELATED WORK

A. Section 31 20 00 - Earth Moving

B. Section 33 05 13 - Manholes and Structures

C. Provision of waste management: Section 01 74 19, Construction of Waste Management Plan.

1.04 SUBMITTALS

A. Submit the name of the pipe and fitting suppliers and Shop Drawings, showing layout details of reinforcement, joint, method of manufacture, and installation of pipe, specials, and fittings for the entire job.

B. Prior to each shipment of pipe submit certified test reports and a notarized affidavit stating that all pipe meets requirements of ASTM D1238 and ASTM D1505.

1.05 REFERENCED STANDARDS

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

1. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
2. ASTM D1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
3. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
4. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
5. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.
6. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
7. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe and (SDR-PR) Based on Outside Diameter.
8. ASTM C507 - Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

B. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening will apply.

PART 2 - PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. High Density Polyethylene (HDPE) Pipe resins will be high molecular weight, high density

polyethylene with a cell classification number of 424420C in accordance with ASTM D3350.

B. HDPE will have a smooth interior and annular exterior corrugations, 12 inch through 60-inch piping will meet ASTM F2648 and will be either AASHTO Type 'S' or Type 'D'.

C. Pipe will be joined using a bell and spigot joint meeting ASTM F2648. The joint will be soil-tight and gaskets, when applicable, will meet the requirements of ASTM F477. Gaskets will be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer will be used on the gasket and bell during assembly.

D. Pipe will support an HS-20 live load with a maximum deflection of five percent of the minimum pipe diameter.

E. Pipe will be furnished in standard laying lengths not exceeding 25 feet.

F. All single pipe high density polyethylene pipe and fittings will be made from the same resin.

G. Pipe will comply with the requirements for test methods, dimensions and markings found in AASHTO Designations M252 and M294.

2.02 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete sewer pipe and fittings will be ASTM C76 or ASTM C655, and ASTM C507 for vertical reinforced-concrete elliptical pipe.

1. Bell-and-spigot ends and rubber gasketed joints with ASTM C443.
2. Class III pipe will be used for typical installations.
3. Class V pipe will be used where cover is two ft. or less, where indicated on the plans, for vertical reinforced-concrete elliptical pipe, and where recommended by the manufacturers.

2.03 POLYVINYL CHLORIDE (PVC):

A. Pipe and Fittings, Type PSM PVC Pipe, will conform to ASTM D3034, Type PSM, SDR 35. Pipe and fittings will have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D 3212. Gaskets will conform to ASTM F 477. Solvent welded joints will not be permitted.

2.04 UNDERGROUND PIPE MARKERS

A. Manufacturers:

1. Any manufacturers of such products will be considered.
2. Substitutions: Refer to Section 01 25 00 – Substitution Requirements.

B. Plastic Ribbon Tape: Bright colored, imprinted with "Storm Drain Line" in large letters, minimum 6 inches wide by four mil. thick, manufactured for direct burial service.

2.05 PIPE IDENTIFICATION

A. The following will be continuously indent printed on the pipe and spaced at intervals not exceeding five feet.

1. Name and/or trademark of the pipe manufacturer.
2. Nominal pipe size.
3. Dimension ratio.
4. The letters PE followed by the polyethylene grade in accordance with ASTM D1248, followed by the hydrostatic design basis in 100's of psi., e.g., PE 3408.
5. Manufacturing standard reference, e.g., ASTM F714.
6. A production code from which the date and place of manufacture can be determined.

PART 3 - EXECUTION

3.01 INSTALLATION - PIPE

A. High Density Polyethylene (HDPE) Pipe will be installed in accordance with the instruction of the manufacturer, as indicated and as specified herein.

B. Polyvinyl Chloride (PVC) Pipe will be installed in accordance with the instruction of the manufacturer, as indicated and as specified herein.

C. Pipe will be laid to lines and grade as indicated with bedding and backfill as indicated.

D. When laying is not in progress, the open ends of the pipe will be closed by fabricated plugs, or by other accepted means. All plugs will be OD fitting type plugs. No plugs will be allowed that require insertion of the plug into the pipe.

E. Pipe will be stored on clean level ground to prevent scratching or gouging. The handling of the pipe will be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches, or gouges on the exterior of the pipe is 10 percent of the wall thickness. The interior pipe surface will be free of cuts, gouges, or scratches.

F. Sections of pipe with cuts, scratches, or gouges deeper than allowed will be removed completely and replaced and the ends of the pipeline rejoined at no additional cost to the Town of Wilmington.

G. Single pipe systems will be jointed by the method of thermal butt fusion, as outlined in ASTM D2657. All joints will be made in strict compliance with the manufacturer's recommendations.

H. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

3.02 TESTING

A. HDPE storm drain pipe installations will be mandrel tested to ensure that the pipe has maintained a circular shape in cross section throughout installation. The pipe will remain within 5 percent of a true circular shape. Pipe deflection beyond five percent will be repaired by reinstallation.

3.03 CLEAN UP

A. Prior to Final Completion of the Work, thoroughly clean all the new pipelines and remove all dirt, stones, and pieces of wood or other materials.

END OF SECTION

SECTION 33 49 23
STORM DRAINAGE RETENTION STRUCTURES

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

A. Attention is directed to the Contract and General Conditions and all Sections within Division 01 - General Requirements which are hereby made a part of this Section of the Specifications.

B. The Construction Manager will either perform the Work of this Section with its own forces or will subcontract such Work to a subcontractor who will furnish a performance and payment bond for the complete scope of Work and listing the Town of Wilmington as the co-obligee. Such bond shall be procured from a surety currently licensed to do business in the Commonwealth of Massachusetts and currently listed on United States Treasury Department Circular 570. A copy of such bond shall be submitted to the Town of Wilmington Project Manager for acceptance and shall be in place prior to the subcontractor commencing Work on the Project.

1.02 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to install precast concrete stormwater management structures for detention, retention, and infiltration systems, including precast components, crushed stone bedding, waterproof membrane and geotextile containment wrap where required, inlet splash pads, access structures, pipe connections, internal flow controls, outlet control structures, and appurtenances as indicated and as specified herein.

1.03 RELATED WORK

A. Section 31 20 00, Earth Moving.

B. Section 33 05 13, Manholes and Structures.

C. Section 33 41 00, Storm Utility Drainage Piping.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's product information and current installation guide for the complete stormwater management system and appurtenances.

B. Shop Drawings: Submit shop drawings for review and approval prior to installation. Drawings shall include dimensions, elevations, layout, and configuration of the system, including internal flow controls, attenuation channels, weirs, baffles, orifices, overflow devices, inlet splash pads, sumps, outlet control structures, access openings, and inlet/outlet pipe openings.

C. Structural Calculations: Submit structural calculations for the precast system prepared, signed, and sealed by a Professional Engineer licensed in the Commonwealth of Massachusetts. Calculations shall address design loading, soil bearing, cover conditions, groundwater, and buoyancy where applicable.

D. Quality Control Documentation: Submit evidence that the precast concrete manufacturer is an NPCA certified plant or otherwise approved by the Engineer.

E. Materials Documentation: Submit concrete mix design, reinforcement data, lifting device data, membrane and geotextile product data, joint sealant data, pipe boot and flange gasket kit data, and waterproof grout or sealant product data, as applicable.

F. Field Verification: Submit written confirmation of subgrade bearing capacity and groundwater elevation conditions prior to placement of the system.

G. Record Information: Submit final installed layout, invert elevations, access locations, and manufacturer-required installation records, if required by the Contract Documents.

1.05 QUALITY ASSURANCE

A. Precast concrete structures and components shall be manufactured in accordance with the approved design shop drawings.

B. Precast concrete structures shall be manufactured by an NPCA certified plant.

C. The Construction Manager shall obtain and be familiar with the manufacturer's product installation guide prior to installation.
D. Where manufacturer's requirements conflict with the Contract Documents, notify the Engineer before proceeding. The more stringent requirement shall govern if discrepancies exist between manufacturer requirements and the Contract Documents.

1.06 REFERENCED STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO HS-20-44 - Highway loading criteria referenced for H-20 design loading.
B. American Concrete Institute (ACI):
   1. ACI 318 - Building Code Requirements for Structural Concrete.
C. ASTM International (ASTM):
   1. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   2. ASTM C33/C33M - Standard Specification for Concrete Aggregates.
   3. ASTM C150/C150M - Standard Specification for Portland Cement.
   4. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   5. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
D. National Precast Concrete Association (NPCA):
   1. NPCA Plant Certification Program and applicable quality control requirements.
E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening will apply, unless otherwise required by governing codes or authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS

A. Substitutions: Refer to Section 01 25 00 - Substitution Requirements. Proposed substitutions shall demonstrate equivalency in storage volume, structural capacity, layout, hydraulic performance, access, maintenance, and installation requirements.

2.02 PRECAST CONCRETE STORMWATER STRUCTURES

A. Precast concrete structures and components shall be manufactured in accordance with the approved design shop drawings.
B. Precast concrete shall have a minimum compressive strength of 5,000 psi at 28 days.
C. Reinforcing steel shall conform to ASTM A615/A615M.
D. Design shall conform to H-20 loading conditions per AASHTO HS-20-44.
E. Precast vendor shall supply sufficient lifting devices cast into the structures capable of supporting the structures during handling and installation.
F. Provide structure openings, access openings, inlet/outlet penetrations, sumps, internal baffles, weirs, orifices, overflow devices, and other internal flow control components as indicated on the approved shop drawings and Contract Drawings.

2.03 STRUCTURAL DESIGN REQUIREMENTS

A. Soil strength shall be verified to provide a minimum soil bearing capacity of 3,000 pounds per square foot, unless a higher capacity is required by the approved structural calculations or Contract Drawings.
B. Subgrade soils shall be compacted to 95 percent of maximum dry density, unless more stringent requirements are indicated in Section 31 20 00 or on the Drawings.
C. Water table elevation shall be verified to be below the system structural section for structural and buoyancy conditions. If groundwater elevation is higher than the structure base, buoyancy calculations shall be submitted for review prior to installation.
D. Buoyancy calculations shall assume a concrete density of 150 pcf. Soils above units may be considered in the calculations using a soil density of 120 pcf. The effects of sidewall friction shall not be used in buoyancy calculations.

2.04 GEOTEXTILE, MEMBRANE, AND SEALING MATERIALS

A. Waterproof Membrane: PPL-24, 24-mil containment membrane supplied by Carthage Mills, or approved equal, where a watertight detention or retention system is required.

B. Geotextile Fabric Pads: 803 PROPEX 801 non-woven geotextile by Carthage Mills, or approved equal, installed as protection for the membrane and as indicated on the Drawings.

C. Joint Sealant Tape: ConSeal CS-212 ribbon tape, 0.065-inch-thick by six-inch-wide, or approved equal.

D. Pipe Boot and Flange Gasket Kits: Watertight rubber boot and flange gasket kit supplied by the system vendor, sized for the proposed inlet/outlet pipe materials and diameters.

E. Auxiliary Sealants: ConSeal CS-102 rope tar, ConSeal CS-212 ribbon tape, Sikaflex 1a construction sealant, waterproof grout, or approved equal for corrugated pipe adapters, pipe penetrations, and field sealing.

2.05 BEDDING AND BACKFILL MATERIALS

A. Crushed Stone Base: Minimum six-inch thickness of 3/4-inch-plus crushed stone, placed level and compacted to 95 percent density, unless otherwise indicated on the Drawings.

B. Backfill: Select native material, structural fill, or structural stone as indicated on the Drawings and accepted by the Engineer.

C. Backfill shall be free from deleterious materials, organics, trash, debris, frozen material, and stones larger than three inches in diameter within six inches of the system top.

2.06 ACCESSORIES AND APPURTENANCES

A. Provide precast concrete or cast-in-place inlet splash pads, sumps, outlet control structures, internal flow control structures, manhole access structures, attenuation channels, weirs, baffles, orifices, overflow devices, pipe adapters, and other appurtenances as indicated on the Contract Drawings and approved shop drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. Install the system in accordance with the approved engineering drawings, approved shop drawings, specifications, structural calculations, and manufacturer's installation guide. Location, dimensions, elevations, pipe sizes, pipe inverts, and access manholes shall be as indicated on the Drawings.

B. Manufacturer’s installation instructions shall supplement the Contract Drawings and approved shop drawings. Actual design may vary. Follow the accepted construction drawings and approved shop drawings as the primary guide.

C. Do not permit construction loads or traffic over the system except in accordance with manufacturer's requirements and the approved structural design.

3.02 EXAMINATION

A. Verify that excavation limits, subgrade elevation, subgrade bearing capacity, groundwater elevation, and proposed system layout are consistent with the Contract Drawings and approved shop drawings.

B. Report discrepancies with the system subgrade soil bearing capacity, groundwater elevation, dimensions, pipe alignments, or elevations to the Engineer before proceeding.

C. Do not begin installation until unacceptable conditions have been corrected and accepted by the Engineer.

3.03 EXCAVATION AND SUBGRADE PREPARATION

A. Excavate the installation area to the specified subgrade elevation.

B. Grade subgrade soils to a consistent level bed free from deleterious materials, including organics, trash, debris, frozen material, and loose or unsuitable soils.

C. Compact subgrade soils to 95 percent density. Maintain prepared subgrade in a firm, stable, and level condition until bedding materials are placed.

3.04 MEMBRANE AND GEOTEXTILE INSTALLATION

A. For detention or retention systems requiring watertight containment, place waterproof membrane sandwiched between geotextile fabric pads over the complete base and sides of the excavation walls.

B. Wrap membrane and fabric pads to contain the required crushed stone base section and to isolate the exterior perimeter of the structures from native material backfill.

C. Wrap fabric over the top of the structures a minimum of 4 feet, except where indicated otherwise on the Drawings.

D. Install fabric and membrane to create a waterproof wrap. Corner folds shall overlap and be folded upward to reduce potential for water entry.

E. ConSeal CS-212 ribbon tape, or approved equal, may be used to adhere and hold membrane and fabric materials in place during excavation and backfill operations.

F. For infiltration systems, omit waterproof membrane unless specifically indicated on the Drawings. Install geotextile and separation materials as indicated.

3.05 BEDDING

A. Install a minimum six-inch thickness of 3/4-inch-plus crushed stone base on top of the filter fabric in the bottom of the excavation, compacted to 95 percent density and graded level.

B. Do not place precast structures on disturbed, uneven, frozen, or otherwise unsuitable bedding.

3.06 PRECAST STRUCTURE INSTALLATION

A. Install precast concrete structures to the specified grades and locations shown on the Drawings and approved shop drawings.

B. Install the structures level and plumb. Minimize gaps between structures to an average of not more than 1/4 inch and no gap greater than 1/2 inch.

C. Unless otherwise noted, structure bottom and top elevations shall be equal to within 1/2 inch.

D. Install precast concrete or cast-in-place inlet splash pads to the specified grade and locations shown on the Drawings.

E. Seal exterior top joints with ConSeal CS-212 ribbon tape, 0.065 inch thick by 6 inches wide, or approved equal. Apply tape to clean, dry surfaces prepared in accordance with manufacturer's recommendations. Apply tape in continuous lengths; where splicing is required, provide a minimum 12-inch overlap.

3.07 PIPE CONNECTIONS

A. Install all pipe inverts to the specified elevations.

B. For inlet/outlet pipes penetrating a membrane system, provide a watertight rubber boot and flange gasket kit supplied by the system vendor.

1. Install rubber boot inside the pipe hole cut into the structure wall. Hole shall be clean, smooth, and free of loose or foreign material.
2. Fit rubber boot tight and snug against the receiving concrete wall section.
3. Tighten the internal metal expansion ring to manufacturer's recommended torque.
4. Slip pipe into the rubber boot and tighten the external metal pipe clamp to manufacturer's recommended torque.

C. Where corrugated pipe is used, provide pipe adapter or sealing material to fill the cavity and produce a flat surface for connection of the pipe boot. Acceptable materials include ConSeal CS-102 rope tar, ConSeal CS-212 ribbon tape, Sikaflex 1a construction sealant, or approved equal.

D. Watertight detention systems shall include a flanged gasket plate sealing the membrane against the wall of the concrete structure at pipe penetrations.

1. Apply a minimum of one continuous band of ConSeal CS-212 ribbon tape against a clean, smooth structure outside wall.
2. Cut the membrane hole large enough to fit the outside diameter of the pipe through at the pipe protrusion location.

3. Press the membrane against the band of CS-212, compressing and adhering the membrane to the sealant band.
4. Place the flange ring around the opening in the membrane, press into place, and fasten with Power-Stud threaded expansion fasteners or approved equal.
5. Use a minimum of four fasteners for smaller diameters and additional fasteners to ensure the ring seats in a flat watertight fit. Torque nuts to hold the ring in place.
6. Fill any wall perforation holes visible between the inside diameter of the ring and the outside diameter of the pipe with waterproof grout.

E. For infiltration systems, a masonry grout filled pipe hole is sufficient unless otherwise indicated.

F. For internal piping configurations, a rubber boot system or masonry grout filled pipe hole is sufficient unless otherwise indicated.

3.08 INTERNAL FLOW CONTROLS AND ACCESS STRUCTURES

A. Install internal flow control structures, attenuation channels, weirs, baffles, orifices, overflow devices, sumps, and outlet control structures in accordance with the Contract Drawings and approved shop drawings.

B. Install manhole access structures and access openings in accordance with the Contract Drawings, approved shop drawings, and Section 33 05 13.

3.09 BACKFILL

A. Backfill around and on top of structures with select native material, structural fill, or structural stone as indicated on the Drawings.

B. Place backfill in nine-inch maximum loose lifts and compact each lift to 95 percent density, unless otherwise indicated.

C. Backfill shall not contain deleterious materials or stones larger than 3 inches in diameter within 6 inches of the system top.

D. Place backfill carefully to prevent displacement of precast structures, damage to pipe penetrations, damage to membrane or geotextile, and damage to sealants.

3.10 CLEANING

A. Prior to Final Completion of the Work, thoroughly clean the storm drainage retention structures, access structures, and connected pipe openings, and remove dirt, stones, pieces of wood, construction debris, and other materials.

END SECTION