TECHNICAL SPECIFICATIONS

All work done under this Contract shall be in conformance with the 1988 Massachusetts Highway Department Standard Specifications for Highways and Bridges; the Supplemental Specifications, dated June 15, 2012; the latest Interim Supplemental Specifications; the Technical specifications contained in this book; the 2014 Construction Standard Details; the 1996 Construction and Traffic Standard Details (as related to traffic standard details only), the latest “Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)” with Massachusetts amendments; the 1990 Standard Drawings for Signs and Supports; the 1968 Standard Drawings for Traffic Signals and Highway Lighting; the latest edition of American Standards for Nursery Stock, City of Lowell Standards, the Plans, and these Special Provisions.

The General Conditions, Supplementary Conditions and Special Provisions shall take precedence over the General Requirements of Division I of the Standard Specifications.
ITEM 102.51   INDIVIDUAL TREE PROTECTION    EACH

The work under this item shall conform to the relevant provisions of Sections 101 and 771 and the following:

The purpose of this item is to prevent damage to branches, stems and root systems of existing individual trees to remain and to ensure their survival. Provisions under this item include steps to minimize soil and root disturbance and to construct protection measures for trees close to construction areas.

Examination of Conditions

The Contractor shall be solely responsible for judging the full extent of the work requirements, including, but not necessarily limited to any equipment and materials necessary for providing tree protection.

Prior to any construction activities, the Contractor shall walk the site with the Engineer and Owner to identify which trees will require protection and to determine approved measures. The Engineer and Owner will have final decision as to tree protection and methods.

The Contractor is responsible for the protection of all existing trees and plants within and immediately adjacent to the construction area that are not designated to be removed for the length of the construction period.

Incidental to the cost of these items, the Contractor shall retain the services of a certified arborist, who shall make recommendations as to the specific appropriate treatment of trees within or near the work zone.

Submittals

Incidental to this item, the Contractor shall provide to the Engineer one (1) copy each of American National Standards Institute (ANSI) Standard Z-133.1 and A300 Standard Practices for Tree, Shrub, and Other Woody Plant Maintenance, Part 1: Pruning. These references shall be kept by the Engineer at his office for the length of the Contract.

Prior to start of work, the Contractor shall submit to the Engineer the name and certification number of the Massachusetts Certified Arborist referenced herein. Cost for Certified Arborist for all activities pertaining to this Item shall be incidental to this item.

Materials

Fence and temporary fence posts shall be subject to the approval of the Engineer. Fencing for individual plants shall be polyethylene fencing or chain link fence (new or used).

Staking for individual tree protection fencing shall be steel posts or 2x4 inch stock as directed and approved by the Engineer.

Wood chips shall conform to provisions of Wood Chip Mulch under Materials Section M6.04.3.

Trunk protection shall be 2x4 inch (50x100 mm) cladding, at least 8 feet in length, clad together with wire. Trunk protection shall include burlap.
ITEM 102.51 (Continued)

Incidental to these items, the Contractor shall provide water for maintaining plants in the construction area that will have exposed root systems for any period during construction.

Construction Methods
To the extent possible, to avoid soil compaction within the root zone, construction activities including, but not limited to, vehicle movement, excavation, embankment, staging and storage of materials or equipment shall not occur underneath the canopy (drip line) of trees to remain. Where these activities will occur within 10 feet of the canopy of trees, the Contractor shall provide Individual Tree Protection as specified herein.

Tree Fencing and Armoring
For individual tree protection, the Contractor shall set posts and fencing at the limits of the tree canopy or as directed by the Engineer and/or Arborist. Where construction activities closer to the trees is unavoidable, the contractor shall tie branches out of the way and place wood chips to a depth of 6 inches on the ground to protect the root systems. The Contractor shall wrap the area of the trunk of the tree with burlap prior to armoring with 2x4 inch cladding. Cladding for tree trunks shall extend from the base of the tree to at least 8 feet from the base.

Where excavation within canopy is unavoidable, the Contractor shall use equipment and methods that shall minimize damage to the tree roots, per recommendations of the Certified Arborist. Such methods may require root pruning prior to, as well as during, any excavation activities.

All fencing, trunk protection, branch protection, and woodchips shall be maintained throughout the duration of the contract. Protective fencing shall be repaired and woodchip mulch replaced as necessary during the duration of the contract at no additional cost.

Cutting and Pruning
Some pruning of roots and branches may be a necessary part of construction. Pruning will be performed on the same side of the tree that roots have been severed.

The Contractor shall retain the services of a Massachusetts State Certified Arborist to oversee any cutting of limbs, stem or roots of existing trees. All cuts shall be clean and executed with an approved tool. Under no circumstances shall excavation in the tree protection area be made with methods that might substantially damage the existing root systems. Excavation operations in these areas shall be monitored by the Certified Arborist to ensure that the impact to root systems is held to a minimum.

Any tree root area exposed by construction shall be covered and watered immediately. Exposed tree roots shall be protected by dampened burlap at all times until they can be covered with soil.

Watering
Water each tree within the construction area where work is in progress twice per week until the surrounding soil of each tree is saturated for the duration of construction activities.

Removal of Protection
After all other construction activities are complete, but prior to final seeding, wood chips, temporary fencing, branch protection, and trunk protection materials shall be removed and disposed of off-site by the Contractor at no additional cost.
ITEM 102.51 (Continued)

Tree Damage

The Contractor shall be held responsible for the health and survival of the existing trees in the immediate vicinity of the construction area. Damage that, in the Engineer's opinion, can be remedied by corrective measures shall be repaired immediately. Broken limbs shall be pruned according to industry standards. Wounds shall not be painted. Trees or shrubs that are damaged irreparably shall, at the Engineer's discretion, be replaced per the requirements of Division I of these Special Provisions. Cost of replacement trees shall be borne by the Contractor.

Measurement and Payment

Individual Tree Protection will be measured and paid for at the contract unit price per each, which price shall include full compensation for all labor, equipment, materials, and incidentals for the satisfactory completion of the work, including the services of a certified arborist, water and fertilizer, fencing, mulch, equipment, tools and the subsequent removal and satisfactory disposal of the protective materials upon completion of the contract, and incidental costs required to complete the work.

Item payment shall be scheduled throughout the length of contract: 30 percent of value shall be paid upon installation, 30 percent approximately halfway through the contract, and the remainder to be paid at the end of the contract after completion of construction operations that would disturb plants and after the protection materials have been removed and properly disposed of off-site by the Contractor.

No separate payment will be made for the fencing or the wood chips, but all costs in connection therewith shall be included in the price bid for Individual Tree Protection.
ITEM 120.1  UNCLASSIFIED EXCAVATION  CUBIC YARD

The work under this item shall conform to the relevant provisions of Section 120 of the Standard Specifications and the following:

The work shall include the disposal of existing materials shown on the drawings to be removed and reset, but which in the judgment of the Engineer are unsuitable for reuse in the proposed work and their disposal is not paid for under a separate item.

The work shall also include the excavation of material and debris of every description regardless of the type encountered; from within the project limits as shown on the drawings and as directed by the Engineer, except materials for which excavation is included with the work specified to be performed under other items.

All materials encountered under unclassified excavation that can meet the gradation of ordinary borrow shall be reused on site.

No separate payment will be made for the off-site disposal of all existing material unsuitable for reuse in the proposed work, but all costs in connection therewith shall be included in the price bid for unclassified excavation.
The work under this item shall include the preparation of a Health and Safety Plan (HASP). It is the Contractor's ultimate responsibility to ensure the health and safety of all of the Contractor's employees and subcontracting personnel, the Engineer's representatives, and the public and environment from any on-site chemical contamination.

A Certified Industrial Hygienist shall prepare the Health and Safety Plan or other competent person with the appropriate OSHA-required training to prepare such a plan. It shall include the components required by OSHA 29 CFR 1910.120(b). The preparer's name and work experience shall be included as part of the Health and Safety Plan submittal. The plan shall be designed to identify, evaluate, and control health and safety hazards and provide for emergency response, if needed. The plan should be drafted in accordance with requirements in the Activity and Use Limitations affecting the project site as identified in Section 180.5 LICENSED SITE PROFESSIONAL (LSP) SERVICES.

The Health and Safety Plan shall address OSHA training required for personnel on site.

The Health and Safety Plan shall be a dynamic document with provisions for change to reflect new information, new practices or procedures, changing site environmental conditions or other situations, which may affect site workers and the public. Health and safety procedures provided by the Contractor shall comply with all federal, state and local regulations that address employee working conditions (e.g. OSHA, RCRA, CERCLA, MADOS, etc.). Equipment used for the purpose of health and safety shall be approved by appropriate agencies and meet pertinent standards and specifications of the appropriate regulatory agencies.

The Health and Safety Plan shall be submitted to the Engineer for approval with compliance with these specifications at least four weeks prior to commencement of work. The review and acceptance of the plan by the Engineer does not relieve the Contractor of the responsibility for attaining the required degree of protection and training, or to comply with all laws, rules, regulations, standards or guidelines in effect during the execution of the Contract.

A copy of the Health and Safety Plan shall be maintained on-site at all times by the Contractor. The on-site copy shall contain the signature of the preparer, the Contractor's Project Manager, and each on-site employee and subcontractors. The employee's signature on the Health and Safety Plan shall be deemed prima facie evidence that the employee has read and understands the plan. A copy of the plan with signatures shall be submitted to the Engineer at the conclusion of the Contract, or at the Engineer's request. Signature sheets shall be submitted monthly, or at the request of the Engineer.

Health and safety plan will be paid for at the lump sum price bid for Item 180.1, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

**Implementation of the Health and Safety Plan**

For all construction activities in which handling or exposure to potentially hazardous materials, the Health and Safety Plan shall specify an on-site Safety Officer. The Site Health and Safety Officer duties shall include, but are not limited to: implementation of the Site Health and Safety Plan, training, evaluating risks, safety oversight, determining levels of personnel protection required, and performing any required monitoring at the site. A Daily log shall be kept by the on-site Safety Officer and provided weekly to the Engineer. This log shall be used to record a description of the
ITEM 180.1 (Continued)

weather conditions, levels of personnel protection being employed, monitoring data and any other information relevant to on-site safety conditions. The Site Health and Safety Officer shall sign and date the Daily log.

In the event that subsurface contamination is discovered during construction, the Site Safety Officer shall be present to oversee all handling, storage, sampling, and transport of such contaminated materials by others.

The level of protection, relative to respiratory and dermal hazards, required to ensure the health and safety of on-site personnel shall be stipulated in the Health and Safety Plan and will be subject to modification by the on-site Safety Officer based on changing site and weather conditions and the following factors: type of operation or activity (job hazard analysis), chemical compounds identified on-site, concentration of the chemicals, physical state of the hazardous materials, potential duration of exposure to hazardous materials, dexterity required to perform work, decontamination procedures, necessary personnel and equipment, and type of equipment to be utilized.

The Contractor shall provide appropriate personnel protective equipment for anyone working in an area either containing or suspected of containing a hazardous environment. This work will include both individuals physically working in these areas and those directing their work. Contingencies for upgrading the level of protection for on-site workers shall be identified in the Health and Safety Plan and the Contractor shall have the necessary materials/equipment on hand to implement the level of protection upgrade in a timely manner. Payment for this level of upgrade protection shall be paid for under Item 180.3 Personal Protection Level “C” Upgrade.

Implementation of Health and Safety Plan will be measured for payment by the number of working day hours the Health and Safety Plan is implemented, as determined by the Engineer and shall include the cost of enforcement by an on-site Safety Officer.

Implementation of health and safety plan will be paid for at the Contract unit price per hour, which price shall include all labor, materials, equipment and incidental costs required for the work.

No separate payment will be made for personnel protective clothing and equipment below Level ‘C’, but all costs in connection therewith shall be included in the unit price bid.

Personnel Protective Clothing and Equipment, Level 'C'

The Contractor shall provide disposable, protective clothing appropriate to the hazard level of the work to all workers. The protective clothing and equipment and its use shall be in strict compliance with the Health and Safety Plan (Item 180.1) included as part of these Contract Documents and all appropriate regulations that address employee working conditions.

Personnel protection Level 'C' will be measured for payment by the actual number of hours the protective clothing and equipment is used times the number of personnel supplied with the Level 'C' clothing and equipment.

Personnel protection Level C will be paid for at the Contract unit price per hour, which price shall include all labor, materials, equipment and incidental costs required to complete the work.
ITEM 180.2 IMPLEMENTATION OF HOUR HEALTH AND SAFETY PLAN

For all construction activities which require handling or exposure to potentially hazardous materials, the Health and Safety Plan shall specify an on-site Safety Officer. The Site Health and Safety Officer duties shall include, but are not limited to: implementation of the site Health and Safety Plan, training, evaluating risks, safety oversight, determining levels of personnel protection required, and performing any required monitoring at the site. A Daily Log shall be kept by the on-site Safety Officer and provided weekly to the Engineer. This log shall be used to record a description of the weather conditions, levels of personnel protection being employed, monitoring data and any other information relevant to on-site safety conditions. The Site Health and Safety officer shall sign and date the Daily Log.

In the event that subsurface contamination is discovered during construction, the Site Safety Officer shall be present to oversee all handling, storage, sampling, and transport of such contaminated materials.

The level of protection, relative to respiratory and dermal hazards, required to ensure the health and safety of on-site personnel will be stipulated in the Health and Safety Plan and will be subject to modification by the on-site Safety Officer based on changing site and weather conditions and the following factors: type of operation or activity, chemical compounds identified on-site, concentration of the chemicals, physical state of the hazardous materials, potential duration of exposure to hazardous materials, dexterity required to perform work, decontamination procedures, necessary personnel and equipment, and type of equipment to be utilized.

The Contractor shall be required to provide appropriate personnel protective equipment for anyone who is working in an area either containing or suspected of containing a hazardous environment. This work will include both individuals physically working in these areas and those directing the work of same. Contingencies for upgrading the level of protection for on-site workers will be identified in the Health and Safety Plan and the contractor shall have the necessary materials/equipment on hand to implement the level of protection upgrade in a timely manner. Payment for this level of upgraded protection shall be paid for under Item 180.3.

BASIS OF PAYMENT

Implementation of the Health and Safety Plan will be paid at the contract bid price per hour of implementing the plan and shall include the cost of enforcement by an on-site Safety Officer. Personnel protective clothing and equipment below Level "C" shall be considered incidental to the project and shall be a cost borne by the contractor.
ITEM 180.3 PERSONNEL PROTECTION HOUR
LEVEL 'C' UPGRADE

The Contractor shall provide to all workers disposable, protective clothing appropriate to the hazard level of the work. The protective equipment and its use shall be in strict compliance with the Health and Safety Plan (Item 180.1), and all appropriate regulations that address employee working conditions.

BASIS OF PAYMENT

Payment for Item 180.3 will be at the contract unit price, per hour, per man, required in level 'C' personnel protection.
The work under this item shall include the testing of contaminated soils, and suspected contaminated soils, and their excavation, handling and stockpiling.

Upon discovery of any contaminated or potentially contaminated soils or sediments, the Contractor shall immediately notify the Engineer and the City of Lowell’s Environmental Officer. The Contractor will arrange for the Contractor’s Licensed Site Professional (Contractor’s LSP) to evaluate and assess potential contamination.

The Contractor’s LSP shall be responsible for the evaluation of conditions evidencing possible contamination, such as non-natural discoloration of soil, petroleum or chemical odor, the presence of petroleum liquid or sheening on surface or groundwater, buried debris or any abnormal gas or materials in the ground which are known or suspected to be contaminated with oil or hazardous materials. Such evaluation shall include appropriate field tests in conformance with DEP and EPA protocols, and stockpile sampling and laboratory analysis. Sampling under this Item shall all include confirmatory sampling of excavations prior to backfill. All laboratories utilized shall meet the certification requirements of the Massachusetts Department of Environmental Protection (DEP).

Excavated materials determined to be contaminated or identified as potentially contaminated by the Contractor’s LSP shall be stockpiled onsite in locations approved by the City and by the Engineer. The Contractor shall provide a description and plan of proposed stockpile areas for approval by the Engineer prior to their use. Then City may require the Contractor to test soils within 2 feet of the surface at select stockpile locations to document existing conditions. Throughout the duration of the project, the Contractor will provide a written log which tracks the disposition of all soils excavated, identifying location of excavation, stockpile designation and ultimate disposition of all soil. This log shall be provided to the Engineer and updated no less frequently than every two weeks.

Contaminated or potentially contaminated soil shall not be mixed or stockpiled with clean soil. Stockpile areas will be graded such that stormwater runoff is diverted from the stockpiles soils; haybales or equivalent barriers will be placed around the perimeter of the stockpiles to prevent contact of runoff with contaminated soils. Leachate from stockpiles sediments shall be contained/controlled and not allowed to run off or mix with stormwater. Appropriate security will be established to minimize worker and passerby contact with stockpiles. The first lift of the stockpiled soils will be placed on a minimum of two layers of six-mil-thick or one layer of 20-mil-thick polyethylene barrier over existing soils or pavement. Stockpiles will be covered with six-mil-thick black polyethylene cover or equivalent covering to form a continuous waterproof barrier over the soil. The cover must be maintained by the Contractor throughout the stockpile period to prevent water from entering the soils and to prevent blowing dust. The transfer of soil shall be performed in such a manner as to prevent the spread of contaminated or potentially contaminated materials. Unless approved by the Engineer, stockpiles shall be no greater than 500 cubic yards. Each stockpile must be clearly separable from adjacent stockpiles and shall be marked via appropriate signage to conform to the contaminated material tracking log and stockpile plan. The Contractor’s LSP shall be responsible for monitoring the Contractor’s performance on material transport and stockpile management.
ITEM 180.4 (Continued)

Based on pre-characterization data and analysis, the Contractor’s LSP may determine that it is possible to live-load trucks for off-site disposition in order to save stockpiling expense.

Stockpiled soils will be characterized for purposes of onsite reuse, off-site disposal or recycling based on sampling and analysis to be conducted by the Contractor’s LSP. Additional sampling may be required for soils requiring off-site disposal/recycling to meet the requirements of the proposed receiving facility. Costs for disposal-related sampling shall be paid for under the Item 181.11.

The Contractor shall be required to supply all personnel and materials necessary to comply with this section and to support the anticipated levels of testing, protection and monitoring described above.

Monitoring/handling and stockpiling of contaminated soils will be measured for payment by the cubic yard of contaminated material monitored, handled and/or stockpiled as measured in place.

Monitoring/handling and stockpiling of contaminated soils will be paid at the Contract unit price per cubic yard, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

Payment for soils testing is described in Section 180.6 Miscellaneous Soil Testing.
A Licensed Site Professional (LSP) will be required to manage the reuse and/or disposal of on-site materials and provide the services necessary to comply with the requirements of the Massachusetts Contingency Plan (MCP), 310 CMR 40.000 and related Federal and state laws, with respect to the scope of work for this Contract. The Contractor’s LSP services are needed solely to support construction activities as needed at an open disposal site and the associated 21E Bill of Lading Paperwork. Ongoing follow-up MCP response actions are outside the scope of the contract. The Contractor shall submit the name and qualifications of the Licensed Site Professional (LSP) and all personnel working under this item to the Engineer and City’s LSP for review and approval at least two weeks prior to initial site activities. The Contractor’s LSP will have a current, valid license issued by the Massachusetts Board of Registration of Hazardous Waste Site Cleanup Professionals. The Contractor’s LSP shall have significant experience in the oversight of MCP activities at active construction sites.

Within the project limits, soil, sediments or groundwater may be considered suspect if they exhibit non-natural discoloration, petroleum or chemical odor, the presence of petroleum liquid or sheening on the ground or surface water or any abnormal gas, debris or materials in the ground. In addition, existing or prior land uses (for example, historic industrial or commercial uses, etc.) may render the soils, sediments or groundwater as suspect. At the direction of the Engineer, the LSP shall evaluate any suspect soils, sediment or groundwater by appropriate field screening and/or laboratory analysis.

The Contractor’s LSP shall review available environmental reports.

All of the reports can be found on the MassDEP Searchable Sites List:
http://public.dep.state.ma.us/SearchableSites2/Search.aspx

The applicable tracking numbers are found below:

- RTN 3-24236
- RTN 3-27324
- RTN 3-4796
- RTN 3-10720
- RTN 3-26816
- RTN 3-27315

The Contractor’s LSP shall meet with the City of Lowell, perform additional test pits and soil testing as appropriate and prepare a Soil and Groundwater Management Plan in accordance with existing Activity and Use Limitations documents describing the protocol related to the reuse and/or export of material excavated on-site and the import of fill material. The City will review the plan and provide the Contractor’s LSP with comments. The LSP shall review documents described in the Section 21 of the Special Conditions.

Generally, the Contractor and Contractor’s LSP will follow this protocol:
- Set-up a pre-construction meeting with the City’s LSP, the Contractor, the Contractor’s LSP and the Engineer to introduce players and discuss responsibilities;
- Contractor’s LSP to evaluate available environmental reports applicable to the site;
- Contractor’s LSP shall recommend the pre-characterization activities;
- LSP to perform test pits, take grab samples, send to lab for environmental and geotechnical testing as needed to supplement existing testing info;
- LSP to evaluate lab results and prepare a draft “pre-characterization memo” describing the contaminant limits for imported and exported soil, testing frequency and reporting requirements. The OWNER and VHB will review and comment. LSP to issue final memorandum.
- LSP and Contractor will implement protocol and will provide email copies of all related correspondence, testing results, Chain of custody documentation, etc. to the OWNER and the ENGINEER. The OWNER will review the data with regard the MCP standards and VHB will review data with regard to MassDOT standards for ordinary borrow.
- Contractor’s LSP shall monitor soil conditions via field screening instruments to evaluate consistency with pre-characterization data and to minimize additional analytical testing needs;
- Where possible, the pre-characterization data should be used to support offsite disposition to avoid redundancy of analytical data.

The Contractor’s LSP will be required to perform and document physical observations and field screening of soils during excavation activities; perform and document collection of samples for laboratory environmental analysis; evaluate physical observations, field screening results, and laboratory analytical data and perform and document classification of soils; perform soil management (i.e. oversee and document proper handling, reuse, and disposal of excavated soils by directing the segregation and stockpiling of soil suitable for on-site reuse, designating soil for off-site recycling, reuse or disposal, etc.); and ensure compliance with the Massachusetts Contingency Plan and the requirements of this Item. The Contractor’s LSP shall maintain written records in a clear and concise format which track the excavation, stockpiling, analysis and reuse/disposal of all suspect and contaminated soils, sediments and groundwater. These records shall be up-to-date and available to the Engineer on a bi-weekly basis. Written records shall be maintained for all field screening procedures and results, sampling points, and segregation and classification of stockpiles. The Contractor’s LSP shall maintain written records documenting sampling locations and method of collection for all samples requiring laboratory analysis. The laboratory report together with the Chain of Custody form for all analytical results shall be submitted to the Engineer within fourteen (14) days after completion of such analyses.

The Contractor’s LSP will prepare, perform/execute, and implement Preliminary Response Actions and Risk Reduction Measures, including but not limited to, Immediate Response Action (IRA) Plan(s), Imminent Hazard Evaluation(s), and Utility-Related/Release Abatement Measure (RAM) Plans, Status Reports and Completion Reports, Response Action Outcome Statements, and any supporting documentation for submittal to the Department of Environmental Protection (DEP). In certain circumstances, the Contractor’s LSP may prepare other MCP submissions such as Release
ITEM 180.5 (Continued)

Notification Forms, Risk Assessments, etc. and related documents such as site-specific Health and Safety Plans as directed by the Engineer. The Contractor’s LSP will prepare and sign all Bills of Lading, including LSP Opinion, and waste manifests or other disposal tracking forms as appropriate subject to the approval of the City’s LSP; make determinations with respect to handling of any contaminated groundwater encountered during dewatering; obtain any discharge permits for dewatering activities; conduct any required Public Involvement Activities; and perform any other activities necessary to properly execute the work of this Contract. Note: Where the requirements of this Item call for physical observations, field screening, environmental sampling, and the like, such activities may be delegated by the Contractor’s LSP to other individuals under the LSP’s supervision that possess the necessary qualifications and training. Nonetheless, the Contractor’s LSP shall be held responsible for the proper performance of this work.

The Contractor’s LSP and the Contractor shall both be held responsible for performing the Work in accordance with all applicable Federal and State laws and regulations. In addition, the work will conform to the regulatory policies and recognized standard practices and codes related to contaminated soil excavation, characterization, handling, transportation, and reuse/disposal activities. The City or City’s LSP shall not be responsible at any time for the Contractor’s LSP or the Contractor’s violation of pertinent State or Federal regulations or endangerment of laborers or others. The Contractor’s LSP and Contractor shall be held responsible for the submission of all MCP documents to the Engineer so as to meet the timeframes specified in the MCP and for the timely submission of data and tracking information as noted within this Item.

The Contractor’s LSP will coordinate all activities with City of Lowell and the Massachusetts Department of Environmental Protection through the Engineer or his/her designee. Unless otherwise directed by the Engineer, the Contractor’s LSP shall submit no information directly to DEP without the prior written approval from the City, except as otherwise provided for at 309 CMR 4.03 (4) (b).

Work under this Item shall be paid at the Contract bid price per hour of service provided to perform the work as described above except as noted herein. The bid price shall reflect the cost of the Contractor’s LSP and all environmental technicians to perform all work tasks and field screening, and produce all documentation. The cost of analyses conducted in accordance with the laboratory sampling and assessment requirements for compliance with the MCP will be paid for within the unit bid price for Item 180.4 – Monitoring/Handling and Stockpiling of Contaminated Soils. The cost of laboratory analyses conducted for waste profiles for disposal purposes will be paid for within the unit bid price for the appropriate disposal Item.
The work under this item shall conform to all relevant provisions of the Standard Specifications, the Special Provisions and the following:

The Engineer may, from time to time, direct the Contractor to obtain soil samples from various locations within the project area and to perform laboratory analyses on those soil samples to assess reuse or disposal options.

SAMPLING AND ANALYSIS
The Contractor shall collect discrete soil sample(s) from locations within individual soil piles or specific land area identified by the Engineer. The soil samples shall be collected at a depth specified by the Engineer. The samples shall be delivered to a Massachusetts certified laboratory using proper chain-of-custody documentation for the analysis of Resource Conservation and Recovery Act (RCRA) 8 metals, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, poly-aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH). Subsequent testing, depending upon initial results, may be required for Toxicity Characteristic Leaching Procedure (TCLP) analyses (Method 1311) for metals.

DATA EVALUATION AND REPORT
The Contractor shall review and summarize the laboratory data from the soil sampling analyses. The data will be compared to Massachusetts Contingency Plan (MCP) soil standards and acceptance criteria for soil recycling and landfill disposal facilities. A letter report shall be delivered to the Engineer outlining the soil sampling methods, laboratory analyses results and proposed options for reuse or disposal of the soil.

Method of Measurement

Miscellaneous Soil Testing will be measured by each round of samples collected, tested and reported to the Engineer. A round of samples shall include a total of three samples.

Basis of Payment

Miscellaneous Soil Testing will be paid for at the Contract unit price per Each, which price shall include all labor, materials, equipment and incidental costs required to complete the work specified above.
ITEM 181.11  DISPOSAL OF UNREGULATED SOIL  TON
ITEM 181.12  DISPOSAL OF REGULATED SOIL TO  TON
            IN-STATE FACILITY
ITEM 181.13  DISPOSAL OF REGULATED SOIL TO  TON
            OUT-OF-STATE FACILITY
ITEM 181.14  DISPOSAL OF HAZARDOUS WASTE  TON

The work under these Items shall include the transportation and disposal of contaminated material excavated, or excavated and stockpiled. It shall also include the cost of any additional laboratory analyses required by a particular disposal facility beyond the standard disposal test set.

Excavation of existing subsurface materials may include the excavation of contaminated soils. The Contractor shall be responsible for the proper coordination of characterization, transport and disposal, recycling or reuse of contaminated soils. Disposal, recycling or reuse will be referred to as “disposal” for the remainder of this specification unless otherwise stated. However, regardless of the use of the term herein, there will be no compensation under these items for reuse within the project limits. The Contractor will be responsible for coordinating the activities necessary for characterization, transport and disposal of contaminated soils. Such coordination will include the Engineer and his/her designee overseeing management of contaminated materials. Contaminated soils must be disposed of in a manner appropriate for the soil classification as described below and in accordance with the applicable laws of local, state and federal authorities. The Contractor shall be responsible for identifying a disposal facility(s) licensed to accept the class of contaminated soils to be managed and assure that the facility can accept the anticipated volume of soil contemplated by the project. The Contractor will be responsible for hiring a Licensed Site Professional (LSP) and all ancillary professional services including laboratories as needed for this work. The Contractor will be responsible for obtaining all permits, approvals, manifests, waste profiles, Bills of Lading, etc. subject to the approval of the Engineer prior to the removal of the contaminated soil from the site. The Contractor and LSP shall prepare and submit to the Engineer for approval all documents required under the Massachusetts Contingency Plan (MCP) and related laws and environmental regulations to conduct characterization, transport, and disposal of contaminated materials.

Classes of Contaminated Soils:
The Contractor and its LSP shall determine, in accordance with Items 180.1 through 180.5, if soil excavated or soil to be excavated is unregulated soil or contaminated soil as defined in this section. Such materials shall be given a designation for purposes of reuse or disposal based on the criteria of the Massachusetts Contingency Plan (MCP). Soils and sediments which are not suitable for reuse will be given a designation for purposes of off-site disposal based on the characterization data and disposal facility license requirements. The Classes of Contaminated Soils are defined as follows:

Unregulated Soil consists of soil, fill and dredged material with measured levels of oil and hazardous material (OHM) contamination at concentrations below the applicable Reportable Concentrations
ITEM 181.11 to 181.14 (Continued)

(RCs) presented in the MCP. Unregulated soil consists of material which may be reused (or otherwise disposed) as fill within the Commonwealth of Massachusetts subject to the non-degradation criteria of the MCP (310 CMR 40.0032(3)), in a restricted manner, such that they are sent to a location with equal or higher concentrations of similar contaminants. Disposal areas include licensed disposal facilities, approved industrial settings in areas which will be capped or covered with pavement or loamed and seeded, and for purposes of this project should be reused as fill within the project site construction corridor whenever possible. The material cannot be placed in residential and/or environmentally sensitive (e.g. wetlands) areas. Under no circumstances shall contaminated soils be placed in an uncontaminated or less contaminated area (including the area above the groundwater table if this area shows no sign of contamination).

The Contractor shall submit to MassDOT the proposed disposal area for unregulated soils for approval. If such a disposal area is not a licensed disposal facility, the Contractor shall submit to the Engineer analytical data to characterize the disposal area sufficiently to verify that the unregulated material generated within the MassDOT construction project limits is equal to or less than the contaminant levels at the disposal site and meets the non-degradation requirements of the MCP. In addition, the Contractor shall provide written confirmation from the owner of the proposed disposal area that s/he has been provided with the analytical data for both the materials to be disposed as well as the disposal site characterization and that s/he agrees to accept this material. A Material Shipping Record or Bill of Lading, as appropriate, shall be used to track the off-site disposal of unregulated soil and a copy, signed by the disposal facility or property owner, shall be provided to the Engineer in order to document legal disposal of the unregulated material.

The cost of on-site disposal of unregulated soil within the project area will be considered incidental to the item of work to which it pertains.

Regulated Soil consists of materials containing measurable levels of OHM that are equal to or exceed the applicable Reportable Concentrations for the site as defined by the MCP, 310 CMR 40.0000. Regulated soil which meets the MCP reuse criteria of the applicable soil/groundwater category for this project area may be reused on site provided that it meets the appropriate geotechnical criteria established by the Engineer. Regulated Soil may be reused (as daily or intermediate cover or pre-cap contouring material) or disposed (as buried waste) at lined landfills within the Commonwealth of Massachusetts or at an unlined landfill that is approved by the Massachusetts Department of Environmental Protection (DEP) for accepting such material, in accordance with DEP Policy #COMM-97-001, or at a similar out-of-state facility. It should be noted that soils which exceed the levels and criteria for disposal at in-state landfills, as outlined in COMM-97-001, may be shipped to an in-state landfill, but require approval from the DEP Division of Solid Waste Management and receiving facility. An additional management alternative for this material is recycling into asphalt. Regulated Soils may also be recycled at a DEP approved recycling facility possessing a Class A recycling permit subject to acceptance by the facility and compliance with DEP Policy #BWSC-94-400. Regulated Soil removed from the site for disposal or treatment must be removed via an LSP approved Bill of Lading, Manifest or applicable material tracking form. This type of facility shall be approved/permited by the State in which it operates to accept the class of contaminated soil in accordance with all applicable local, state and federal regulations.

Hazardous Waste consists of materials which must be disposed of at a facility permitted and operated in full compliance with Federal Regulation 40 CFR 260-265, Massachusetts Regulation 310 CMR
ITEM 181.11 to 181.14 (Continued)

30.000, Toxic Substances Control Act (TSCA) regulations, or the regulations of other states, and all other applicable local, state, and federal regulations. All excavated materials classified as hazardous waste shall be disposed of at an out-of-state permitted facility. This facility shall be a RCRA hazardous waste or TSCA facility, or RCRA hazardous waste incinerator. This type of facility shall be approved/permitted by the State in which it operates to accept hazardous waste in accordance with all applicable local, state and federal regulations and shall be permitted to accept all contamination which may be present in the soil excavate. The Contractor shall ensure that, when needed, the facility can accept TSCA waste materials i.e. polychlorinated biphenyls (PCBs). Hazardous waste must be removed from the site for disposal or treatment via an LSP approved Manifest.

Monitoring/Sampling/Testing Requirements:
The Contractor shall be responsible for monitoring, sampling and testing during and following excavation of contaminated soils to determine the specific class of contaminated material. Monitoring, sampling and testing frequency and techniques should be performed in accordance with Items 180.1 through 180.5. Additional sampling and analysis may be necessary to meet the requirements of the disposal facility license. The cost of such additional sampling and analysis shall be included in the bid cost for the applicable disposal items. The Contractor shall obtain sufficient information to demonstrate that the contaminated soil meets the disposal criteria set by the receiving facility that will accept the material.

No excavated material will be permanently placed on-site or removed for off-site disposal until the results of chemical analyses have been received and the materials have been properly classified. The Contractor shall submit to the Engineer results of field and laboratory chemical analyses tests within seven days after their completion, accompanied by the classification of the material determined by the Contractor, and the intended disposition of the material. The Contractor shall submit to the Engineer for review all plans and documents relevant to LSP services, including but not limited to, all documents that must be submitted to the DEP.

Copies of the fully executed Weight Slips/Bills of Lading/Manifests/Material Shipping Records or other material tracking form received by the Contractor from each disposal facility and for each load disposed of at that facility, shall be submitted to Engineer and the Contractor’s LSP within three (3) days of receipt by the Contractor. The Contractor is responsible for preparing and submitting such documents for review and signature by the LSP or other appropriate person with signatory authority, three (3) days in advance of transporting soil off-site. The Contractor shall furnish a form attached to each manifest or other material tracking form for all material removed off-site, certifying that the material was delivered to the site approved for the class of material. If the proposed disposition of the material is for reuse within the project construction corridor, the Contractor shall cooperate with MassDOT to obtain a suitable representative sample(s) of the material to establish its structural characteristics in order to meet the applicable structural requirements as fill for the project.

All material transported off-site shall be loaded by the Contractor into properly licensed and permitted vehicles and transported directly to the selected disposal or recycling facility and be accompanied by the applicable shipping paper. At a minimum, truck bodies must be structurally sound with sealed tail gates, and trucks shall be lined and loads covered with a liner, which shall be placed to form a continuous waterproof tarpaulin to protect the load from wind and rain.
Decontamination of Equipment:
Tools and equipment which are to be taken from and reused off site shall be decontaminated in accordance with applicable local, state and federal regulations. This requirement shall include, but not be limited to, all tools, heavy machinery and excavating and hauling equipment used during excavation, stockpiling and handling of contaminated material. Decontamination of equipment is considered incidental to the applicable excavation item, Item 180.4 and Items 181.11 – 181.14.

Regulatory Requirements:
The Contractor shall be responsible for adhering to regulations, specifications and recognized standard practices related to contaminated material handling during excavation and disposal activities. MassDOT shall not be responsible at any time for the Contractor’s violation of pertinent State or Federal regulations or endangerment of laborers and others. The Contractor shall comply with all rules, regulations, laws, permits and ordinances of all authorities having jurisdiction including, but not limited to, Massachusetts Department of Environmental Protection, the U.S. Environmental Protection Agency, Federal Department of Transportation (DOT), Massachusetts Water Resources Authority (MWRA), the Commonwealth of Massachusetts and other applicable local, state and federal agencies governing the disposal of contaminated soils.

All labor, materials, equipment and services necessary to make the work comply with such regulations shall be provided by the Contractor without additional cost to MassDOT. Whenever there is a conflict or overlap within the regulations, the most stringent provisions are applicable. The Contractor shall reimburse MassDOT for all costs it incurs, including penalties and/or for fines, as a result of the Contractor’s failure to adhere to the regulations, specifications, recognized standard practices, etc., that relate to contaminated material handling, transportation and disposal.

Submittals:
I. Summary of Sampling Results, Classification of Material and Proposed Disposal Option.
The following information, presented in tabular format, must be submitted to the Engineer for review and approval prior to any reuse on-site or disposal off-site. This requirement is on-going throughout the project duration. At least two weeks prior to the start of any excavation activity, the Contractor shall submit a tracking template to be used to present the information as stipulated below. Excavation will not begin until the format is acceptable to MassDOT.

Characterization Reports will be submitted for all soil, sediment, debris and groundwater characterized through the sampling and analysis programs required under Items 180.4, 180.6, and 181.11 – 181.14. Each report will include a site plan which identifies the sampling locations represented in the Report. The Construction Plan sheets may be used as a baseplan to record this information.

The Sampling Results will be presented in tabular format. Each sample will be identified by appropriate identification matching the sample identification shown on the Chain of Custody Record. The sample must also be identified by location (e.g. grid number or stockpile number). For each sample, the following information must be listed: the classification (unregulated, regulated, etc.), proposed disposal option for the stockpile or unit of material represented, and, all analytical results.
ITEM 181.11 to 181.14 (Continued)

Each Characterization Report will include the laboratory analytical report and Chain of Custody Record for the samples included in the Report.

II. Stockpiling, Transport, and Disposal. At least two weeks prior to the start of any excavation activity, the Contractor shall submit, in writing, the following for review and shall not begin excavation activity until the entire submittal is acceptable to MassDOT.

A. Excavation and Stockpiling Protocol:

   Provide a written description of the management protocols for performing excavation and stockpiling and/or direct loading for transport, referencing the locations and methods of excavating and stockpiling excavated material in accordance with Items 180.1 through 180.5.

B. Disposal and Recycling Facilities:

   1. Provide the name, address, applicable licenses and approved waste profile for disposal and recycling location(s) where contaminated soil will be disposed. Present information substantiating the suitability of proposed sites to receive classifications of materials intended to be disposed there, including the ability of the facility to accept anticipated volumes of material.

   2. Provide a summary of the history of compliance actions for each disposal/recycling facility proposed to be used by the Contractor. The compliance history shall include a comprehensive list of any state or federal citations, notices of non-compliance, consent decrees or violations relative to the management of waste (including remediation waste) at the facility. Material should not be sent to facilities which are actively considered by the DEP, USEPA or other responsible agency to be in violation of federal, state or local hazardous waste or hazardous material regulations. MassDOT reserves the right to reject any facility on the basis of poor compliance history.

C. Transportation:

   The name, address, applicable license and insurance certificates of the licensed hauler(s) and equipment and handling methods to be used in excavation, segregation, transport, disposal or recycling.


The following documents are required for all excavation, reuse and disposal operations and shall be in the format described. At least two weeks prior to the start of any excavation or demolition activity, the Contractor shall submit the tracking templates required to present the information as stipulated below. Excavation or demolition will not begin until the format is acceptable to MassDOT.

All soils, sediments and demolition debris must be tracked from the point of excavation to stockpiling to onsite treatment/processing operations to off-site disposal or onsite reuse as applicable.

   1. Demolition Debris. Demolition debris must be tracked if the debris is stockpiled at a location other than the point of origin or if treatment or material processing is conducted. Identification of locations will be based on the station-offset of the location. The tracking table will identify date and point of generation, any field screening such as PID or dust
monitoring, visual observations/comments, quantity, and stockpile ID/processing operation location. For each unit of material tracked, the table will also track reuse of the material on-site, providing reuse date, location of reuse as defined by start and end station, width of reuse location by offset, the fill elevation range, quantity, and finish grade for said location. For demolition debris which is not reused on site, the table will also track disposal of the material as defined by disposal date, quantity and disposal facility. The table must provide a reference to any analytical data generated for the material.

2. Soil/Sediment. Soil excavation will be identified based on the station-offset of the excavation location limits. The tracking table will identify date and point of generation, any field screening such as PID or dust monitoring, visual observations, quantity, and stockpile number/location. For each unit of material tracked, the table will also track reuse of the material on-site and disposal of the material offsite using the same categories identified for demolition debris above.

**Basis of Payment and Method of Measurement for Items 181.11 Through 181.14:**

Disposal of contaminated soil shall be measured for payment by the Ton of actual and verified weight of contaminated materials removed and disposed of. The quantities will be determined only by weight slips issued by and signed by the disposal facility. The most cost-effective, legal disposal method shall be used.

- **Item 181.11** Measurement for Disposal of Unregulated Soil shall be under the Contract Unit Price by the weight, in Tons (TN), of contaminated materials removed from the site and transported to and disposed of at an approved location or licensed facility, and includes any and all costs for approvals, permits, fees and taxes, additional testing/characterization required by the facility beyond the standard disposal test set, decontamination procedures, transportation and disposal.

- **Item 181.12** Measurement for Disposal of Regulated Soil – In-State Facility shall be under the Contract Unit Price by the weight, in Tons (TN), of contaminated materials removed from the site and transported to and disposed of at an approved in-state facility, and includes any and all costs for approvals, permits, fees and taxes, testing/characterization required by the facility beyond the standard disposal test set, decontamination procedures, transportation and disposal.

- **Item 181.13** Measurement for Disposal of Regulated Soil - Out-of-State Facility shall be under the Contract Unit Price by the weight, in Tons (TN), of contaminated materials removed from the site and transported to and disposed of at an approved out-of-state facility, and includes any and all costs for approvals, permits, fees and taxes, testing/characterization required by the facility beyond the standard disposal test set, decontamination procedures, transportation and disposal.

- **Item 181.14** Measurement for Disposal of Hazardous Waste shall be under the Contract Unit Price by the weight, in Tons (TN), of hazardous waste removed from the site and transported to and disposed of at the licensed hazardous waste facility, and includes any and all costs for approvals, permits, fees and taxes, testing/characterization required by the facility beyond the standard disposal test set, decontamination procedures, transportation and disposal.
ITEM 191. MAST ARM SOIL BORING EACH

The work under these Items shall conform to the relevant provisions of Section 190 of the Standard Specifications and the following:

The work under these items shall include mobilization and set-up of boring equipment, the drilling of hollow stem auger borings, drive sample borings and rock core borings, the retrieval of soil samples, the visual classification of the soil, the recording of boring logs and samples, and the dismantling and transporting of the equipment to and from each site.

**General**

Hollow stem auger borings shall be taken at the locations of the proposed traffic signal mast-arm foundations as shown on the plans and as directed by the Engineer. The Engineer shall be notified a minimum of 72 hours before borings are taken.

Two types of samples will be required in vertical soil borings:

1. **Standard Sample.** A standard penetration test using a split spoon sampler shall be made at the ground surface and at every change in soil stratum, but the sampling intervals shall not exceed 5 feet in a continuous stratum. The auger hole shall terminate at a depth of twenty (20) feet and a split spoon sample shall be taken at the bottom of the hole.

2. **Supplement Sample.** A volume sample shall be taken at 5 feet intervals in order to classify the subsurface soils with respect to grain size and visual classification as required. Each sample shall consist of the remainder of the spoon sample and shall be contained in liter jars appropriately labeled.

The purpose of this method along with its sampling procedure is to determine the visual properties, arrangement and thickness of the various soil strata as they exist in the ground. The elevations/depths at which any change in stratification occurs shall be located and recorded on the log by the driller. Detection of stratum changes should be made by careful observation of the soil as it exists in the augered hole and by the rate of penetration of the auger during drilling.

The auger casing I.D. shall be a minimum of 3 inches for all holes in which split spoon samples are required. The O.D. shall be a maximum of 7 inches to limit the size of the resulting hole.

**Supplement Samples**

The liter jar samples shall have positive identification of the contents by typewritten glued-on label. The following information shall be shown:

1. Name and address of boring contractor
2. Date sample was taken
3. Location and name of project.
4. Location of borehole by station and offset or identifying number of borehole, if so identified on the plan.
ITEM 191. (Continued)

5. Depth below ground surface at which sample was obtained and recorded blow counts of 6 inches of penetration of the sampler.

Upon completion of all borings, the Contractor shall submit two copies of the typewritten boring logs to the Engineer and deliver the jarred samples plus two copies of the typewritten logs to Vanasse Hangen Brustlin, Inc., Watertown, Massachusetts.

Obstructions

Obstructions other than ledge shall be considered in accordance with Section 190.60E of the Standard Specifications. The actual location of the additional boring will be specified by the Engineer. When ledge is encountered, a rock core boring will be made in accordance with Section 190.63 of the Standard Specifications.

Rock Core

If rock is encountered at an elevation above the specified highest bottom elevation, then a rock core boring will be made in accordance with Section 190.63 of the Standard Specification. The core hole shall be large enough to accommodate the required auger casing so that sampling may be continued past the rock obstruction. The minimum cored depth shall be 10 feet.

Practical Refusal

Practical refusal of the sample spoon or "refusal" is as defined by Section 190.60F of the Standard Specifications.

Due to the size of the resulting auger hole, it is particularly important that upon completion, all borings shall be backfilled with clean, well-graded sand and tamped to fill all voids created during the augering procedure.

Advancing the Boring for Soil Sampling

As the boring is advanced, care shall be taken to note and record the depth where wet soil is encountered if this should occur.

If groundwater is encountered then the water level in the hollow stem shall be maintained at the top of the casing at all times during the sampling operation to avoid unequal hydrostatic pressure that could result in blow-in of fine-granular soils and inaccurate blow counts.

In each boring the driller shall record the water level prior to backfilling and whenever possible, prior to the start of each day's work.

Each boring shall be advanced by using a hollow stem auger with cutting head and center rod and plug assembly. The hollow stem auger will advance and case the hole simultaneously to the required sampling levels. The center rod and plug assembly is held in place by the cap and inside drill rod connecting the auger and its assembly to the rotating spindle on the drilling machine to prevent soil from entering the mouth of the auger. Upon reaching the sampling level, the plug is to be retreated by withdrawing the center rod to permit lowering of the sampler through the auger.

The sample shall be obtained by driving the sampler 18 inches into the undisturbed material below the bottom of the auger. The sampling and handling procedure shall be as specified under Section 190.61 of the Standard Specifications.
ITEM 191. (Continued)

After the sampling operations are completed and the sampler has been retracted, the plug is re-inserted and held in place by the center rod; another auger section is connected to the first, together with one additional center rod section to secure the plug to the cap and the hole is advanced.

This procedure shall be repeated until the required bottom elevation is reached. The auger shall be stopped at any depth level to allow normal sampling practices upon request by the Engineer.

If, in the judgment of the Engineer, the borehole cannot be advanced by the hollow stem auger method due to the material encountered (with the exception of bedrock) and every attempt has been made by the driller to complete the boring using the conventionally cased, drive sample, wash boring method as specified in Section 190 of the Standard Specifications, then the borehole shall be cored.

**Measurement and Payment**

Payment for Item 191. Mast Arm Soil Boring will be paid for at the Contract unit price per each, which price shall include all mobilization, labor, materials, equipment, fees, permitting and incidental costs required to complete the work.
ITEM 201. CATCH BASIN EACH
ITEM 201.1 CATCH BASIN – SHALLOW COVER EACH
ITEM 202. MANHOLE EACH
ITEM 222.3 FRAME AND GRATE (OR COVER) MUNICIPAL STANDARD EACH

The work under these items shall conform to the relevant provisions of Section 201 and 220 of the Standard Specifications and the following:

Shallow Cover Catch Basin shall be used at locations shown on the plans and constructed with flat tops to meet the proposed grades shown on the plans. A doghouse opening as shown on the construction details shall be used as needed for locations with shallow cover. The opening shall be sized to ensure a 2-inch maximum clearance is provided around the pipe and shall be sealed with non-shrink grout. The top slab of the structure shall not rest directly on the pipe. All proposed catch basins shall be City of Lowell standard 4-foot diameter precast concrete structures constructed with a minimum 4-foot sump and hood.

New catch basin and drainage manhole castings shall be per City of Lowell Standards, as shown on the plans.

New or reset drainage structure castings located within the roadway shall be set to intermediate course on actively travelled roadways.

The work shall also consist of removing and discarding existing frames and grates (or covers) that are found to be unsuitable for re-use, that do not meet the City of Lowell Standards, and as directed by the Engineer. Said items shall become the property of the Contractor and shall be removed from the project and disposed of legally.

Measurement and Payment

Catch Basins and Manholes shall be measured for payment per structure, complete in place, which price shall include all labor, material, equipment and incidental costs required to complete the work.

Catch basin hoods will not be paid for separately, but will be included in the unit price bid for Item 201, Catch Basin.

Frame and Grate (or Cover) Municipal Standard shall be measured by each, complete in place.

Frame and Grate (or Cover) Municipal Standard shall be paid for at the contract unit price each, which price shall include all labor, materials, equipment and other incidental costs required to complete the work.
ITEM 223.1 FRAME AND GRATE OR COVER EACH REMOVED AND STACKED

The work to be done under this item shall conform to the relevant provisions of Section 220 of the Standard Specifications and the following:

When Item 222.1 is being used to replace existing undamaged frame and grates deemed unsuitable by the Engineer, the frame and grates shall be removed, transported, and stacked at the discretion of the Engineer, at locations to be coordinated with the City.

The contract unit price for the above item shall constitute full payment for all labor, tools, equipment, transportation, and other incidentals necessary to satisfactorily complete the work.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Unit</th>
</tr>
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<tbody>
<tr>
<td>303.06</td>
<td>6 Inch Ductile Iron Water Pipe (Mechanical Joint)</td>
<td>Foot</td>
</tr>
<tr>
<td>303.12</td>
<td>12 Inch Ductile Iron Water Pipe (Mechanical Joint)</td>
<td>Foot</td>
</tr>
<tr>
<td>309.</td>
<td>Ductile Iron Fittings for Water Pipe</td>
<td>Pound</td>
</tr>
<tr>
<td>350.12</td>
<td>12 Inch Gate and Gate Box</td>
<td>Each</td>
</tr>
<tr>
<td>357.06</td>
<td>6 Inch Gate Box</td>
<td>Each</td>
</tr>
<tr>
<td>357.12</td>
<td>12 Inch Gate Box</td>
<td>Each</td>
</tr>
<tr>
<td>371.12</td>
<td>12 Inch Coupling</td>
<td>Each</td>
</tr>
<tr>
<td>376.</td>
<td>Hydrant</td>
<td>Each</td>
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The work under this section shall conform to the relevant provisions of section 300 of the Standard Specifications, the latest American Water Works Association standards and technical manuals related to water supply materials and installation and the following:

The Lowell Regional Water Utility (LRWU) and the Lowell Department of Public Works shall be notified prior to starting construction of any portion of the municipal water system.

The closing of valves necessary for making connections with existing municipal system will be done by LRWU employees, assisted by the Contractor. Sufficient notice shall be given LRWU of planned connection. No allowance will be made for any delay in closing of valves. A 48-hour notice shall be given to residents or businesses affected by the shut-down, and shall be done by the Contractor under the direction of the LRWU.

LRWU may establish the time of shutdown to be within the normal daily low demand period.

The work under these items shall conform to the relevant provisions of Section 300 of the Standard Specifications and the following:

Approval of Materials

The Contractor shall submit the names of the material suppliers, shop drawings and certificates of compliance to the Engineer for approval prior to ordering any materials, including Contractor’s Material and Test Certificate (FM Global Form 85B).

As-Built Drawings

The Contractor shall submit As-Built Drawings upon completion and acceptance of work. As-Built Drawings shall be complete and shall indicate the true measurements and locations, horizontal and vertical, of all new construction. As-Built Drawings shall include a minimum of three ties to each gate valve box from fixed permanent objects. As-Built Drawings shall also contain any additional information required by the municipality, and shall be stamped with the seal of a Licensed Land Surveyor and Licensed Professional Engineer.
Pipe and Fittings

Pipe shall be ductile iron, Class 52, conforming to ANSI A21.50/AWWA C150 and ANSI A21.51/AWWA C151.

Pipe shall be supplied in lengths not exceeding 20 feet. Each pipe and fitting shall markings casted into the metal in accordance with ANSI A21.10/AWWA C110, including manufacturer's identification, country material was made in, pressure rating, nominal diameter and degrees or fraction of circle (for bends).

Fittings shall be ductile iron, Class 250 minimum, conforming to applicable ANSI, NEWWA, and AWWA specifications. All fittings (bends, tees, solid sleeve connectors, reducers, etc.) and valves shall be mechanical joint and restrained. Cast iron plugs shall be installed at all pipe ends and shall be included in fittings for payment.

Pipe and fittings shall have a cement mortar lining and bituminous seal coat on the inside and a coal tar enamel coat on the outside in accordance with ANSI A21.4 (AWWA C104) and ANSI A21.6 (AWWA C106), as amended, except that the cement mortar lining shall be 1/8-inch in thickness for pipe 2 inches to 12 inches in diameter. Bituminous seal coat shall be a product acceptable to the National Sanitation Foundation (NSF) for use in potable water and shall be so listed in the most current NSF summary of approved products under ANSI/NSF Standards 61.

Pipe shall be standard restrained mechanical joint pipe.

Rubber gaskets for push-on and mechanical joints shall conform to ANSI A21.11/AWWA C111.

Pipe and Fittings Installation

Care shall be taken in loading, transporting, and unloading to prevent injury to the pipes, fittings or coatings. Pipe and fittings shall not be dropped. All pipe or fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Engineer. Any pipe found to be defective, before or after laying, shall be satisfactorily removed and replaced with sound pipe at no additional cost to the Owner.

All pipe and fittings shall be installed in conformance with AWWA Standard Specifications C600, except as otherwise provided herein. All pipe and fittings shall be sound and clean before laying and shall be laid on a shaped bedding providing uniform, firm support over the entire length of each section barrel. BLOCKING WILL NOT BE PERMITTED. The select bedding material shall be placed and tamped along the sides of the pipe to complete the bedding.

Pipe shall be laid with good alignment and at a uniform 5-foot depth to top of pipe below proposed grade except where extra depth is required to clear other utilities and to connect to existing pipes, valves or fittings. Joint deflection shall not exceed that recommended by the manufacturer. Additional fittings shall be furnished and installed as required to cross existing utilities. Solid sleeves shall be used only where approved by the Engineer. Cast iron plugs shall be installed at all pipe ends and shall be included in fittings for payment.

When pipe laying is stopped for any length of time, including short periods, the open ends of the pipe and fittings shall be closed with a watertight plug or cap as approved by the Engineer.
ITEMS 303.06 through 376. (Continued)

Necessary pipe cutting shall be accomplished by power saw and shall leave a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a push-on bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be undamaged.

Push-on joints shall be made in strict accordance with the manufacturer's instructions. The rubber gasket shall be inserted in the groove of the bell end of the pipe, the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined and pushed home with a jack or by other means. After jointing the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

Mechanical joints shall be installed in accordance with the "Notes of Method of Installation" of ANSI A21.11 and the instructions of the manufacturer. The Contractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Extension wrenches or pipe over handle or ordinary ratchet wrench shall not be used to secure greater leverage.

Water/Sewer Separation

When a water pipe crosses above or below a sewer pipe, the following procedures shall be utilized. The Contractor shall comply with these following procedures:

Whenever possible, water mains shall be laid at a minimum at least 10 feet, horizontally, from any existing or proposed sewer. Should local conditions prevent a lateral separation of 10 feet, a water main may be laid closer than 10 feet to a sewer if:

a. It is laid in a separate trench, or if;

b. It is laid in the same trench with the sewer located at one side on a bench of undisturbed earth, and if;

c. In either case, the elevations of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

Whenever water mains must cross under sewers, the water main shall be laid at such an elevation that the top of the water main is at least 18 inches below the bottom of the sewer. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

When it is impossible to obtain horizontal and/or vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint cement lined ductile iron pipe or other equivalent based on water tightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure water tightness or both pipes shall be encased in concrete.

Valves

Gate valves shall be resilient wedge values conforming to AWWA C509 and shall be rated for 200 psi minimum working pressure and shall be shell tested at a minimum of 400 psi. Valves shall be Underwriters Laboratory (UL) and Factory Mutual (FM) approved. Stuffing boxes shall be of the O-ring type. The operating nut shall be standard AWWA 2-inch square. Buried valves shall have
ITEMS 303.06 through 376. (Continued)

mechanical joint ends conforming to AWWA C111. Exposed valves in vaults shall have flanged joints ends conforming to AWWA C111 unless shown as mechanical joints on plans.

All valves shall open right (clockwise) as required by the local water and fire departments.

All valves shall be of the iron body type, bronze mounted, double disc parallel seal, non-rising stem type. All ferrous parts of the valves, except finished or bearing surfaces, shall be given two coats of asphalt varnish.

After the valves are assembled and tested, a third coat shall be applied on the exterior.

Valve Boxes

Valve boxes shall be two-section, cast iron, heavy pattern adjustable type, with cast iron cover. The upper sections shall have a bottom flange of sufficient bearing area to prevent settling. The bottom section shall enclose the valve stuffing box and operating nut. Boxes shall be of lengths adapted to 5-foot pipe cover or more and have a minimum of 6 inches of overlap in the most extended position. Covers shall have the word "WATER" cast in the top and shall be held in place with bronze bolts.

Couplings

Couplings shall be used to:

1. repair split pipe or replace sections of damaged pipe;
2. install or cut-in hydrants or valves into a water main;
3. couple different pipe types; and
4. correct misaligned pipe ends.

Couplings shall have a pressure rating of 250 psi or greater. Materials shall be manufactured in accordance with the following:

1. Center and end rings: ASTM-A536
3. Bolts & Hex Nuts: AWWA C111

Couplings shall be epoxy-coated ductile iron.

Corporation Cocks and Curb Stops

Corporation cocks shall be LWRU approved brass ball type corporation valves or equivalent with a compression-type fitting, on the outlet end. The inlet end should be threaded per LRWU.

Curb stops shall be LWRU approved brass ball valve curb stop or approved equivalent, with compression-type fittings, on both ends.

Stops shall be sized to receive the service tubing without the use of enlargement/reduction fittings.
ITEMS 303.06 through 376. (Continued)

Service Boxes
Service boxes shall be LRWU approved cast iron improved extension type with arch pattern base. Covers shall be held in place with bronze bolts and the word WATER shall be cast into the top surface of the cover. Service box shafts shall have a minimum inside diameter of 2-1/2 inches.

Water Service
Services two inches or smaller shall be ASTM B88 copper water tubing, Type K, for underground water service and shall be in accordance with ANSI/AWWA C800.

Water service fittings including couplings and adapters, check valves and service saddles shall be in conformance with ANSI/AWWA C800, Underground Service Line Valves and Fittings.

Joints in copper tubing shall be made with three part compression couplings or an approved equal.

Services 3 inches and greater shall be 4-inch minimum ductile iron pipe.

Service Pipe: Care shall be exercised in placing and laying of services to prevent kinks or sharp bends and to prevent contact with sharp stones or ledge which would damage to the pipe. At least 6 inches of sand shall be placed adjacent to, under, and above the pipe, and no stone larger than 2 inches shall be placed over the pipe until the depth of backfill above the pipe is in excess of 1 foot.

Corporation Cock: Taps to the pipe shall be threaded and shall be made at the horizontal diameter of the main. The tap shall be made by means of a tapping machine manufactured for this purpose and supplied by the Contractor. The tap and drill shall be kept sharp and shall have threads matching those of the stop. Corporation stop threads shall be coated with sealing compound and the stop screwed firmly into the water with the key upward and the inlet end projecting at least 1/8 inch beyond the inside face of the pipe. Corporation stop shall be left in the on open position after installation of the service pipe.

Curb Stop and Service Boxes: Curb stop and service boxes shall be of a size equal to the size of the service pipe and shall be installed in the locations shown on the Drawings in final locations approved by LRWU. The boxes shall be set in a vertical position and flush with the proposed finish grade.

Pipe Insulation
Pipe insulation shall be installed in locations indicated on the plans and when water main cannot be installed with at least 5 feet of cover. Pipe insulation shall be installed with waterproof jacket in accordance with MHD M9.11.5 and MHD Section 301.60. Insulation thickness shall be as indicated on the plans and as directed by the Engineer. Work shall include insulation, jacket and jacket fasteners.

Hydrants
Hydrants shall be LRWU standard, Kennedy, American Darling, Mueller or approved equal and shall conform to the "Standard" Specifications for Fire Hydrants for Ordinary Water Works Service," AWWA C502 and the following:

Hydrants shall be according to manufacturer's standard pattern of standard size and shall have one 4-1/2-inch pumper nozzle and two 2-1/2-inch hose nozzles.

Hydrant inlet connections shall have mechanical joints for 6-inch ductile iron pipes.
ITEMS 303.06 through 376. (Continued)

Hydrant valve opening shall have an area at least equal to the area of a 5-1/4-inch diameter circle and be obstructed only by the valve rod. Each hydrant shall be able to deliver 500 gallons per minute through its two 2-1/2-inch hose nozzles when opened together with a loss of not more than 2 psi in the hydrant.

Each hydrant shall be designed for installation in a trench that will provide 5 feet of cover. Hydrant extension shall be as manufactured by the company furnishing the hydrants and of a style appropriate for the hydrants as furnished.

Hydrants shall be hydrostatically tested as specified in AWWA C502.

All nozzle threads shall be American National Standard.

Hydrant operating nut shall be AWWA Standard pentagonal type measuring 2-1/2 inches point to flat.

Hydrants shall be equipped with "O" ring packing.

Each nozzle cap shall be provided with a Buna N rubber washer.

Hydrants shall be so arranged that the direction of outlets may be turned 90 degrees without interference with the drip mechanism and without the mechanism obstructing the discharge from any outlet.

A bronze or rustproof steel nut and check nut shall be provided to hold the main hydrant valve on its stem.

Hydrants shall open by turning an operating nut to **right (clockwise)** as required by LRWU and Fire Department and must be marked with an arrow and word "OPEN" to indicate the direction to turn stem to open hydrant.

All iron work to be set below ground shall be thoroughly cleaned and painted with two coats of asphalt varnish specified in AWWA C502, and iron work to be exposed above ground shall be shop painted with two coats of paint of quality and color conforming to the present Town standard.

Each hydrant shall be designed such that the hydrant valve closes with line pressure preventing loss of water and consequent flooding in the event of traffic damage.

Each hydrant shall be furnished with a steel chair holder, double steel hose cap chain, steel pumper cap chair and any other hooks or appurtenances required for proper use.

**Hydrant Installation**

Hydrants shall be set at the locations shown on the drawings, or as directed by the Engineer, and bedded on a firm foundation. A drainage pit 2 feet 6 inches in diameter shall be back-filled with crushed stone in conformance to M2.01.1 and satisfactorily compacted. Additional stone shall be brought up and around 6 inches over the drain ports. Each hydrant shall be set in true vertical alignment and properly braced. A concrete thrust block shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Felt roofing paper shall be placed around hydrant elbow before placing concrete. Care shall be taken to insure that concrete does not plug the drain ports. Hydrant paint shall be touched up as required after installation.

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ITEMS 303.06 through 376. (Continued)

Thrust Restraints

Thrust restraints shall be installed at all tees, bends, plugs, caps, tapping sleeves and other locations as directed by the Engineer in accordance with the dimensions and details shown on the plans.

Whenever water pipes can be placed against undisturbed earth, concrete thrust blocks may be installed. The back of thrust blocks shall be placed against undisturbed earth and the sides shall be formed. Felt roofing paper shall be placed to protect pipe joints. Concrete shall not be placed over bolts or nuts, or in a manner which prevents the removal of joints.

Concrete shall have a minimum strength Class of 3,000 psi.

Whenever water pipes are installed within fill sections, the Contractor shall use mechanical restrained joint pipe and wedge-type mechanical joint restraints rated for 350 psi.

Restrained Joints

Pipe with restrained joints shall be installed in all areas where the pipe is within fill materials and also at locations shown on the Drawings. Restrained joints shall be installed at bends, reducers, tees, valves, dead ends, and hydrants. The minimum length of pipe to be restrained on either side of the joint shall be as shown on the table below. The fittings of the new piping shall be for restrained joints, as marked on the Drawings.

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Number of Joints to Restrain on Either Side of Fitting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Based on 18-Foot Pipe Length)</td>
</tr>
<tr>
<td>90 degree bend</td>
<td>3</td>
</tr>
<tr>
<td>45 degree bend</td>
<td>2</td>
</tr>
<tr>
<td>22-1/2 degree bend</td>
<td>2</td>
</tr>
<tr>
<td>Tee:</td>
<td></td>
</tr>
<tr>
<td>Branch</td>
<td>3</td>
</tr>
<tr>
<td>Run</td>
<td>2</td>
</tr>
</tbody>
</table>

No restraining is required in the direction of the existing pipe if only a short length of it is exposed in the trench for making a connection.

Restrained joint assemblies for push-on pipe and fittings shall be made in strict accordance with the manufacturer's recommended installation procedures.

Restrained joint assemblies for mechanical joint pipe shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
Approval of Pressure Testing and Disinfection Plan

The Contractor shall submit a plan and description of the procedures for pressure testing and disinfection for approval by LRWU and the Engineer prior to performing the work. The Contractor shall notify the LRWU and the Engineer 48 hours prior to testing and disinfection.

Pressure Testing

Pressure testing shall be conducted by a certified independent water testing company after thrust block have cured to the required 3000 psi strength. The Contractor shall provide all necessary equipment and conduct hydrostatic pressure and leakage tests on the new water system installed under the Contract in conformance with AWWA 600, the regulations of the Massachusetts State Board of Health and the following:

Prior to testing, the entire pipe section shall be flushed to remove any rocks or debris which may have inadvertently entered the pipe during construction. The water system shall be subjected to a hydrostatic pressure of 200 psi and this pressure shall be maintained for at least one hour. The leakage test shall be conducted at a pressure of 150 psi and this pressure shall be maintained for at least two hours.

Permitted leakage shall conform to AWWA C600. Leaks exceeding this standard shall be located and all defective pipes, fittings, pipe joints, valves and other material removed and replaced with new material to correct the leak, as directed by the Engineer, at no additional cost to the Owner.

All testing shall be done in a manner which prevents the entrance of contaminated water or pollutants into the existing water system.

Disinfection

Before being placed in service, all new water pipe shall be chlorinated in accordance with ANSI/AWWA C651 Standard for Disinfecting Water Mains.

The location of the chlorination and sampling points will be determined by the Engineer in the field. Taps for chlorination and sampling shall be installed by the Contractor. The Contractor shall uncover and backfill the taps as required.

The pipe section being disinfected shall be flushed to remove discolored water and sediment from the pipe. A 25 mg/l chlorine solution in approved dosages shall be inserted through a tap at one end while water is being withdrawn at the other end of the pipe section. The chlorine concentration in the water in the pipe shall be maintained at minimum 25 mg/l available chlorine during filling. To assure that this concentration is maintained, the chlorine residual shall be measured at regular intervals in accordance with procedures described in Standard Methods and AWWA M12, Simplified Procedure for Water Examination, Section K.

During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the pipe supplying the water. Chlorine application shall not cease until the entire pipe section is filled with chlorine solution. The chlorinated water shall be retained in the pipe for at least a twenty-four hour period. The treated water shall contain a chlorine residual throughout the length of the pipe section as indicated in AWWA C651.
ITEMS 303.06 through 376. (Continued)

Following the chlorination period, all treated water shall be flushed from the pipe section and replaced with water from the distribution system in accordance with the FM Global Data Sheet, section 2.1.5.8, Flushing Underground Mains. Prior to disposal of treated water the Contractor shall check with local authorities to determine if the discharge will cause damage to the receiving body or sewer and, if required, the Contractor shall neutralize the chlorinated water in accordance with Appendix B, AWWA C650. Bacteriological sampling and analysis of the replacement water may then be made by the Contractor in full accordance with AWWA Specification C651. A minimum of three samples shall be taken by the Contractor at locations directed by the Engineer along the length of water pipe being chlorinated and sent to a State approved private laboratory for analyses. The Contractor shall rechlorinate if the samples show presence of Coliform, and the pipe section shall not be placed in service until all of the repeat samples show no presence of Coliform.

Furnish two copies of a Certificate of Disinfection Report to LRWU and the Engineer.

The Contractor shall pay all costs for all testing, flushing, chlorinating; laboratory analyses, sampling, water supply and municipal charges.

Measurement and Payment

No separate payment will be made for excavation, concrete, gravel borrow and crushed stone bedding and backfill, dewatering, insulation, sampling, flushing, testing and disinfection, but all costs in connection therewith shall be included in the unit prices bid for the respective items.
ITEM 415. PAVEMENT MICROMILLING SQUARE YARD

The work under this item shall conform to the relevant provisions of Section 130 Pavement Milling within Section 450 of the Standard Specifications and the following:

This work shall consist of micromilling and removal of existing Hot Mix Asphalt (HMA) pavement courses from the project by the Contractor. Micromilling shall be performed in conformity with the approved QC Plan. The Contractor shall present and discuss in sufficient detail the Quality Control information and activities related to milling at the Construction Quality Meeting required under Section 450. Unless otherwise specified, the milled material shall become the property of the Contractor.

Milling Equipment Requirements

The milling equipment shall be self-propelled with sufficient power, traction, and stability to remove the existing HMA pavement to the specified depth and cross-slope. The milling machine shall be capable of operating at a minimum speed of 10 feet per minute, designed so that the operator can at all times observe the milling operation without leaving the control area of the machine, and equipped with the following:

(a) A built in automatic grade control system that can control the longitudinal profile and the transverse cross-slope to produce the specified results.
(b) Longitudinal controls capable of operating from any longitudinal grade reference, including string line, 30 foot ski minimum, 30 foot mobile string line minimum, or a matching shoe.
(c) The transverse controls shall have an automatic system for controlling cross-slope at a given rate.
(d) Cutting heads able to provide a minimum 6 foot cutting width and a 0 to 4 inch (0 to 100 mm) deep cut in one pass. The teeth on the revolving cutting drum must be continually maintained and shall be replaced as warranted to provide a uniform pavement texture.
(e) An integral pickup and conveying device to immediately remove milled material from the roadway and discharge the millings into a truck, all in one operation.
(f) All necessary safety devices such as reflectors, headlights, taillights, flashing lights and back up signals so as to operate safely in both day and night.
(g) A means of effectively limiting the amount of dust escaping from the milling and removal operation in accordance with local, State, and Federal air pollution control laws and regulations.

When milling smaller areas or areas where it is impractical to use the above described equipment, the use of a smaller or lesser-equipped milling machine may be permitted when approved by the Engineer.
ITEM 415. (Continued)

Sweeper Equipment Requirements
The Contractor shall provide a sufficient number of mechanical sweepers to ensure that the milled surface is free of millings and debris at the end of each day’s milling operations. Each sweeper shall be equipped with a water tank, spray assembly to control dust, a pick-up broom, a dual gutter broom, and a dirt hopper. The sweepers shall be capable of removing millings and loose debris from the textured pavement.

Milling Operations
The milling operations shall be scheduled to minimize the duration and placement of traffic on the milled surface. The milling operations shall not proceed more than 3 miles ahead of the paving operations. Under no circumstances shall the milled surface be left exposed to traffic for a period exceeding seven days. The Engineer may allow the Contractor to adjust the above limitations on milling production when necessary.

The Contractor shall coordinate milling and paving operations to minimize the exposure of milled surfaces to traffic. The Contractor shall ensure that milled surfaces are overlaid in a timely manner to avoid damage to the pavement structure. Any damage to the pavement structure resulting from extended exposure of the milled surface to traffic shall be repaired as directed by the Engineer at the Contractor’s expense.

The existing pavement shall be removed to the average depth shown on the plans, in a manner that will restore the pavement surface to a uniform cross-section and longitudinal profile. The longitudinal profile of the milled surface shall be established using a 30 foot mobile ski, mobile string line, or stationary string line. The cross-slope of the milled surface shall be established by a second sensing device or by an automatic cross-slope control mechanism. The Contractor will be responsible for providing all grades necessary to remove the material to the proper line, grade, cross section, superelevation, and transitions shown on the plans or as directed by the Engineer. The requirement for automatic grade or slope controls may be waived by the Engineer in locations warranted by the situation, including intersections and closely confined areas.

The Engineer may adjust the average milling depth specified on the plans by ± 3/4” (± 20mm) during each milling pass at no additional payment to minimize delamination of the underlying pavement course or to otherwise provide a more stable surface. If delamination or exposure of concrete occurs when milling a HMA pavement course from an underlying Portland Cement Concrete (PCC) pavement, the Contractor shall cease milling operations and consult the Engineer to determine whether to reduce the milling depth or make other adjustments to the operation.

Protection of Inlets and Utilities
Throughout the milling operation, protection shall be provided around existing catch basin inlets, manholes, utility valve boxes, and any similar structures. Any damage to such structures as a result of the milling operation is the Contractor’s responsibility and shall be repaired at the Contractor’s
ITEM 415. (Continued)

expense. To prevent the infiltration of milled material into the storm sewer system the Contractor shall take special care to prevent the milled material from falling into the inlet openings or inlet grates. Any milled material that falls into inlet openings or inlet grates shall be removed at the Contractor’s expense.

Vertical Faces

All permanent limits of the milled area shall be sawcut or otherwise neatly cut by mechanical means to provide a clean and sound vertical face. No vertical faces, transverse or longitudinal, shall be left exposed to traffic. If any vertical face is formed in an area exposed to traffic a temporary paved transition with a maximum 12:1 slope shall be established. If the milling machine is used to temporarily transition the milled pavement surface to the existing pavement surface, the temporary transition shall be constructed at a maximum 12:1 slope.

Opening to Traffic

Prior to opening a milled area to traffic, the milled surface shall be thoroughly swept with a mechanical sweeper to remove all remaining millings and dust. This operation shall be conducted in a manner so as to minimize the potential for creation of a traffic hazard and to comply with local, State, and Federal air pollution control laws and regulations. Any damage to vehicular traffic as a result of milled material becoming airborne is the responsibility of the Contractor and shall be repaired at the Contractor’s expense. Temporary pavement markings shall be placed in accordance with the provisions of Subsection 850.64.

Milled Surface Inspection

The milled surface shall provide a satisfactory riding surface with a uniform textured appearance. The milled surface shall be free from gouges, excessive longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, non-uniform milling teeth, improper use of equipment, or otherwise poor workmanship. Any unsatisfactory surfaces produced shall be corrected by remilling at the Contractor’s expense and to the satisfaction of the Engineer.

The Contractor shall perform Quality Control inspection of all work items addressed as specified in the table below. Inspection activities during milling of HMA pavement may be performed by qualified Production personnel (e.g. Skilled Laborers, Foremen, Superintendents). However, the Contractor’s QC personnel shall have overall responsibility for QC inspection. The Contractor shall not rely on the results of Department Acceptance inspection for Quality Control purposes. The Engineer shall be provided the opportunity to monitor and witness all QC inspection.
ITEM 415. (Continued)

Minimum QC Inspection of Milling Operations

<table>
<thead>
<tr>
<th>Inspection Component</th>
<th>Items Inspected</th>
<th>Minimum Inspection Frequency</th>
<th>Point of Inspection</th>
<th>Inspection Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>As specified in QC Plan</td>
<td>Per QC Plan</td>
<td>Per QC Plan</td>
<td>Per QC Plan</td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td>Protection of Inlets &amp; Utilities</td>
<td>Per QC Plan</td>
<td>Existing Surface</td>
<td>Visual Check</td>
</tr>
<tr>
<td></td>
<td>Removal of Millings &amp; Dust</td>
<td>Per QC Plan</td>
<td>Milled Surface</td>
<td>Visual Check</td>
</tr>
<tr>
<td>Workmanship</td>
<td>Milling Depth</td>
<td>Per QC Plan</td>
<td>Milled Surface</td>
<td>Check Measurement</td>
</tr>
<tr>
<td></td>
<td>Cross-Slope &amp; Profile</td>
<td>Per QC Plan</td>
<td>Milled Surface</td>
<td>Check Measurement</td>
</tr>
<tr>
<td></td>
<td>Milled Surface Texture</td>
<td>Per QC Plan</td>
<td>Milled Surface</td>
<td>Visual Check</td>
</tr>
<tr>
<td></td>
<td>Milled Surface Roughness</td>
<td>Once per 500 feet per milled lane</td>
<td>Milled Surface per Subsection 410.67</td>
<td>10 foot standard straightedge</td>
</tr>
<tr>
<td></td>
<td>Sawcut Limit Vertical Face</td>
<td>Per QC Plan</td>
<td>Sawcut Limits</td>
<td>Visual Check</td>
</tr>
</tbody>
</table>

The milled surface of each travel lane shall be divided into longitudinal Sublots of 500 feet. The Contractor shall perform a minimum of one random QC measurement within each Sublot with a 10 foot straightedge in the transverse direction across the milled surface. Additional selective QC measurements within each Sublot will be performed as deemed necessary by the QC personnel. All QC inspection results shall be recorded on NETTCP Inspection Report Forms. The Engineer will also randomly inspect a minimum of 25% of the Sublots. The Contractor shall perform surface texture measurements with a 10 foot straightedge in the transverse direction across the milled surface. The milled surface shall have a texture such that the variation from the edge of the straightedge to the top of ridges between any two ridge contact points shall not exceed 1/8 inch (3 mm). The difference in height from the top of any ridge to the bottom of the groove adjacent to that ridge shall not exceed 1/16”. Any point in the surface not meeting these requirements shall be corrected as directed by the Engineer at the Contractor’s expense.
ITEM 415. (Continued)

In isolated areas where surface delamination between existing HMA layers or a surface delamination of HMA on Portland Cement Concrete causes a non-uniform texture to occur, the straightedge surface measurement requirements stated in the preceding paragraph may be waived, subject to the approval of the Engineer.

Micromilling Equipment Requirements

The micromilling machine shall be equipped with a drum specifically designed to provide the surface specified below.

Control Strip

The Contractor shall micromill a control strip. The control strip shall be 500 feet minimum in length with a uniformly textured surface and cross slope, as approved by the Engineer.

The micromilled surface of the control strip shall provide a satisfactory riding surface with a uniform textured appearance. The micromilled surface shall be free from gouges, excessive longitudinal grooves and ridges, oil film, and other imperfections that are a result of defective equipment, non-uniform milling teeth, improper use of equipment, or otherwise poor workmanship. Any unsatisfactory surfaces produced in the control strip shall be corrected by additional micromilling at the Contractor’s expense and to the satisfaction of the Engineer.

The micromilled pavement surface shall have a transverse pattern of 0.2 – 0.3 inch center to center of each strike area. The Contractor shall perform surface texture measurements with a 10 foot straightedge in the transverse direction across the milled surface. The milled surface shall have a texture such that the variation from the edge of the straightedge to the top of ridges between any two ridge contact points shall not exceed 1/8 inch. The difference in height from the top of any ridge to the bottom of the groove adjacent to that ridge shall not exceed 1/16”. Any point in the surface not meeting these requirements shall be corrected as directed by the Engineer at the Contractor’s expense.

Micromilled Surface Inspection

The Contractor shall perform Quality Control inspection of all work items addressed under Section 415. The Contractor shall not rely on the results of Department Acceptance inspection for Quality Control purposes.

The micromilled surface shall meet the requirements of 415.62.
ITEM 415. (Continued)

Measurement and Payment

Pavement Micromilling will be measured for payment by the number of square yards of area from which the milling of existing HMA pavement has been completed and the work accepted. No area deductions will be made for minor unmilled areas such as catch basin inlets, manholes, utility boxes and any similar utility structures.

Pavement Micromilling, removal and disposal of existing HMA pavement will be paid for at the contract unit price per square yard. This price shall include all equipment, tools, labor, and materials incidental thereto. No additional payments will be made for multiple passes with the milling machine to remove the existing HMA surface to the grade specified.

No separate payments will be made for: performing handwork removal of existing pavement and providing protection around catch basin inlets, manholes, utility valve boxes and any similar structures; repairing surface defects as a result of the Contractor’s negligence; providing protection to underground utilities from the vibration of the milling operation; sawcutting micromilled limits; installing and removing any temporary transition; removing and disposing of millings; furnishing a sweeper and sweeping after milling. The costs for these items shall be included in the contract unit price for Pay Item 415., Pavement Micromilling.

Hot mix asphalt for patching will be paid for under Item 451.

Hot mix asphalt for temporary access and traffic maintenance will be paid for under Item 472.
| ITEM 450.90 | CONTRACTOR QUALITY CONTROL | TON |
| ITEM 451. | HOT MIX ASPHALT FOR PATCHING | TON |
| ITEM 452. | ASPHALT EMULSION FOR TACK COAT | GALLON |
| ITEM 453. | HOT MIX ASPHALT JOINT SEALANT | FOOT |
| ITEM 455.22 | SUPERPAVE SURFACE COURSE – 9.5 (SSC – 9.5) | TON |
| ITEM 455.31 | SUPERPAVE INTERMEDIATE COURSE – 12.5 (SIC – 12.5) | TON |
| ITEM 455.42 | SUPERPAVE BASE COURSE – 37.5 (SBC – 37.5) | TON |
| ITEM 455.51 | SUPERPAVE LEVELING COURSE – 4.75 (SLC – 4.75) | TON |

**GENERAL:** This type of pavement shall be composed of mineral aggregate, mineral filler (if required) and bituminous material. The materials supplied must conform in all respects to Section M3.11.00 to M3.11.09 inclusive Hot Mix Asphalt Standard Specification as published by the Department of Public Works, Commonwealth of Massachusetts, February 25, 2010. Edition and all addendas.

**APPLICATION:** All such material as is applied or “laid in place” shall be applied in a manner consistent with quality workmanship and subject to the approval of the Commissioner of Public Works. Resurfacing operation must start within 72 hours of notification from the Commissioner of Public Works. Locations shall include Roadways, Public Parking lots and other areas determined by the Commissioner of Public Works and/or Engineers.

Work under this item shall be in conformance with the provisions of Section 460 of the MDPW Specifications.

The Contractor shall work weekdays or nights to complete any project that is required within this contract. No additional compensation will be made if the Contractor is directed by the Engineer to work nights to complete pavement on Thorndike Street.

Work under these Items shall conform to the relevant provisions of Section 450 and 455 of the Standard Specification and MHD Document 00717 SUPERPAVE REQUIREMENTS and the following:

- The PGAB Grade selected for this Contract is PG 64-28.

**Note:** Hot mix asphalt (HMA) Walks and Drives may be Superpave HMA mixtures paved in accordance with Section 701 of the Standard Specification which shall be the basis for the work and included under Item 702. HMA Walks and Item 703. HMA Drives. These items shall not be subject to QA sampling and testing.
ITEM 482.3  SAWING ASPHALT PAVEMENT  FOOT

ITEM 482.5  SAWING ASPHALT PAVEMENT  FOOT
FOR BOX WIDENING

The work under these items shall conform to the relevant provisions of Section 120 of the Standard Specifications and the following:

The work shall include the sawcutting of existing asphalt pavements where shown on the plans, and as directed by the Engineer.

Sawcut equipment shall be approved by the Engineer prior to commencing work.

The existing pavement shall be sawcut through its full depth, or to the elevation of the abutting proposed pavement subgrade, whichever is lesser, and at all joints between existing and proposed pavements, and at all utility trenches through existing pavement to remain, to provide a uniform, vertical surface for the proposed pavement joint with the existing pavement.

Sawcut edges which become broken, ragged or undermined as a result of the Contractor's operations shall be re-sawcut prior to the placement of abutting proposed pavement at no additional cost to the Owner.

Sawcut surfaces in asphalt pavement shall be sprayed or painted with a uniform, thin coat of RS-1 asphalt emulsion immediately before placement of hot mix asphalt material against the surfaces. Sawcut surfaces abutting the proposed pavement top course shall be coated with hot-poured rubberized asphalt sealer.

Sawing asphalt pavement and sawing cement concrete will be paid for at the respective Contract unit price per foot, which price shall include all labor, materials, equipment, and incidental costs required to complete the work.

Asphalt emulsion will be paid for under Item 452.

Hot-poured rubberized asphalt sealer will be paid for under Item 453.
The work under these items shall conform to the relevant provisions of Section 120 of the Standard Specifications and the following:

The work shall include the sawcutting of existing cement concrete pavements where shown on the plans, and as directed by the Engineer.

Sawcut equipment shall be approved by the Engineer prior to commencing work.

The existing concrete shall be sawcut through its full depth, or to the elevation of the abutting proposed pavement subgrade, whichever is lesser, at all joints between existing and proposed pavements to provide a uniform, vertical surface for the proposed pavement joint with the existing pavement.

Sawcut edges which become broken, ragged or undermined as a result of the Contractor's operations shall be re-sawcut prior to the placement of abutting proposed pavement or concrete at no additional cost to the Owner.

Sawing cement concrete will be measured for payment by the foot on the pavement surface complete in place.

Sawing concrete pavement overlain with asphalt pavement will be measured for payment under Item 482.4.

Sawing cement concrete will be paid for at the Contract unit price per foot, which prices shall include all labor, materials, equipment, and incidental costs required to complete the work.
Work under this item shall conform to the relevant provisions of Section 500 of the Standard Specifications and the following:

Existing granite curb, curb inlets, and curb corners shall be cleaned by sandblasting to remove any paint, joint mortar, asphalt material or other undesirable material adhered to the granite before resetting, as required by the Engineer. The Contractor shall only reset existing curbing that has been approved by the Engineer for re-use. All unsuitable curbing shall be offered to the Owner. Curbing provided to the owner shall be stockpiled onsite. All remaining curbing shall be legally disposed of off-site.

Curved granite curb with different radius than the proposed curb are unsuitable for reuse. Damaged curb stones are unsuitable for reuse.

All stones to be reused which have damaged curb ends shall be sawcut square with the top plane so when stones are placed end to end the joint opening does not exceed one half inch.

Reset curb stones shall be reset contiguously. New curb stones shall be installed contiguously. Alternating new and old stones shall not be permitted.

The Contractor is advised that granite curb, curb inlets, and curb corners removed may be reset elsewhere at a different location within the Contract limits and all costs incurred for handling and transporting existing curb shall be included in the price bid.

Work under this item shall include all types of curbing removed and reset.

No separate payment will be made for storage, transporting and handling of existing granite curb to be reused, discarding of unsuitable curb, excavation, concrete to set curbing, sawcutting and other incidental work, but all costs in connection therewith shall be included in the Contract unit price bid.
ITEM 584.1 GRANITE BLOCK WALL REMOVED AND RESET

Work under this item shall conform to the relevant provisions of Section 500 of the Standard Specifications and the following:

General
The work shall include removing the existing granite block wall at the locations shown on the plans and resetting in close conformity with the lines and grades shown on the plans or directed by the Engineer.

Existing granite blocks shall be cleaned by sandblasting to remove any paint, joint mortar, asphalt material or other undesirable material adhered to the granite before resetting, as required by the Engineer. The Contractor shall only reset existing granite blocks that have been approved by the Engineer for re-use.

All stones to be reused which have damaged ends shall be sawcut square with the top plane so when stones are placed end to end the joint opening does not exceed one half inch. Any part of the granite block wall that is damaged or lost either directly or indirectly as a result of the Contractor's operations shall be replaced by the Contractor at his own expense.

Installation
The trench excavated for the granite block wall shall be excavated to a minimum width of 18 inches. The subgrade of the trench shall be a depth below the proposed finish grade of the wall equal to 6 inches plus the depth of the wall stone.

The subgrade of the trench shall be thoroughly rammed or tamped until firm and unyielding. Where unsuitable subgrade is encountered, the trench shall be excavated an additional 12 inches and gravel borrow shall be placed and thoroughly compacted by tamping to the required grade.

The foundation for the granite blocks shall consist of a 6-inch bed of concrete that extends 6 inches beyond both faces of the granite block and encompasses both sides of the buried portion of granite block, as shown on the construction details. Care shall be taken in placing the concrete to avoid disturbing the line or grade of the blocks.

Each stone shall be brushed clean and free from loose particles, and thoroughly wetted with clean, fresh water before setting.

The joints between the granite blocks (both front and back) shall be carefully filled with cement mortar and neatly pointed to the top and front exposed portions. After pointing, the stones shall be satisfactorily cleaned of all excess mortar that may have been forced out of the joints.

Measurement and Payment
No separate payment will be made for storage, transporting and handling of existing granite block to be reused, excavation, concrete to set curbing, sawcutting and other incidental work, but all costs in connection therewith shall be included in the Contract unit price bid.
ITEM 697.1 SILT SACK EACH

Work under this item shall conform to the relevant provisions of Section 670 of the Standard Specifications and the following:

The work under this item includes the furnishing, installation, maintenance and removal of a reusable fabric sack to be installed in drainage structures for the protection of wetlands and other resource areas and the prevention of silt and sediment from the construction site from entering the storm water collection system. Devices shall be ACF Environmental (800)-448-3636; Reed & Graham, Inc. Geosynthetics (888)-381-0800; The BMP Store (800)-644-9223; or approved equal.

Construction

Silt sacks shall be installed in retained existing and proposed catch basins within the project limits and as required by the Resident Engineer. The silt sack shall be as manufactured to fit the opening of the drainage structure under regular flow conditions, and shall be mounted under the grate. The insert shall be secured from the surface such that the grate can be removed without the insert discharging into the structure. The filter material shall be installed and maintained in accordance with the manufacturer’s written literature and as required by the Engineer.

Silt sacks shall remain in place until the placement of the pavement overlay or top course and the graded areas have become permanently stabilized by vegetative growth. All materials used for the filter fabric will become the property of the Contractor and shall be removed from the site.

The Contractor shall inspect the condition of silt sacks after each rainstorm and during major rain events. Silt sacks shall be cleaned periodically to remove and disposed of accumulated debris as required. Silt sacks, which become damaged during construction operations, shall be repaired or replaced immediately at no additional cost to the Department.

When emptying the silt sack, the contractor shall take all due care to prevent sediment from entering the structure. Any silt or other debris found in the drainage system at the end of construction shall be removed at the Contractors expense. The silt and sediment from the silt sack shall be legally disposed of offsite. Under no condition shall silt and sediment from the insert be deposited on site and used in construction.

All curb openings shall be blocked to prevent stormwater from bypassing the device.

Material collected in silt sacks is considered solid waste and must be disposed of in accordance with the MassDOT standard specifications for Item 227.3, Removal of Drainage Structure Sediment.

Measurement and Payment

Silt sacks will be measured and paid at the Contract unit price per each, complete in place, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for removal and disposal of the sediment from the insert, but all costs in connection therewith shall be included in the Contract unit price bid.
ITEM 701.2  CEMENT CONCRETE WHEELCHAIR RAMP  SQUARE YARD

The work under this item shall conform to the relevant provisions of Section 701 of the Standard Specifications and the following:

Cement concrete wheelchair ramps shall be constructed at locations shown on the Plans and in conformance with the latest Architectural Access Board’s Rules and Regulations and MassDOT Wheelchair Ramp Construction Standards. Concrete score lines as specified in Section 701 shall be continuous throughout the wheelchair ramps.

Detectable tactile warning surface shall be a cast iron surface applied, wet-set, truncated dome detectable warning system.

Detectable tactile warning surface shall conform to the requirements of MassDOT as shown on the Metric/English Supplemental Drawing M/E 107.6.5R dated December 2004.

Surface Applied Tactile Warning Tiles must be compliant with ADAAG, PROWAG, and CA Title 24 requirements. Division of the State Architect IR 11B-3 (1/26/05) and IR 11B-4 (1/01/11).

No separate payment will be made for the detectable warning panels, but all costs in connection therewith shall be included in the unit price bid.
ITEM 706.  

BRICK WALK  

SQUARE YARD

The work under this item shall conform to the relevant provisions of Section 700 of the Standard Specifications and the following:

The work of this section consists of furnishing and installing brick pavers on a concrete base and gravel subbase.

Samples and submittals

Submit samples of brick for color range.

Construct a 6’x6’ sample of brick walk including the concrete subbase, setting bed, brick (showing the coursing and edges) with sand swept joints. The constructed sample may be part of the finished work.

Materials

Base and subbase
Brick Walk base materials shall consist of compacted gravel borrow (M1.03.0, Type b) as shown on Drawings.

Concrete subbase

The dimensions of the lumber used to form concrete pavements shall not be less than 2 inches nominal thickness by the required pavement depth of 4 inches, 6 inches or 8 inches.

Cast-in-place concrete shall be air-entrained concrete with minimum 28-day compressive strength of 4,000 pounds per square inch (30 MPa), conforming to the requirements and applicable provisions of M4.02. Concrete shall be air-entrained 7 percent minimum +/-1 percent, by volume. Concrete shall have a slump of 2 inches (50 mm) to 4 inches (100 mm) slump. Maximum Aggregate Size: Aggregate size shall be a maximum of 3/4 inches (18.8 mm). Thickness of Concrete: Depths shall be as noted on the Contract Documents.

Curing shall be by moist curing or by use of curing compound. Curing paper shall be nonstaining, fiber reinforced laminated kraft bituminous product conforming to ASTM C 171. Four mil polyethylene sheeting may be substituted for curing paper. Curing compound shall be a resin-base, white pigmented conforming to ASTM C 309, Type 2.

Provide expansion joints as indicated and in accordance with the following. Unless otherwise indicated on the Contract Documents, expansion joints shall be located 20 feet (6.0 m) on-center, maximum.

Closed cell polymer foam meeting requirements of ASTM D 1752, Sections 3.1 to 3.4, based on compression requirement of 10 pounds per square inch minimum and 25 pounds per square inch maximum. Recovery rate following 50 percent compression shall exceed 99 percent recovery, per
ASTM D 545. Foam shall be equal to Ceramar Foam Filler, manufactured by W.R. Meadows, Inc., or an approved equal. Expansion joint filler shall have a removable cap cover for the joint filler with integral permanent plastic bond breaker such as Snap-Cap from Seal Tight manufactured by W.R. Meadows, Inc., or approved equal. Cover width shall be sized to match width of joint filler.

Transverse construction joints shall be placed whenever placing of concrete is suspended for more than 30 minutes. Butt joint with dowels or thickened edge joint shall be used if construction joints occurs at location of control joint. Submit sketch to Contracting Officer for review and acceptance of proposed system. Keyed joints with tiebars shall be used if the joint occurs at any other location.

Bond breaker shall be asphalt felt conforming to ASTM D 226, Type I or 6 mil polyethylene sheeting.

**Asphalt Setting Bed**

Asphalt cement to be used in the asphalt setting bed shall conform to ASTM D 3381. Viscosity grade shall be A.C. 10 or A.C. 20. Fine aggregate to be used in the asphalt setting bed shall be clean, hard sand with durable particles and free from adherent coating, lumps of clay, alkali salts, and organic matter. Aggregate shall be uniformly graded from "coarse" to "fine" with 100 percent by weight passing the No. 4 sieve and shall meet the gradation requirements when tested in accordance with ASTM C 136. Fine aggregate shall be dried and shall be combined with hot asphalt cement, and the mix shall be heated to approximately 300 degrees Fahrenheit at an asphalt plant. The approximate proportion of materials shall be 7 percent cement asphalt and 93 percent fine aggregate. Each ton of material shall be apportioned by weight in the approximate ratio of 145 pounds asphalt to 1,855 pounds sand. The Contractor shall determine the exact proportions to produce the best possible mixture for construction of the asphalt setting bed to meet specified requirements.

**Neoprene-modified asphalt setting bed**

Neoprene modified asphalt adhesive shall meet the following requirements:

**Mastic (asphalt adhesive):**

a. Solids (base) content by volume = 75± 1 percent.
b. Weight = 8.0 to 8.5 pounds/gallon.
c. Solvent vehicle = Varsol [over 100 degrees Fahrenheit flash].

**Base (2 percent neoprene, 10 percent fibers, 88 percent asphalt):**

a. Melting point (ASTM D 36) = 200 degrees Fahrenheit minimum.
b. Penetration at 77 degrees Fahrenheit 100 gram load 5 second = 23 to 27.
c. Ductility (ASTM D 113 at 77 degrees Fahrenheit (25 degrees Centigrade), 5 cm/minute) = 125 cm, minimum.

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Asphaltic Primer

Primer for base beneath asphalt setting bed and brick pavers shall be an emulsified asphalt rapid setting type conforming to AASHTO M 140, Grade RS-1, or AASHTO M 208.

Sand for Joint Filler

Joint filler between paver joints shall be filled with sand meeting ASTM C 33 with cement meeting the requirements of ASTM C150. Sand and cement shall be mixed in a 4:1 proportion. Sand/cement mixture shall contain coloring additive to match joint filler mixture with color of concrete pavers, as applicable by pavement area. Sand shall be clean, washed sand, free from silt and clay.

a. Color of joint filler shall match the dark color range of the concrete pavers and shall be approved by the Architect.

b. Sand shall be from a single source. Source of supply shall not be changed during course of job without written permission of the Architect.

Paving Brick

Brick pavers shall meet or exceed the requirements of ASTM C 902, Class SX, Abrasion Type I, Application PX.

Brick pavers shall be equal to the following:
“Medium Iron Spot 77”, 8 inches x 4 inches x 2-1/4 inch nominal size, color red blend, manufactured by Endicott Clay Products Company, P.O. Box 17, Fairbury, NE 68352; Spaulding Brick Company, Wilmington, MA 01887, local distributor.

“Pawnee Paver”, 8 inches x 4 inches x 2-1/4 inch nominal size, color red blend, manufactured by The Belden Brick Company, P.O. Box 20910, Canton, OH 44701; Spaulding Brick Company, Wilmington, MA 01887, local distributor.

"Autumn Haze", 8 inches x 4 inches x 2-1/4 inches nominal size, color red blend, manufactured by Glen-Gery Brick Corp., 1166 Spring Street, P.O. Box 7001, Wyomissing, PA; Spaulding Brick Company, Wilmington, MA 01887, local distributor.

Brick shall conform to the following requirements:
Average absorption, 24 hour cold-water absorption test equals 4 percent or less. Average compressive strength of not less than 10,500 pounds per square inch (72.5 MPa) for any five bricks tested.
Capable of withstanding at least the equivalent of 100 cycles of freeze-thaw conditions. Permissible paver tolerances shall conform to ASTM C 902. Paver shall not vary from nominal dimensions by more than 1/8 inch (3.2 mm). Color and texture shall match the sample at the office of the Engineer, and shall be as approved by the Engineer from samples submitted by the Contractor prior to delivery.
Brick shall be uniform in color, size, appearance, and dimensions, and shall have smooth regular edges where they are closely butted. Brick shall have a temporary wax coating with a 130 degrees Fahrenheit melting point to protect surface from latex-modified mortar. Laminated brick will not be accepted.
Expansion Joint Filler shall be preformed bituminous type, ASTM D994-71.
Construction Methods

Base and subbase shall be furnished and installed per the requirements of the Standard Specifications.

Concrete Formwork

All forms shall be joined neatly and tightly, shall be set true to line and grade, well staked and braced, and shall have uniform bearing throughout their length. Remove all forms and miscellaneous appurtenances from pavement edges and dispose of all formwork and appurtenances at the end of the construction project.

Forms shall not be moved for 72 hours after the concrete has been placed, or for a longer period if directed by the Engineer. Remove all forms. Extreme care shall be taken in removing forms in order that no damage will be done to the concrete. Under no condition shall any bar, pick or other tool be used which depends upon leverage on the concrete for removal of the forms.

Portland Cement Concrete Subbase

Paving mix, equipment, methods of mixing and placing, and precautions to be observed as to weather, condition of base and the like, shall meet the requirements of ACI 316R. Pavement shall be constructed in accordance with the Contract Documents. The Engineer shall be notified of concrete placement sufficiently in advance of start of operation to allow his representative to complete preliminary inspection of the work, including subgrade, forms, and reinforcing steel, if used. No concrete shall be deposited until the Engineer has inspected the placing of reinforcement and given permission to place concrete.

Normal concrete placement procedures shall be followed. Concrete shall arrive at the job site so that no additional water will be required to produce the desired slump. When conditions develop that required addition of water to produce the desired slump, permission of the Contracting Officer must be obtained. The concrete shall be transported from the mixer to its place of deposit by a method that will prevent segregation or loss of material.

Concrete pavement shall be placed in a series of alternate pours such that every other panel bounded by expansion joints shall be poured first.

The intervening panels shall then be poured as a secondary operation only after the first panels have hardened sufficiently to allow the removal of all temporary transverse forming supports.

Concrete shall be placed in one course, to full depth, as detailed on the Contract Documents. Work shall not be performed during rainy weather or when temperature is less than 40 degrees Fahrenheit. In the event that unforeseen rain occurs, cover all broom finished concrete surfaces with plastic sheet covering to prevent alteration of texture. Concrete slabs with textured concrete surfaces altered by rain shall be removed from the site as directed by the Engineer. Adjacent work shall be protected from stain and damage during entire operation. Damaged and stained areas shall be
replaced or repaired to equal their original conditions. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed shall thoroughly damp when concrete is placed. There shall be no free water on surface. Concrete which has set or partially set before placing shall not be employed. Retempering of concrete will not be permitted. Concrete shall be thoroughly spaded and tamped to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms. When joining fresh concrete to concrete which has attained full set, latter shall be cleaned of foreign matter, and mortar scum and laitance shall be removed by chipping and washing. Laitance is the accumulation of fine particles on the surface of freshly poured concrete caused by an upward movement of water through the concrete. This can be caused by too much mixing water, by excessive tamping, or by vibration of the concrete. Clean, roughened base surface shall be saturated with water, but shall have no free water on surface. A coat of 1:1 cement-sand grout, approximately 1/8 inches thick, shall be well scrubbed into thoroughly dampened concrete base. New concrete shall be placed immediately, before grout has dried or set.

Surfaces shall not vary more than 5/16 inch when tested with a 10-foot straightedge. Contractor shall examine the concrete base to determine its adequacy to receive brick pavers and setting bed. Concrete shall have fully cured prior to the work of installing brick pavers. Evidence of inadequate base shall be brought to the immediate attention of the Engineer and be corrected by the Contractor as directed by the Engineer at no additional cost to the Department.

Asphalt Prime Coat

The surface of the base shall receive an asphalt prime coat before laying asphalt setting bed. Prime coat shall be applied at rate that will leave asphalt residue of 5 to 7 gallons per 100 square yards after evaporation of vehicle. Base surface shall be dry and clean when prime coat is applied. Asphalt setting bed shall not be placed until vehicle has completely evaporated from prime coat.

Asphalt Setting Bed for Brick Walk

Asphalt setting bed shall be installed over the fully dry asphalt prime coat. Control bars 3/4 inch deep shall be placed directly over the base. If grades must be adjusted, wood chocks under depth control bars shall be set to proper grade. Set two bars parallel to each other to serve as guides for the striking board. The depth control bars must be set carefully to bring the pavers, when laid, to proper grade.

While still hot 250 degrees Fahrenheit some of the asphalt bed material shall be placed between the parallel depth control bars. This bed shall be pulled with the striking board over the control bars several times. After each passage, low porous spots shall be showered with fresh asphalt material to produce a smooth, firm, and even setting bed. As soon as this initial panel is completed, advance the first bar to the next position in readiness for striking the next panel. After the depth control bars and wood chocks have been removed, carefully fill any depressions that remain.

The setting bed shall be rolled with a power roller to a nominal depth of 3/4 inch while still hot. The setting bed thickness shall be adjusted so that when the bricks are placed and rolled, the top surface of the pavers will be at the required finished grade.
A coating of neoprene-modified asphalt adhesive shall be applied by mopping, squeegeeing, or troweling over the top surface of the asphalt setting bed so as to provide a bond under the pavers. If adhesive is trowel-applied, trowel shall be serrated type with serrations not to exceed 1/16 inch.

Setting Brick Pavers

No pavers shall be laid in inclement weather or when the temperature is 36 degrees Fahrenheit, and dropping, nor shall any work be done on rising temperatures until the temperature reaches 32 degrees Fahrenheit. Frozen mortar materials shall not be used. Brick pavers shall be on a asphalt setting bed over a prepared base. All setting shall be done by competent masons under adequate supervision. Brick pavers with chips, cracks, stains, or other defects that might be visible in the finished work shall not be used.

After the modified asphalt adhesive is applied, carefully place the pavers by hand in straight courses with hand tight joints and uniform top surface. Brick pavers shall be set true to the required lines and grades in the pattern detailed on the Contract Documents. Brick pavers shall be neatly cut and fitted at all perimeters and closures to fit neatly and closely, with joints uniform in thickness. Pavers shall be cut with a water-cooled, cut-off wheel masonry saw using a diamond blade. Under work of brick paving, set boxes for valves and gates to final grade that is flush with adjacent brick pavement. Tolerances: Check surface with a 10-foot straightedge. Correct deviances greater than 1/8 inch.

Joint Treatment for Brick Walk

Joints between pavers shall be hand tight and shall be uniform in thickness. Joint thickness shall not exceed 1/8 inch.

Joint filler shall be swept dry into the joints between pavers until the joints are completely filled. Surface shall be swept clean. Swept surface shall than be thoroughly dampened with a low-volume fine spray of water.

1. Sweep sand/cement mixture into paver joints until joints are filled solid. Fog lightly with water and repeat a minimum of three times or until joints are compacted and full.
2. Prior to acceptance, the paved area shall be flooded with water to assure that there are no depressions. Pavers with top surfaces greater than 1/16 inch above or below adjacent pavers shall be removed and reset. Remove and reset pavers as required until surface is true to line and grade. Refill sand joints as necessary until all joints are filled to finish grade.

Unit paving shall be kept damp by intermittent spraying for three days, minimum, to effectively cure the joints.

Clean dirt and mortar stains from brick with fiber brushes and water or other approved method. Wire brushes and solutions that might cause discoloration will not be permitted.
Method of Measurement

Brick walk will be measured by the square yard, complete, in place.

Basis for Payment

Brick walk will be paid for at the contract unit price per square yard, which price shall be full compensation for complete compliance with requirements of this item, including all labor, materials, equipment and incidental costs required for the work, concrete, hot mix asphalt setting bed, and brick.
ITEM 711.12  BOLLARD REMOVED AND RESET  EACH

This work consists of removing and resetting an existing bollard as indicated on the Plans or as directed by the Engineer.

General
Bollard shall be carefully removed and cleaned. The contractor shall replace, at his own expense, any materials damaged by his method of removal and operations. The bollard shall be cleaned of soil and concrete and neatly stacked, stored and protected until needed for resetting. Any holes caused by excavation under this item shall be backfilled with an approved granular fill and compacted. The bollard shall be reset at the location shown on the plans, providing the same amount of reveal as the original.

Measurement and Payment
Bollard Removed and Reset will be paid for at the contract unit price per Each. The price shall constitute full and complete compensation for all labor, tools, materials and equipment, excavation, cleaning, stockpiling backfill, compaction and all other incidentals required to finish the work, complete in place and accepted by the Engineer.
This Item addresses the Contractor’s preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP) and submission of a Notice of Intent (NOI) required by the National Pollutant Discharge Elimination System (NPDES) and applicable Construction General Permit.

The NPDES CGP requires the submission by the Contractor preforming site disturbing activities of a Notice of Intent (NOI) to the U.S. EPA prior to the start of construction (defined as any activity which disturbs land, including clearing and grubbing). There is a fourteen (14) day review period commencing from the date on which EPA enters the Notice into their database. The Contractor is advised that, based on the review of the NOI, EPA may require additional information, including but not limited to, the submission of the Storm Water Pollution Prevention Plan for review. Work may not commence on the project until final authorization has been granted by EPA. Any additional time required by EPA for review of submittals will not constitute a basis for claim of delay.

In addition, if the project discharges to an Outstanding Resource Water, vernal pool, or is within a coastal ACEC as identified by the Massachusetts Department of Environmental Protection (DEP), a separate notification to DEP is required. DEP may also require submission of the Storm Water Pollution Prevention Plan for review and approval. Filing fees associated with the notification to DEP and, if required, the SWPPP filing to DEP shall be paid by the Contractor.

The General Permit also requires the preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP) in accordance with the afore-mentioned statutes and regulations. The Plan will include the General Permit conditions and detailed descriptions of controls of erosion and sedimentation to be implemented during construction. It is the responsibility of the Contractor to prepare the SWPPP to meet the requirements of the most recently issued CGP. The Contractor shall submit the Plan to the City for approval at least four weeks prior to any site activities. It is the responsibility of the Contractor to be familiar with the General Permit conditions and the conditions of any state Wetlands Protection Act Order, Water Quality Certification, Corps of Engineers Section 404 Permit and other environmental permits applicable to this project and to include in the Stormwater Pollution Prevention Plan the methods and means necessary to comply with applicable conditions of said permits (reference to Part 9.1.1 of the 2012 CGP).

It is the responsibility of the Contractor to complete the SWPPP in accordance with the EPA Construction General Permit, provide all information required, and obtain any and all certifications as required by the Construction General Permit. Any amendments to the SWPPP required by site conditions, schedule changes, revised work, construction methodologies, and the like are the responsibility of the Contractor. Amendments will require the approval of the City prior to implementation.

Included in the General Permit conditions is the requirement for inspection of all erosion controls and site conditions on a weekly basis as well as after each incidence of rainfall exceeding 0.25 inches in twenty-four hours. For multi-day storms, EPA requires that an inspection must be performed during or after the first day of the event and after the end of the event. The Contractor shall choose a qualified individual who will be on-site during construction to perform these inspections. The Engineer must approve the contractor’s inspector. In addition, if the Engineer determines at any
ITEM 756. (Continued)

time that the inspector’s performance is inadequate, the Contractor shall provide an alternate inspector. Written weekly inspection forms, storm event inspection forms, and Monthly Summary Reports must be completed and provided to the Engineer. Monthly Summary Reports must include a summary of construction activities undertaken during the reporting period, general site conditions, erosion control maintenance and corrective actions taken, the anticipated schedule of construction activities for the next reporting period, any SWPPP amendments, and representative photographs.

The Contractor is responsible for preparation of the Plan, all SWPPP certifications, inspections, reports and any and all corrective actions necessary to comply with the provisions of the General Permit. Work associated with performance of inspections is not included under this Item. The Standard Specifications require adequate erosion control for the duration of the Contract. This Item addresses acceptable completion of the SWPPP, any revisions/amendments required during construction, and preparation of monthly reports. In addition, any erosion controls beyond those specified in bid items elsewhere in this contract which are selected by the Contractor to facilitate and/or address the Contractor’s schedule, methods and prosecution of the work shall be considered incidental to this item.

Work associated with performance of inspections of all erosion controls and site conditions is considered incidental to this Item. The Standard Specifications require adequate erosion control for the duration of the Contract. Inspection of these controls is considered incidental to the applicable items. Additional erosion controls beyond those specified in bid items elsewhere in this contract which are selected by the Contractor to facilitate and/or address the Contractor’s schedule, methods, and prosecution of the work shall be considered incidental to this item.

The CGP requires the submission of a Notice of Termination (NOT) from all operators when final stabilization has been achieved, as well as removal and proper disposal of all construction materials, waste and waste handling devices, removal of all equipment and construction vehicles, removal of all temporary stormwater controls, etc. Approval of final stabilization by the Engineer and confirmation of submission of the NOT will be required prior to submission of the Resident Engineer’s Final Estimate. The permittee is required to use EPA’s electronic NOI system or “eNOI system” to prepare and submit NOT. The electronic NOT form can be found at www.epa.gov/npdes/stormwater/cgpenoi. If you are given approval by the EPA Regional Office to use a paper NOT, you must complete the form in Appendix K of the 2012 CGP.

Compensation

Payment for all work under this Item shall be made at the contract unit price, lump sum, which shall include all work detailed above, including Plan preparation, required revisions, revisions/addenda during construction, monthly reports and filing fees.

Payment of fifty (50) % of the contract price shall be made upon acceptance of the Stormwater Pollution Prevention plan. Payment of forty (40) % of the contract price shall be made in equal installments for implementation of the Stormwater Pollution Prevention plan. Payment of the final ten (10) % of the contract price shall be paid upon satisfactory submissions of a Notice of termination (NOT) when final stabilization has been achieved.
ITEM 765. SEEDING SQUARE YARD

Description

Except as indicated below and on the Drawings, all work shall be in accordance with the pertinent requirements of Standard Specifications Section 765, Seeding.

Seeding work shall include the seeding and maintenance of all proposed and existing lawn areas within the project limits, as shown on the Drawings and/or as specified herein and includes, but is not limited to, the following:

A. Surface Preparation
B. Seeding and Mulching
C. Establishment
D. Maintenance and Monitoring
E. Inspection and Acceptance of Work

All seeding shall be done by a firm having a minimum of five years’ experience with seeding. Prior to beginning work, the Contractor shall furnish proof of qualifications to the Engineer for approval.

All areas disturbed by construction shall be seeded as soon as possible.

Placement of loam will be paid for under: Item No. 751, Loam Borrow.

Submittals:

At least thirty (30) days prior to intended use, the Contractor shall provide the following samples and submittals for approval in conformance with requirements of the General Conditions. Do not order materials until Engineer's approval of samples, certifications or test results has been obtained. Delivered materials shall closely match the approved samples. The Engineer has the right to reject on or after delivery any material that does not meet these Specifications. Acceptance shall not constitute final acceptance.

Seed: Submit a manufacturer’s Certificate of Compliance to the Specifications with each shipment of each type of seed. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.

Fertilizer:

Submit the Product literature of seeding fertilizer and certificate showing composition and analysis.

a. Submit the purchasing receipt showing the total quantity purchased for the project prior to installation.

Hydroseeding: Prior to the start of hydroseeding, submit a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water.

Erosion Control Matting: Submit four (4) copies of the manufacturer’s literature and one (1) sample.

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ITEM 765. (Continued)

Wood Cellulose Fiber Mulch: Submit four (4) copies of manufacturer's literature and one (1) material sample.
Peat: Submit a one (1) cubic foot sample and supplier's certification of contents.
All additives needed to amend a specific soil in order to meet these specifications.

Materials

Loam Borrow materials and construction methods shall be as per Section 751 LOAM BORROW.
Seed mixture shall be fresh, clean, new crop seed. Grass shall be of the previous year's crop and in no case shall the weed seed content exceed 0.25% by weight. The seed shall be furnished and delivered in the proportion specified below in new, clean, sealed and properly labeled containers. All seed shall comply with State and Federal seed laws. Submit manufacturer's Certificates of Compliance. Seed that has become wet, moldy or otherwise damaged shall not be acceptable. Chewings fescue, hard fescue, tall fescue and ryegrass shall contain Acromonium endophytes. Seed containing endophyte must be kept cool and dry at all times; do not stockpile in the sun.

Seed Mixture Composition

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Proportion by Weight</th>
<th>Germination Minimum</th>
<th>Purity Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creeping Red Fescue</td>
<td>65%</td>
<td>85%</td>
<td>95%</td>
</tr>
<tr>
<td>Chewings Fescue</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td>20%</td>
<td>85%</td>
<td>90%</td>
</tr>
<tr>
<td>Perennial Rye</td>
<td>15%</td>
<td>90%</td>
<td>90%</td>
</tr>
</tbody>
</table>

Bluegrass and rye grass varieties shall be within the top 50 percent and 25 percent respectively, of varieties tested in National Turfgrass Evaluation Program, or currently recommended as low maintenance varieties by University of Massachusetts or the University of Rhode Island.

Seeding rate for the Shade Lawn Seed Mix shall be 6 pounds per 1,000 square feet.

Limestone
Agricultural limestone containing a minimum of 85 percent calcium carbonate or equivalent.
ITEM 765. (Continued)

Wood Cellulose Fiber Mulch

Mulch to cover hydروseeded areas with slopes less than 3 to 1 shall be fiber processed from whole wood chips and clean recycled newsprint in a 1:1 proportion manufactured specifically for standard hydraulic mulching equipment. Fiber shall not be produced from recycled material such as sawdust, paper, or cardboard.

Moisture content shall not exceed 10%, plus or minus 3% as defined by the pulp and paper industry standards. Fiber shall have a water holding capacity of not less than 900 grams water per 100 grams fiber.

The mulch shall be of such character that the fiber will be dispersed into a uniform slurry when mixed with water. It shall be nontoxic to plant life or animal life.

The mulch shall contain a non-petroleum based organic tackifier and a green dye to allow for easy visual metering during application but shall be noninjurious to plant growth.

Lawn Fertilizers

Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers which shall bear the manufacturer's certificate of compliance covering analysis. At least 50% by weight of the nitrogen content shall be derived from organic materials. Fertilizer shall contain not less than the percentages of weight of ingredients as follows or as recommended by the soil analysis:

<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>Phosphorus</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>6%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Nitrogen fertilizer shall be slowly soluble ureaformaldehyde, methylene urea, or isobutylidene diurea; or slow release sulfur-coated urea.

Phosphorus shall be superphosphate or treble superphosphate. Superphosphate shall be composed of finely ground phosphate rock as commonly used for agricultural purposes containing not less than 18% available phosphoric acid.

Potassium shall be sulfate of potash, K₂SO₄.

Salt indexes per unit of nutrient for nitrogen, phosphorous, and potassium shall be less than 1.0 when compared to sodium nitrate (6.3).

Water

The Contractor shall be responsible to furnish his own supply of water to the site at no extra cost. If possible, the Owner shall furnish the Contractor upon request with an adequate source and supply of water at no charge. However, if the Owner's water supply is not available or not functioning, the Contractor shall be held responsible to furnish adequate supplies at his own cost. All work injured or
ITEM 765. (Continued)

damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.

Construction Methods

Before the application of limestone, fertilizer and seed, the Contractor shall harrow or roto-till to a depth of 3 inches all areas to receive seed which have not been prepared with 6 inches or more of new loam. When loam borrow is placed and is paid for under the respective item of this contract, it will not require harrowing or roto-tilling.

Loam borrow shall be placed in quantities sufficient to produce, after compaction, a depth of 4 inches in accordance with the MassDOT Standard Specification requirements of Section 751 LOAM BORROW.

Contractor shall request Engineer's written approval of fine grading prior to seeding.

Limit of grading and earthwork shall be limit of seeding unless otherwise indicated on the Contract Documents. All lawn areas disturbed outside the limit of seeding shall be prepared and seeded as specified herein at no additional cost.

The season for seeding work shall be from April 1 to June 1 and from August 15 to September 30. The actual lawn construction work shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions and by accepted practice in this locality.

Hydroseeding

Prior to the start of work, the Engineer shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of hydroseeding that can be covered with the quantity of solution in the hydroseeded.

Seed Application Rate:

Seed shall be added to the hydroseeding slurry at six (6) pounds per thousand square feet.

A mobile tank with a capacity of at least 500 gallons shall be filled with water and seed in quantities so they may be sprayed in the specified proportions per unit of area to be hydroseeded. The slurry shall be thoroughly mixed by means of positive agitation in the tank. The slurry shall be applied by means of a centrifugal pump using the turret or hose application technique from the mobile tank. The hose or turret shall be equipped with a nozzle of a proper design to ensure even distribution of the hydroseeding slurry over the area to be hydroseeded and shall be operated by a person thoroughly familiar with this type of seeding operation.

Install erosion control matting as specified above.

Lawn Maintenance

Maintenance shall begin immediately after any area is seeded or hydroseeded and shall continue for a minimum of sixty (60) day active growing period following the completion of all lawn construction.
ITEM 765. (Continued)

work, and until final acceptance of the project. In the event that seeding operations are completed too late in the Fall for adequate germination and growth of grass, then maintenance shall continue into the following Spring for the minimum 60 day period and reseeding shall take place as necessary at that time.

Maintenance shall include reseeding, mowing, watering, weeding, fertilizing, and resetting and straightening of protective barriers. Lawn work maintenance shall also include chemical treatments as required for fungus and/or pest control.

Watering:
The Contractor shall provide all labor and arrange for all watering necessary to establish an acceptable lawn. Contractor shall water all seeded areas daily, as specified, during maintenance period unless natural rainfall during the previous week has been greater than one inch and the soil in the seeded area is moist to a depth of 2 inches or greater. In the event that the Contractor has not watered seeded areas as required for at least a seven day period, the Department may elect to have the seeded areas watered by others and to reduce the value of the seeding contract item by the amount paid for outside watering.

Watering shall be done in a manner which will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply one (1) complete coverage to the lawn areas in an eight (8) hour period.

Protection:
All seeded areas shall be protected by a double nylon string barrier. The strings shall be supported by 1 inch x 1 inch hardwood stakes spaced 6 feet on center. Strings shall be located parallel to finish grade at 6 inch and 18 inch elevations. Yellow surveyor's flagging will be attached to the strings at 6 foot intervals.

Barriers must be raised immediately after lawn construction and shall be maintained until Acceptance.

Reseeding:
After the grass in seeded areas has appeared, all areas and parts of areas which, in the opinion of the Engineer, fail to show a uniform stand of grass, for any reason whatsoever, shall be reseeded and such areas and parts of areas shall be reseeded repeatedly until all areas are covered with satisfactory growth of grass. Reseeding together with necessary grading, fertilizing, and trimming shall be done at the expense of the Contractor who shall spread the seed by a method approved by the Engineer and during an approved season.

Mowing:
The Contractor shall keep lawn areas mowed until Acceptance of the contract by cutting to a height of two inches (2") when growth reaches three inches (3") or as directed by the Engineer.

Remove and discard clippings and debris generated by each mowing and edging operation.
ITEM 765. (Continued)

During the maintenance period, any decline in the condition of lawns or hydroseeded areas shall require the Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, the Contractor shall, at his own expense, engage professional horticulturists to inspect lawns and to identify problems and recommend corrective procedures.

Following the minimum required maintenance periods for lawn work construction, the Contractor shall request the Engineer in writing for a formal inspection of the completed work. Seeded areas shall have a close stand of grass with no weeds present and no bare spots greater than 3 inches (3”) in diameter. At least 90% of the grass established shall be permanent grass species. At the time of acceptance, the Contractor shall remove temporary barriers used to protect lawn areas.

Absolutely no debris may be left on the site. Excavated material shall be removed as directed. Repair any damage to site or structures to restore them to their original condition, as directed by the Engineer, at no cost to the Department.

Method of Measurement

The method of measurement shall be in units of square yardage of planted seed.

Basis for Payment

Item No. 765 SEEDING will be measured by the SQUARE YARD installed complete-in-place all which price and payment shall constitute full compensation for complete compliance with requirements of this item, including all labor, equipment, materials, tools, incidental work, and construction methods.

Placement and fine grading of loam will be paid for in Item No. 751 LOAM BORROW Amendments, water, and maintenance shall be considered incidental to the work and not paid for separately.
ITEM 786.481  JUNIPER SHRUB – ‘SHORE’ 12-18 INCH SPREAD  EACH
ITEM 794.327  SUMAC SHRUB – FRAGRANT ‘GRO-LOW’ –  18-24 INCH HEIGHT  EACH
ITEM 796.010  BEARBERRY – 12-18 INCH SPREAD  EACH
ITEM 796.212  ROSE – BEACH – 18-24 INCH HEIGHT  EACH

General

This Section supersedes Section 771 PLANTING TREES, SHRUBS AND GROUNDCOVER of the Standard Specifications for the items of work specified herein.

The work of this Section consists of amendment of soils, planting mix, aged bark mulch, planting shrubs, guarantee of plants and related items as indicated on the Drawings or specified herein.

References and Standards

The following related terms are used herein and shall mean:


Samples and Submittals

At least 30 days prior to ordering the below listed materials, submit certified testing results and representative samples to Engineer for selection. No materials shall be ordered or delivered until required samples, certifications, manufacturer's literature and test results have been reviewed by Engineer. Delivered materials shall closely match the approved samples.
Soils: Contractor shall submit for approval all sources of loam and soil amendments prior to ordering. Soils brought in from off-site shall be free of invasive species. Off-site source shall be identified and available for inspection by the Engineer prior to transport of soil to the site.

Fertilizer: Submit manufacturer's literature.

Antidesiccant: Submit manufacturer's literature.

Examination of Conditions

All areas to be planted, shall be inspected by the Contractor before starting work and any defect such as incorrect grading shall be reported to the Engineer prior to beginning this work.

The Contractor shall be solely responsible for judging the full extent of work requirements involved, including but not limited to the potential need for storing and maintaining plants temporarily and re-handling plants prior to final installation.

Materials

Plant Materials

The Contractor shall furnish all plants shown on the Drawings, as specified, and in quantities listed on the PLANT SCHEDULE. The Contractor shall be responsible for the procurement of all plants within this contract. No substitutions will be permitted. All plants shall be nursery grown.

Plants shall be in accordance with the ASNS Standards of the American Association of Nurserymen (AAN) as a minimum requirement for acceptance. Botanical plant names shall be in accordance with plant designations included in Standardized Plant Names.

All plants shall be typical of their species or variety and have a normal habit of growth. All plants shall be legibly tagged with the proper name. Only plant stock grown within hardiness Zones 1 through 5, as established by the Arnold Arboretum, Jamaica Plain, Massachusetts, will be accepted. The Contractor's suppliers must certify in writing that the stock has actually been grown under Zone 5 orhardier conditions. Plants not so certified will not be accepted.

The root system of each plant shall be well provided with fibrous roots. All parts shall be moist and show active green cambium when cut. They shall be sound, healthy, and vigorous, well-branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs, or larvae.

All plants must be moved with the root systems as solid units with balls of earth firmly wrapped with untreated 8 ounce burlap, firmly held in place by a stout cord or wire in containers of a size as specified or of adequate size to allow root development for the plant size as per ASNS requirements. Plants prepared with plastic or other non-biodegradable wrappings will not be accepted. The diameter and depth of the balls of earth on balled and burlapped plants must be sufficient to encompass the fibrous
root feeding system necessary for the healthy development of the plant. No plant will be accepted when the ball of earth surrounding its roots has been badly cracked or broken prior to, or during the process of planting or after the burlap, staves, ropes, container or platform required in connection with its transplanting have been removed. The plants and balls shall remain intact during all operation. All balled and burlapped plants that cannot be planted at once must be heeled in by setting in the ground and covering the balls with soil and watering.

Shrubs

All shrubs shall meet the following standards:

All shrubs shall be healthy and vigorous plants which are very well shaped, heavily branched, densely foliated, and true to form for the variety.

Canes or Trunk(s) and Branches:

a. Well formed and sturdy.
b. Branching shall be uniformly distributed close to the ground.
c. 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).
d. Pruning scars shall be clean cut and shall leave little or no protrusion from the trunk or branch.
e. Graft unions shall be completely healed.
f. No suckers or water sprouts.
g. Contain no dead wood.
h. Free of cracks, splits, or cambium peeling.

No shrub with pest or mechanical damage will be accepted.

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.

Perennials

All perennials shall meet the following standards:

Perennials shall be potted 3 year stock, field grown clumps, and all clumps shall have not less than 6 buds, eyes or crowns.

Perennials shall be healthy and well cared for, with no evidence of insects or diseases present. Insect-ridden or diseased plants shall be rejected. Plants shall have a deep green foliage and dense, compact growth. Perennials shall have multi-stemmed bases and shall be two year potted stock minimum, one year in cutting bench and one year in pots.
Container Grown Stock

Each plant shall have an extensive, symmetrically balanced fibrous root system. Any root ball which shows signs of asymmetry, injury, or damage to the root system shall be rejected.

Curling or spiraling of the roots along the walls of rigid containers will not be accepted.

All parts of the fibrous root system of all plants shall be moist and fresh with a white color when washed of soil. When the plant is removed from the container, the visible root mass shall be healthy with white root tips. The root systems of all plants shall be free of disease, insect pests, eggs, or larvae.

All trees, and all shrubs which are not grown in containers must be moved with the root systems as solid units with balls of earth firmly wrapped with untreated 8 ounce natural, biodegradable fabric burlap, firmly laced with stout, natural biodegradable cord or twine. The base of the tree trunks shall be wrapped with a protective burlap layer, surrounded by a cardboard trunk protector, and loosely tied with twine.

The diameter and depth of the balls of earth must encompass the fibrous and root feeding system necessary for the healthy recovery of the plant. Minimum root ball diameters and depths shall be in accordance with ASNS standards.

No plants shall be loose in the container.

Container grown plants which have roots growing out of the container will be rejected.

Plants delivered by truck and plants requiring storage on site shall be properly wrapped and covered to prevent wind-drying and desiccation of branches, leaves or buds; plant balls shall be firmly bound, unbroken, reasonably moist to indicate watering prior to delivery and during storage and tree trunks shall be free from fresh scars and damage in handling. No trees with double-leaders or twin-heads will be acceptable without the written approval of the Engineer. No plant material from cold storage will be accepted.

Planting Fertilizer

Fertilizer shall be provided for each plant through the use of slow-release fertilizer packets which are designed and certified by the manufacturer to provide controlled release of fertilizer over a minimum 3 year period. Each packet shall consist of 4 ounces of water soluble fertilizer with a minimum guaranteed analysis of available elements as follows:

16% Nitrogen, 8% Phosphoric Acid, and 16% Potash

Bone meal shall be fine ground, steam-cooked, packing house bone with a minimum analysis of 23 percent phosphoric acid and 1.0 percent of nitrogen.
Planting Mix

Planting mix shall be approved loam which has been pH adjusted according to particular planting applications and improved through the addition of organic matter as directed below. Planting loam shall conform to the following pH levels:

a. For ericaceous plants and broad-leaved evergreens requiring an acid soil, planting loam shall have a true pH of 4.5 to 5.5. If it does not, it shall be amended by the Contractor to the proper pH range by mixing with sulfur as specified herein.

b. Planting loam for general planting of non-acid loving plants shall have a true pH value of 5.5 to 6.5. If it does not, it shall be amended by the Contractor to the proper pH range by mixing with dolomitic limestone as specified herein.

c. The amount of either sulfur or limestone required to adjust the planting loam to the proper pH range (above) shall be approved by the Engineer on the basis of soil tests as specified herein. It is not possible to safely add more than two hundred pounds (200 lbs.) of limestone/one thousand (1,000) square feet of loam, incorporated into the soil, or fifty pounds (50 lbs.) of limestone/one thousand (1,000) square feet of loam, surface application, within a single season. Therefore loam shall have a starting pH of no lower than 4.2 for ericaceous plants and broad-leaved evergreens, and a starting pH of no lower than 5.0 for general planting of non-acid loving plants.

Planting mix shall consist of pH adjusted loam which has been thoroughly premixed with organic material in the proportions of one (1) part organic matter, (leaf compost or peat), with five (5) parts of approved loam.

Aged Pine Bark Mulch

Aged Pine Bark Mulch shall be pine bark mulch aged a minimum of six (6) months and not longer than two (2) years. The mulch shall be dark brown in color, free of pieces of wood thicker than one-quarter inch. Bark mulch shall be shredded to a uniform size; free of dirt, debris and foreign matter; with pieces no thicker than 1/4 in (6 mm). Mulch must be free of stringy material over 4 inches in length, free of pieces over 3 inches in width and shall not contain, in the judgement of the Engineer, an excess of fine particles.

Weed Barrier Fabric

Geotextile fabric for weed control shall be of woven, nonwoven, spun-bonded, or needle-punched construction; composed of polyethylene, polypropylene, or polyester materials.

1. Geotextile fabric shall have porosity of not greater than 5 percent open.

2. Geotextile shall be Weed-X by Dalen Products, Knoxville, TN; DeWitt Pro 5 by the DeWitt Company, Sikeston, MO; or approved equal.
Antidesiccants

Antidesiccants shall be emulsions or other materials which will provide a protective film over plant surfaces permeable enough to permit transpiration and specifically manufactured for that purpose. Manufacturer of antidesiccant shall be subject to the Engineer's approval. Antidesiccant shall be delivered in containers of the manufacturer and shall be mixed according to the manufacturer's instructions.

Water

The Contractor shall be responsible to furnish his own supply of water to the site at no extra cost. If possible, the Owner shall furnish the Contractor upon request with an adequate source and supply of water at no charge. However, if the Owner's water supply is not available or not functioning, the Contractor shall be responsible to furnish adequate supplies at his own cost. All work injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.

Construction Methods

Planting

Furnishing and planting of plant material shall include, but shall not be limited to, the digging of the pits and plant beds, amendment of loam as required to produce planting soil mix, provision of soil additives required to adjust for pH requirements of specific plants, furnishing the plants as specified as well as the labor of planting, fertilizing, mulching, guying, and maintenance.

The Contractor shall locate plant material sources and ensure that plants are shipped in timely fashion for installation.

Contractor shall locate all underground utilities within 10 feet of the proposed planting pits and notify the Engineer of any conflicts prior to digging plant pits.

Location for all trees and shrubs and outlines for groundcover and bulb planting areas shall be staked on the ground by the Contractor for approval by the Engineer before any plant pits or plant beds are dug. Notify the Engineer no less than 3 days prior to desired date of inspection of staking to schedule site visit.

Seasons for Planting:

Spring: Deciduous materials - March 21 through May 1
          Evergreen materials - April 15 through June 1

Fall:    Deciduous materials - Oct. 1 through Dec. 1
           Evergreen materials - Aug. 15 through October 15
Certain trees, as shown on the Plant List on the Drawings, shall only be planted in the spring. Contractor shall arrange project schedule as necessary to allow for spring planting of these trees. Substitutions of other plants for the trees specified in order to perform fall planting will not be accepted.

Planting:

Loam fill shall be installed as per requirements of Section 751.

At least one month prior to the expected planting date, the Contractor shall request that the Engineer provide a representative to select and tag stock to be planted under this Section. The Contractor shall pay for the transportation, subsistence, and overnight accommodations, if necessary, for the Engineer's representative during the period of time required to select and tag the plant material. Time spent to locate plant material shall be paid for by Contractor only if Engineer is sent to site where materials were not satisfactory to Engineer or cannot be located.

A representative of the Contractor shall accompany the Engineer on all plant material selection field trips, unless otherwise ordered by the Engineer.

All trees, a representative sample of each shrub species, and all plants designated as "specimen quality" on the Plant Schedule shall be selected by the Engineer at the place of growth prior to digging for conformity to specification requirements as to quality, size, and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work. Cost of replacement of materials rejected by the engineer at the site shall be borne by the Contractor.

All plants for the project shall be individually tagged prior to digging with the Engineer's seals. No plants shall be accepted for delivery to the site without such seals.

All trees and shrubs shall be planted within 5 working days of arrival on site or shall be rejected by the Engineer. Container grown shrubs stored on site shall be shaded from direct sunlight at all times and shall not be stored on paved surfaces.

Plant pits shall be excavated as shown on Drawings. Shrub planting beds shall be excavated 2 feet below proposed finish grade and shall extend a minimum of 1 foot beyond the rootball of shrubs placed at the edge of the planting bed.

Loosen the perimeter roots on the rootball of all container-grown shrubs, groundcovers and perennials prior to planting, as directed by the Engineer.

Remove groundcovers and perennials from their pots immediately before planting. Handle plants carefully to prevent damaging roots. Place each plant in individual hole and firm the loam around the roots. Water thoroughly and mulch as shown on the Drawings. Groundcover plants may be planted after the bark mulch is placed.
All plant roots and earth balls must be damp and thoroughly protected from sun and wind from the beginning of the digging operation, during transportation and at the site until the final planting. Remove container plants from containers prior to planting. Trees and shrubs shall be placed in the center of plant pits, plumb with the crown of their roots exposed and located above the surrounding finish grade. After completion of planting installations, remove rope, burlap and wire baskets from only the top 1/3 of the root balls. Loam shall be backfilled in layers of not more than 6 inches and each layer watered sufficiently to settle before the next layer is put in place. Enough loam shall be used to bring the surface to finished grade when settled. A saucer shall be formed around each plant at a depth of 6 inches for trees and 4 inches for shrubs.

At the time of planting, install fertilizer packets at a depth of 6 to 8 inches equally spaced around the plant as it is being backfilled. Packets shall be placed approximately 3 inches away from the plant roots or plant ball. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, any damaged or broken packets shall be replaced with new packets. The application rates for fertilizer packets shall be as follows:

<table>
<thead>
<tr>
<th>Type of Plant</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shrubs</td>
<td>One packet for each 12 inches of height or spread</td>
</tr>
</tbody>
</table>

All plants shall be watered immediately following planting as necessary to thoroughly moisten rootball and plant pit loam and thereafter shall be inspected frequently for watering needs and watered, as required, to provide adequate moisture in the planting pit. The Contractor shall inspect tree pits 24 hours after initial watering to confirm that they are draining properly. If surface water or excessively saturated plant pit soils exist, the Contractor shall immediately notify the Engineer. The Engineer shall recommend remedial measures based upon site conditions which shall be paid for as an extra to the contract.

Aged Pine Bark Mulch shall be placed in shrub planting beds to a depth shown on the drawings, after settlement, no later than one week after planting. No bark mulch shall be placed in contact with tree trunks or shrub stems. No mulch shall be applied prior to the first watering of the plant materials.

Pruning:

a. Shrubs shall be pruned following planting in accordance with the American Nurserymen's Association Standards for Class I, fine pruning, to preserve the natural character of the plant, as directed by the Engineer.

b. All dead wood or suckers and all broken or badly bruised branches shall be removed. Never cut a leader.

Antidesiccant shall be applied to all evergreen and other plants in the late fall as directed by the Engineer.
Absolutely no debris may be left on the site. Excavated material shall be removed as directed. Repair any damage to site or structures to restore them to their original condition as directed by the Engineer, at no cost to the Department.

**Plant Maintenance**

Contractor shall maintain all new plantings as indicated below. Maintenance shall begin immediately after each plant is planted and shall continue for a minimum of two years following the completion of all planting installations, or until the final acceptance of all planting work, whichever is a longer period of time.

Maintenance of new plantings shall consist of keeping the plants in a healthy growing condition and shall include but is not limited to watering, weeding, cultivating, pruning, re-mulching, tightening and repairing of guys, removal of dead material, resetting plants to proper grades or upright position, and maintaining the planting saucer.

1. Plants shall be inspected for watering needs at least twice each week and watered as necessary to promote plant growth and vitality.

2. Planting beds shall be kept free of weeds, and mulch shall be maintained at the required depth. Beds and individual pits shall be neat in appearance with clearly defined edges and maintained to the designed layout.

3. Plants that die during the maintenance period shall be removed by the Contractor within one week of notification and replaced during that growing season.

Work of pruning, fertilizing, spraying, and similar activities shall be undertaken only by certified arborists and chemical applicators, as pertinent to the work being performed.

During the maintenance period, any decline in the condition of existing trees and new plantings shall require the Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, the Contractor shall engage professional arborists and/or horticulturalists to inspect plant materials and to identify problems and recommend corrective procedures. The Engineer shall be immediately advised of such actions. Inspection and recommendation reports shall be submitted to the Engineer.

**Clean Up**

Absolutely no debris may be left on the site. Repair any damage to site or structures to restore them to their original condition, as directed, at no cost to the Department.
Acceptable Standards

General

1. The Engineer will inspect the work upon the request of the Contractor. Requests for inspection shall be received by the Engineer at least ten days before the anticipated date of inspection.

2. The inspection dates shall follow the minimum maintenance periods called out for respective work items.

3. Upon acceptance of the work, the Engineer shall issue a written Certificate of Acceptance notice to the Contractor.

Planting

1. At the time of inspection, if the plant materials and workmanship are acceptable by the Engineer, the date of the inspection shall establish the end of the maintenance period and the commencement of the required guarantee period for planting work.

2. At the time of inspection or if, in the Engineer's opinion plant materials and/or workmanship is deficient, acceptance will not be granted, and the Contractor's responsibility for deficiencies are corrected. All dead and unsatisfactory plants shall be removed promptly from the project. Replacement plants shall conform in all respects to the Specifications for the original plants and shall be planted in the same manner.

Plant Material Replacements

All shrubs, vines, groundcovers, and trees shall be inspected by the Engineer two years after acceptance and shall be alive and in satisfactory growth at the end of that time.

Each plant shall show at least 75 percent healthy growth and shall have the natural character of a plant of its species as determined by the Engineer. Plants found to be unacceptable shall be removed promptly from the site and replaced immediately or during the next normal planting season, as permitted by the specifications, until the replaced plants live for two full years. A final replacement inspection will be made after the replacement plantings have lived through two full years.

All replacements shall be plants of the species, variety and size specified in the PLANT LIST. The cost shall be borne by the Contractor, including deciduous trees, except for possible replacements due to vandalism or neglect on the part of others.

Compensation

Method of Measurement

The method of measurement shall be in units of each plant. Excavation, soil amendments, water,
staking, weed barrier fabric, antidesiccant, planting fertilizer, and aged pine bark mulch shall be considered incidental to the work and not paid for separately.

**Basis for Payment**

Item Nos. 786.481 through 796.249 will be measured per each, installed complete-in-place including plants, planting mix (soil amendments), mulch, guarantee of plants and all which price and payment shall constitute full compensation for complete compliance with requirements of this item, including all labor, equipment, materials, tools, incidental work, and construction methods.

Loam Borrow will be paid for under Item 751.
ITEM 804.2  2-INCH ELECTRICAL CONDUIT  FOOT
   TYPE NM PLASTIC (UL)

ITEM 804.3  3-INCH ELECTRICAL CONDUIT  FOOT
   TYPE NM PLASTIC (UL)

ITEM 804.4  4-INCH ELECTRICAL CONDUIT  FOOT
   TYPE NM PLASTIC (UL)

The work under this Item shall conform to the relevant provisions of Section 801 of the Standard Specifications and the following:

Description

The work shall include the furnishing and installation of 2-inch, 3-inch, and 4-inch non-metallic conduit for highway lighting, traffic signal systems, telephone/cable, and communication duct system in accordance with the plans and as directed by the Engineer.

The conduit material shall be Schedule 80 polyvinyl chloride (PVC) plastic conduit, conforming to UL 651. Fittings shall conform to UL 614B.

The footage of conduit estimated under this Item is not guaranteed by the Engineer; it may be increased or decreased by the Engineer depending upon actual conditions encountered as provided for in Section 4.06 of the Standard Specifications.

Where new conduits are installed in existing grass areas outside the limits of grading, the work shall include the placement of a minimum of 6 inches of loam and seed to restore the disturbed areas to their original condition. No separate payment will be made for this work, but all costs in connection therewith shall be included in the unit price bid.

Where new conduits are installed in existing sidewalk or paved median areas to remain, the work shall include replacement of the gravel base material and the surface pavement to match preconstruction conditions. No separate payment will be made for this work, but all costs in connection therewith shall be included in the unit price bid.

At locations shown on the plans, and as directed by the Engineer, new conduits installed under the existing or proposed roadway locations, shall include cement concrete encasement. Concrete shall be placed 3-inches around the conduit as shown on the construction details. The work shall also include replacement of the gravel base material and the surface pavement to match preconstruction conditions.

Multiple conduit runs shall utilize base and intermediate plastic spacers maintaining a 3” space between conduits placed at 8’-0” centers maximum. Spacer assemblies shall be secured using steel tie wire. Conduit bank joints shall be staggered.
All sweeps at utility pole risers shall have a minimum radius of thirty-six inches (36”). The riser sweeps shall be galvanized steel RGS conduit. Where RGS conduit is run underground, it shall be PVC coated. Special tooling and procedures in accordance with the manufacturer’s installation requirements shall be adhered to for proper installation so that the PVC coating is not damaged during conduit installation.

The trench for conduits shall be excavated to a minimum width of 18” to a depth not less than that required to provide the minimum conduit cover requirements from the final finished grade. Refer to details on the contract drawings. Depths shall be increased as necessary where there are conduit crossings with other underground utilities shown on the contract plans.

Metabolic warning tape shall be placed above the conduits as shown on the Construction Details.

**Measurement and Payment**

Electrical Conduit will be paid for at the Contract unit price per foot, which price shall include sawcutting, excavation, ordinary borrow, gravel borrow, warning tape, sand bedding, all labor, materials, equipment and incidental costs required to complete the work.

Hot mix asphalt trench patching will be paid for under Item 451. - HMA for Patching

Cement concrete for tel/cable and communication duct bank encasement shall be paid for under Item 903.
Under these item, the Contractor shall furnish all material and labor required to install the underground telephone/cable television pullbox and duct bank systems including structures, cast iron covers, concrete encased duct banks and utility pole risers at locations indicated on the Contract Drawings and as directed by the Engineer. Work and methods of installation shall be in conformance with Verizon and Comcast standards and Section 801 of the Standard Specifications.

General:
Precast pull box shall conform to the following:

a. Concrete minimum strength shall be 4,000 psi @ 28 days.
b. Steel reinforcement shall meet ASTM A-615, grade 60 with a minimum cover of 1” provided.
c. Structure shall be designed for HS-20 loading.
d. A 24” diameter standard manhole frame and cover shall be provided and set in full mortar bed, adjusted to grade. COVER SHALL BE IMPRINTED WITH “COMMUNICATIONS”
e. 6 inches of ¾” crushed stone shall be placed at the bottom of the structures.
f. All conduits entering the handhole shall be grouted with shrink proof cement grout.
g. Patching and surface restoration of the disturbed area including loam borrow, seed, and fine grading, etc. to match the surrounding surfaces in kind shall be included in the handhole item.

Shop Drawings:
The Contractor shall submit shop drawings for conduits, structures, duct bank spacers, cast iron frames, covers and all other materials associated with the telephone and cable television duct and pullbox system for review by the Engineer, Verizon and Comcast prior to ordering materials or installations.

Inspection:
The Contractor shall notify Verizon and the Engineer two (2) weeks in advance of installation of duct and manhole system and coordinate inspection of duct and manhole system with Verizon and the Engineer.

The Contractor shall notify Comcast and the Engineer two (2) weeks in advance of installation of duct and manhole system and coordinate inspection of duct and manhole system with Comcast and the Engineer.
ITEMS 811.03 & 811.04 (Continued)

Measurement & Compensation

The underground telephone and cable pullboxes and communication handholes will be measured per each, complete in place in the locations shown on the drawings.

Pullboxes and Handholes will be paid for at the Contract unit price per each, which price shall include all labor, excavation and backfill, frame and cover, crushed stone bedding, equipment and incidental costs required to complete the work.

No payment will be made to Verizon, Comcast or the Contractor for any work performed by Verizon or Comcast.
ITEM 811.22  ELETRIC HANDBOLES – SD2.022  EACH

ITEM 811.31  PULL BOX 12 X 12 INCHES – SD2.031  EACH

The work under these Items shall conform to the relevant provisions of Section 801 of the Standard Specifications and the following:

The work shall include the furnishing and installation of electric handholes, pull boxes, grounding rods, frames, and covers for the traffic signal systems, street lighting and underground service connections in accordance with the plans and as directed by the Engineer.

Electric handholes for light poles shall include the furnishing and installation of grounding rods in each handhole and connection to the equipment grounding conductors from all circuits entering the handhole. Ground Rods shall be \( \frac{3}{4} \)’’ x 10’-0” long, copper clad type. Connections to ground rods are to be made using bare tinned copper stranded ground electrode conductors exothermically welded to ground rod. Mechanical connectors are not to be used.

All pull box covers associated with traffic signals shall have “TRAFFIC” embossed on the cover. All pull box covers associated with lighting shall have “STREET LIGHTING” embossed on the cover.

**Method of Measurement and Basis of Payment**

Electric pull boxes and handholes will be measured and paid for at the Contract unit prices per each, which prices shall include all labor, materials, equipment, and incidental costs required to complete the work.
ITEM 811.38  ELECTRIC HANDHOLE REMOVED AND RESET  EACH

Work under this Item shall conform to the relevant provisions of Section 800 of the Standard Specifications and the following:

Work to be done under this item includes the dismantling, removal, transporting and resetting of existing lighting handholes and frame and covers at the locations shown on the plans and as directed by the Engineer. The remaining hole shall be backfilled with compacted ordinary borrow and the ground surface restored or replaced in kind to match adjacent surface materials. In locations where the removed handhole is within limits of the proposed roadway widening, the remaining hole shall be backfilled with compacted gravel borrow.

The Contractor shall exercise particular care in the dismantling, removal, transporting and resetting of the existing lighting handholes designated to be reused. Any structure that is damaged through carelessness or lack of protection by the Contractor shall be replaced at the Contractor's expense.

Electric handholes removed and reset for light poles shall include the furnishing and installation of grounding rods in each handhole and connection to the equipment grounding conductors from all circuits entering the handhole. Ground Rods shall be ¾” x 10’-0” long, copper clad type. Connections to ground rods are to be made using bare tinned copper stranded ground electrode conductors exothermically welded to ground rod. Mechanical connectors are not to be used.

Method of Measurement and Basis of Payment
Electric handholes removed and reset will be measured and paid for at the Contract unit price per each, which prices shall include all labor, materials, equipment, and incidental costs required to complete the work.
ITEM 812.09 LIGHT STANDARD FOUNDATION PRECAST EACH

The work of this item shall conform to the relevant provisions of Section 801, 813 and 820 of the Standard Specifications, and the following:

The work shall include the furnishing and installation of concrete light standard foundation for street lighting system as shown on the plans, in accordance with the light pole manufacturer, and as directed.

Refer to the plans for the details of the light standard foundation dimensions and installation grade requirements.

Submittals
Submittals for light standard foundations shall be made in a timely fashion including all manufactures data sheets, and shop drawings, as applicable, and specified herein.

Materials
All light standard foundations shall be constructed per Section 801.62 of the Standard specifications, except deviations may be required based on field conditions. All deviations must be approved by the engineer prior to making any changes.

Light standard foundations should be placed per the plans and positioned using an approved grade. Precast concrete foundations shall include epoxy coated reinforcing, as shown on the plans, and per the manufacturer’s Structural Engineer’s recommendations. Confirm exact light fixture pole base anchor bolt requirements for size, length, projection, bolt circle diameter and pattern with the pole manufacturer prior to furnish and installation and install accordingly. Anchor bolts shall be hot dipped galvanized and j-hook style. Minimum foundation diameter and depth shall be as indicated on the plans.

Furnish and install galvanized rigid metal conduit in foundation and coupling and plastic type NM conduit stub out over to adjacent handhole, as shown on the plans.

Measurement and Payment
Light Standard Foundations will be measured for payment by each foundation installed.

Light Standard Foundation Concrete will be paid for at the Contract unit price per each installed, which price shall be full compensation for all labor, materials, galvanized anchor bolts, galvanized nuts and washers, rigid metal conduit, plastic Type NM conduit, elbows, sweeps, compaction and leveling, excavation (except rock), backfilling and all incidental costs required for the work.
ITEM 813.792  COMMUNICATION CABLE SYSTEM  LUMP SUM

The work under this Item shall conform to the relevant provisions of Section 800 of the Standard Specifications and the following:

The work shall include furnishing and installation of copper communication cable, and all appurtenances required to interface with the local intersection controllers as shown on the plans.

**Proposed Copper Cable**

The Contractor shall furnish and install a complete underground copper communication cable system including wiring, grounding and incidental work between traffic signal controllers. Reference is made to the general plans included in the contract documents. The cable run shall be installed as follows:

Along the Thorndike Street corridor, in proposed conduit, between the traffic controller cabinets at the Charles A. Gallagher Transportation Terminal intersection and the YMCA Drive intersection, via the traffic controller cabinet at the Highland Street intersection.

Cable installed underground shall consist of a 12 Pair, twisted 19AWG, shielded communications cable, IMSA SPEC 40-2. All conductor cable shall be terminated on a terminal block. Each communications pair initially used for system control shall include lightning and surge protection. The protection device shall include capabilities for peak surge current protection of 10K amperes with a response time of less than 5 nanoseconds. Units shall be plug mounted EDCO model PC-642 series surrestor, or approved equivalent.

All communications cable shall be installed in accordance with applicable industry standards and safety practices for telephone communications cable installation. All communications cable shall be installed in the presence of the Engineer.

The cables shall be terminated only on terminal strips located inside traffic controller cabinets. The Contractor shall provide as-built wiring lists for each terminal point as part of the required documentation. The jacket color and associated function of each communication wire shall be clearly indicated. The Contractor shall be responsible for the complete installation and proper wiring of the communication cable, including any necessary accessories such as surge protectors, terminal blocks, etc. No cable splices shall be allowed between controller cabinets.

Communication cable installed under this contract shall be identified with permanently attached plastic labels at each controller cabinet. The labels shall either be embossed or printed with permanent non-fading ink, indicating the name of the intersection that is at the other end of the cable and bearing the legend "TRAFFIC COMMUNICATIONS CABLE". The tags shall also be labeled with the location of the cable’s termination point. The Engineer shall approve the label format and attachment mechanism before label installation.
ITEM 813.792 (Cont.)

The communication cable shall be tested by the Contractor in the presence of the Engineer, using a 500 volt megaohm meter. Individual readings between each conductor and every other conductor and the shield, shall be at least 100-megohms in order for the cable to be accepted. In addition, continuity readings shall be performed for each conductor. Readings appropriate for the length and gauge of cable shall be obtained in order for the cable to be accepted.

Basis of Payment

The work under Item 813.792 will be paid for at the Contract lump sum price, which price shall include all labor, materials, equipment, and incidental costs required to complete the work. No separate payment will be made for the removal and stacking of existing communication cable, but all costs in connection therewith shall be included in the lump sum price bid for Item 813.792.
ITEM 816.01  TRAFFIC SIGNAL RECONSTRUCTION  LUMP SUM
LOCATION NO. 1

ITEM 816.02  TRAFFIC SIGNAL RECONSTRUCTION  LUMP SUM
LOCATION NO. 2

ITEM 816.03  TRAFFIC SIGNAL RECONSTRUCTION  LUMP SUM
LOCATION NO. 3

The work under these items shall conform to the relevant provisions of Section 800 of the Standard Specifications, the 2009 Manual on Uniform Traffic Control Devices (MUTCD), and the following:

The work shall include the furnishing and installation of part or all of the following items: local traffic signal controllers; cabinets and foundations; traffic signal master controller; signal posts and foundations; mast arm assemblies with anchor bolts and foundations; signal heads; backplates; single point video detection; pedestrian signals with countdown timers; audible pedestrian signal (APS) push buttons with signs; emergency vehicle preemption; pull boxes; all cable and wiring; ground rods, equipment grounding and bonding; service connections; maintenance of existing signal equipment, removal and stacking or disposal or existing signal equipment and all other equipment, materials and incidental costs necessary to provide complete, fully operational traffic control signal systems as specific herein and as shown on the plans. The locations are as follows:

- Thorndike Street at Charles A. Gallagher Transportation Terminal (Item 816.01)
- Thorndike Street at Highland Street (Item 816.02)
- Thorndike Street at YMCA Drive (Item 816.03)

A list of major traffic signal items required at each location is included on the plans.

**Shop Drawings**

Within 30 days following execution of the Contract, the Contractor shall submit shop drawings for signal supports, a list of equipment, and manufacturer's equipment specifications to the Engineer in accordance with the relevant provisions of Section 815.20.

No work shall be commenced by the Contractor until approval of the shop drawings and manufacturer's data has been received in writing from the Engineer. Approval of these drawings will be general in character and shall not relieve the Contractor from the responsibility of, or the necessity of, furnishing materials and workmanship conforming to the plans and specifications.

The Contractor shall deliver to the Engineer a certificate of compliance with the manufacturer for all materials purchased from the manufacturer.
**Items 816.01, 816.02, and 816.03 (Continued)**

**Existing Installations**

Existing signal installations to be reconstructed under Item 816.01 through 816.03 shall be maintained in operation throughout the construction period and until the new signal is ready for operation. The Contractor may use temporary supports for signal heads as necessary to allow construction activities.

Any temporary installations shall be in conformance with the MUTCD at all times. If an existing signal is to be turned off temporarily to allow controllers switch overs or rewiring, police detail shall be used to control traffic at the intersection.

Once construction is completed and the new signal is in operation, unused items of the old signal shall be completely removed, stacked, and delivered to the Lowell Electrical Department as directed by the Engineer in accordance with Section 815.65. Old cable and unusable materials shall be disposed of by the Contractor.

**Signal Turn-on**

Prior to initial turn-on of the new signals, equipment, signal displays, vehicle detection as shown on the plans and called for in these special provisions, shall be installed and operable. Applicable signs and pavement makings shall also be in place when the new signals are operational.

**Service Connections**

Under these Items service connections shown on the plans are approximate only. The Contractor shall determine exact locations from the servicing utility, arrange to complete the service connection, and be responsible for all charges incidental thereto.

**Testing of Grounding System**

The Contractor shall perform testing of the equipment grounding system in the presence of the Engineer in accordance with MassDOT Standard Specifications.

**Flashing Operation**

Changes from automatic flashing to stop-and-go operation and from stop-and-go to automatic flashing operation shall occur as set forth in the MUTCD.
Items 816.01, 816.02, and 816.03 (Continued)

**Traffic Signal System Master Controller**

Under Item 816.01, the Contractor shall furnish and install a traffic signal system master controller (TSSM) which shall consist of a digital microprocessor-based unit installed and housed in the traffic controller cabinet at Thorndike Street at Charles A. Gallagher Transportation Terminal. The make and model of the TSSM shall be of the same manufacturer as the local traffic signal controller units under this project.

The TSSM shall be capable of implementing traffic responsive control, time base control, time of day control or remote control of operation for its particular system of traffic controllers.

**Traffic Signal Equipment**

The traffic signal controller unit (CU), malfunction management unit (MMU), cabinet power supply, bus interface units (BIUs) and all other ancillary traffic signal control components included in the traffic control cabinet shall comply with the National Electrical Manufacturers Association (NEMA) Standard No. TS 2-2003 (R2008) V2.06, Traffic Controller Assemblies with National Transportation Communications for ITS Protocol (NTCIP) Requirements.

**Traffic Signal Controllers**

The traffic controllers supplied shall conform to Section 3 “Controller Units” of the NEMA TS 2 Standard. The traffic controller shall be supplied in a TS 2 Type 1 Configuration as required in the list of major traffic signal items included on the plans. Specifically, the controller units (CU) shall be supplied as actuated controllers with NTCIP capabilities; defined as Type A1N in Subsection 3.2 of the NEMA TS 2 Standard.

The TS 2 Type 1 cabinets shall, at a minimum, meet the requirements of configuration 3 as defined in Table 5-2, “Type 1 Configurations” of the NEMA TS 2 Standard.

The CU shall utilize an interface conforming to Subsection 3.3 of the NEMA TS 2 Standard. The CU shall utilize an input/output interface conforming to the requirements of Paragraph 3.3.1 for all input/output functions with the Terminals and Facilities (TF), Malfunction Management Unit (MMU), detector rack assemblies and auxiliary devices. The CU shall also meet the requirements of Paragraph 3.3.6 “NTCIP Requirements” of the NEMA TS 2 Standard and the Advanced Traffic Controller (ATC) standard 5.2b.

The CU shall be supplied with Port 1, Port 2, and Port 3 as defined by the requirements of Subsections 3.3.1, 3.3.2, and 3.3.3, respectively.
Items 816.01, 816.02, and 816.03 (Continued)

The controller shall be a keyboard-entry menu-driven unit conforming to City of Lowell Standards, with internal time base coordination, emergency preemption, and programmatic capability. The controller unit shall be complete with a module for remote communications (future use). Note: As part of the shop drawing submission the Contractor shall provide written approval of the controller unit from the City.

Malfunction Management Unit

The malfunction management unit (MMU) shall comply with Section 4 of the NEMA TS 2 standard. The MMU shall be capable of operating as either a Type 16 with 16 channels (8 vehicle, 4 pedestrian, 4 overlap) or a Type 12 with 12 channels (8 vehicle, 4 overlap). The MMU’s supplied shall be configured to operate as Type 16 units.

The MMU’s in either the Type 16 or Type 12 configuration shall be capable of operating in a NEMA TS 2 Type 1 cabinet, a NEMA TS 2 Type 2 cabinet, or a NEMA TS 1 cabinet without loss of functionality.

The MMUs shall support the MUTCD’s Flashing Yellow Arrow treatment, and shall be supplied with 10/100 Base-T Ethernet port.

Single-Point Video System

The Contractor shall provide and install a Single-Point Video Detection (SPVD) System at each of the project intersections as shown on the plans and these special provisions. The SPVD system shall include a single ultra wide angle lens camera, video processor unit, detection algorithms, all cables, connections, mounting hardware, application software, and accessories required by the manufacturer for proper operation of the system, including but not limited to surge protection devices.

The SPVD system shall detect and monitor vehicles on approach roadways utilizing advanced, omni-directional, vehicle tracking algorithms along with three-dimensional vehicle modeling to supply accurate and consistent stop line detection. The SPVD system shall be able to count vehicles and store this information on a database that can be retrieved by the City at a later date. The SPVD system shall include software for counting vehicles, including turning movement counts by 15-minute time intervals and be capable of storing said data.

The SPMS system shall include all necessary software and hardware to allow the end user to program, setup, and/or modify detection zones within the video camera image.

One pointing device and one color monitor within each of the controller cabinets for future viewing of the camera images shall be supplied by the Contractor. The Contractor shall also supply any necessary cables, interface devices and software for monitoring video detection via laptop computers.
Items 816.01, 816.02, and 816.03 (Continued)

The camera shall be mounted at the intersection, as shown on the plan or as directed by The Engineer, At a minimum, the SPVD shall meet the following requirements:

Camera
- Power: 48 VDC, single burial grade CAT 5e cable
- Operating Temp: -35°C to +60°C
- Humidity: Up to 100%
- Dimensions: 10” diameter x 9”
- Weight: less than 11 lbs.
- The camera shall include an ultra-wide-angle lens.
- The camera shall include a heater to prevent the formation of ice and condensation.
- The camera, when properly installed and configured, shall be able to concurrently observe at least 5 lanes of traffic per approach.

The camera shall be able to concurrently observe more than one approach.

Video Processor Unit
- Power: 120-240 VAC, requiring 150 watts or less.
- Operating Temp: -34°C to +74°C
- Humidity: Up to 95% non-condensing
- Dimensions: 12.25” wide x 11.25” depth x 5” high
- Weight: 12 lbs.
- Enclosure: Rack mount in traffic cabinet
- The video processor unit shall save configurations and zone plans locally to maintain operation with or without monitoring equipment connected.
- The video processor unit shall be designed to function dependably in the adverse environment found in the typical roadside traffic cabinet.
- The video processor unit shall include at least 24 detector outputs.
- The video processor unit shall include an SDLC connection for TS2 type controllers
- The video processor unit shall include a USB on the front surface for simple data collection on non-networked systems.
- The video processor unit shall include both LAN and WAN RJ-45 interface ports on the front surface of the unit.

Application Software
- The application software shall support the creation and modification of at least twenty-four (24) polygonal detection zones within the graphical user interface.
- The application software will show images of the detection zones superimposed on the video image of traffic.
- The application software shall support the assignment of a detector output(s) to each zone. These assignments can be modified at any time through the software.
Items 816.01, 816.02, and 816.03 (Continued)

- The application software shall support direction of travel assignment within detection zones. The vehicle detection zone shall not activate for objects traveling any direction other than the one specified for detection. Cross-street and wrong way traffic shall not cause detection.
- The application software shall change the color of the zone within the graphical user interface as vehicles enter or exit a detection zone, changing its occupancy status. This will be required for real-time or historical monitoring, and may be turned on or off by the user at any time.
- The application software shall provide visual indication of the light state for each zone within the graphical user interface.
- The application software shall feature the ability to digitally pan, tilt, and zoom within the camera’s field of view without movement of the camera.
- The application software shall maintain a database of current and historical traffic data, and allow for the user to run reports against this data to include traffic counts, turn movements, speed, and classification at a minimum.
- The application software shall feature the ability to mask objects that occlude the camera field of view and/or disrupt the camera automatic gain and exposure control.
- The application software shall feature an optional reporting interface offering point and click reporting for turning movement counts and vehicle classification.

The Contractor shall provide software that enables a technician to test all features and functions of the SPVD system, and to perform all set-up procedures. This software shall be delivered on a CD so that it can be installed on other tablets/laptops. The owner shall have the right to make and use an unlimited number of copies of this software.

The SPVD system shall be installed in accordance with the manufacturer’s recommended procedure for installation.

The SPVD system shall be installed by factory certified installers and as recommended by the manufacturer and documented in installation materials provided by the manufacturer. Proof of the factory certification shall be provided. Installation includes connecting the SPVD to the traffic signal controller and power supply in the associated controller cabinet assembly. When the setup is complete and the SPVD system is ready for operation, the values of all parameters that were set during the process shall be delivered to the Engineer in printed and computer-readable form. All equipment, such as software, laptop computer, tools and cables, needed for setup work shall be provided by the Contractor.

The Contractor shall be responsible for the proper programming of the SPVD, orientation of the SPVD, and all other work necessary to provide a complete operating system. The Contractor may be required to field adjust the location of the SPVD system in the presence of the Engineer to properly detect approaching vehicles.

The cabinet documentation (box prints) shall show all wiring between the SPVD system and the controller cabinets.
Items 816.01, 816.02, and 816.03 (Continued)

Data Stick/Drive

The Contractor shall supply a USB stick or drive used for collecting and synchronizing data and site configurations between video processor unit and the GridSmart® Client. The USB stick of drive must be NTFS-formatted and have enough available space to allow data to be synchronized.

Warranty - The supplier shall provide a three-year warranty on the SPVD system following installation and warranty registration. The camera shall include an additional warranty to require no aiming or focusing for a period of five years. During the warranty period, technical support shall be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory-certified personnel or factory-certified installers. During the warranty period, updates to SPVD software shall be available from the supplier without charge.

Training - The Contractor shall provide four (4) hours of personnel training in the use of the traffic SPVD system and software. This training is to be conducted with the City. The Contractor is to coordinate with the City as to the exact location and time of the training. It is the responsibility of the Contractor to provide training manuals, class notes, and other instructional materials for up to four attendees at the training sessions.

No training shall begin unless and until the final inspection process indicates, in the opinion of the Engineer, that the SPVD system is sufficiently complete and operational such that training would be useful at the time.

Loop Detector Rack Assemblies

The detector rack assemblies shall conform to Paragraph 5.3.4 of the NEMA TS 2 Standard. The detector rack assembly shall be supplied in a Type 2 configuration as defined in Table 5-9 of the NEMA TS 2 Standard.

Cabinet Power Supply

A separate power supply shall be supplied and installed in each of the TS 2 cabinets. As a minimum, the power supply shall meet all requirements of Paragraph 5.3.5 of the NEMA TS 2 Standard. The unit shall be AC line powered and provide regulated DC power, unregulated AC power, a line frequency reference for the rack mounted loop amplifiers, bus interface units, load switches and other auxiliary cabinet equipment as required.

The power supply shall be either shelf mounted or installed as part of the loop detector rack assembly.
Items 816.01, 816.02, and 816.03 (Continued)

The unit shall contain four LED indicators on the front panel to indicate the four outputs;
1. + 12 VDC +/- 1 VDC @ 2.0 amps,
2. + 24 VDC +/- 2 VDC @ 2.0 amps,
3. 12 VAC @ 250 milliamps, and
4. 60 Hz line frequency reference.

A test point terminal shall also be located on the unit’s front panel for + 24VDC and logic ground testing.

Load Switches

Load switches shall comply with Subsection 6.2 of the NEMA TS 2 standard. All load switches shall utilize optically isolated encapsulated modular solid state relays. Discrete components on circuit boards are not acceptable.

Load switch indicator lights shall be LED-type and wired on the input side of the device.

Flasher

Flashers shall comply with Subsection 6.3 of the NEMA TS 2 standard and be equipped with two output indicator lights which will show flashing power out to the cabinet assembly.

Flash Transfer Relays

Flash transfer relays shall comply with Subsection 6.4 of the NEMA TS 2 standard.

The field electrical loading for flash operation shall be wired through the transfer relays such that the load on the 2-circuit flasher is as balanced as possible within the limitations of the signal phasing.

Traffic Controller Cabinets

Controller Cabinets shall conform to the NEMA TS 2 Standards, Section 7. Cabinet sizes shall be as indicated on the plans and as shown below.
Items 816.01, 816.02, and 816.03 (Continued)

<table>
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<td>6</td>
<td>3</td>
<td>2</td>
<td>16 Channel</td>
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</table>

* Approximate cabinet dimensions are provided in inches.

Cabinets shall be made of aluminum and shall have a powder coat finish **GLOSS BLACK** as noted in the specification herein.

Each of the cabinets shall be furnished with a slide-out/slide in shelf appropriate for the size and load of a laptop computer.

Where applicable, the cabinets shall be installed with the door opening positioned to allow general observation of the flow of traffic and the inside of the cabinets at the same time.

Controller cabinet foundations shall not obstruct a sidewalk or crosswalk so that passage by physically-challenged persons is impaired.

**GFI Duplex Outlet**

The Contractor shall supply and install a second separate GFI protected duplex outlet in the proposed controller cabinets, and mounted on the side wall of the cabinets for servicing other devices.

**Bus Interface Units**

The Bus Interface Units (BIU) shall comply with Section 8 of the NEMA TS 2 Standard. The BIU shall be fully interchangeable with any other manufacturer’s unit and interchangeable in a NEMA TS 2 Type 2 cabinet assembly.

At a minimum the BIU shall perform the interface function between port 1 at the controller unit, the malfunction management unit (MMU), the loop detector rack assembly, and the terminal facilities. The cabinets shall be supplied with the appropriate number of BIUs required to provide an operating traffic control signal per the plans and these specifications.

As a minimum, two LED indicators shall be provided on the BIU front panel. One indicator shall serve a dual use; as a power on indication and as a diagnostic indicator for proper operation of the device. The second indicator shall serve as a transmit indicator illuminating each time data is transmitted.
Items 816.01, 816.02, and 816.03 (Continued)

Surge Suppression

The Contractor shall supply and install surge suppression on all outputs and inputs in all the traffic signal controller cabinets in accordance with MassDOT Standards. Contractor shall contact MassDOT Electrical Systems Unit directly for requirements and/or questions.

Spare Equipment

The Contractor shall provide the following spare signal equipment in each of the proposed traffic signal controller cabinets:

- A full complement of load switches to accommodate each available position of the back panel.
- A full complement of flash transfer relays to accommodate each available position of the back panel.
- Two (2) Bus Interface Units.
- A 25-foot RS-232 cable for communication function with a laptop

Testing of Grounding System

The Contractor shall perform testing of the equipment grounding system in the presence of the Engineer in accordance with MassDOT Standard Specifications.

Emergency Preemption

The emergency vehicle preemption system shall be installed in the same cabinets as the controllers and shall conform to City of Lowell Standards. **Note: As part of the shop drawing submission the Contractor shall provide written approval of the preemption system from the City.**

The emergency vehicle preemption control system shall consist of a data-encoded phase selector to be installed within the traffic control cabinet in the detector racks. This unit will serve to validate, identify, classify, and record the signal from the optical detectors located on support structures at the intersections.

Upon receiving a valid signal from the detector, the phase selector shall generate a preemp call to the controller initiating a preemption operation as shown on the plans.

The optical detector shall be single input, single output unit used to control one approach. All traffic signal installations shall be supplied with a minimum of two optical detectors unless otherwise noted in the major items list.
Items 816.01, 816.02, and 816.03 (Continued)

The phase selector shall be a rack-mounted plug-in four channel dual priority device. The phase selector shall plug into an empty slot in the detector rack. Programming the phase selector shall be via a PC-based computer utilizing unit specific software. One copy of software on a CD shall be supplied and licensed to the City of Lowell. A hard copy of final programming data shall be left in the control cabinet. A complete set of interface cables for phase selector to laptop connection shall be supplied in the cabinet.

The Contractor shall install a confirmation strobe at the traffic signal location as shown on the plans. The confirmation strobe shall serve to validate to the driver of the emergency vehicle that the traffic signal has recognized the preemption call and will initiate the proper preemption sequence. The confirmation strobe shall be a white lens.

The Contractor shall be responsible for the proper programming of the phase selector, orientation of the optical detectors, and all other work necessary to provide a complete and operating emergency vehicle preemption system. The Contractor may be required to field adjust the location of the optical detectors in the presence of the Engineer to properly detect preemption calls from approaching vehicles.

Mast Arms, Poles and Foundations

Mast arm poles shall be fabricated and constructed in conformance with the 2015 MassDOT Overhead Signal Structure and Foundation Standard Drawings and as stated below.

Acceptance of Type 2 mast arm poles will be contingent upon review and approval of shop drawings submitted by the Contractor. Longhand design calculations shall be submitted by the Contractor with the shop drawings for all Type 2 mast arm poles.

Please note – soil boring information has not been provided within these specifications and associated design plans. The Contractor must perform soil borings at the locations of the proposed traffic signal mast arm foundations to determine the existing soil conditions. Reference is made to Item 191 – Mast Arm Soil Boring for more information.

Prior to installation, the Contractor shall notify the Engineer in writing of his selection of mast arm foundation footing sizes.

The Contractor is wholly responsible for the design of all foundations regardless of soil conditions and/or ledge found at the proposed foundation locations.

If soil conditions or ledge prevent the use of MassDOT standard foundation type, the Contractor is responsible to select and design alternative foundation types. Alternative foundation types could include spread footings, coring and socketing into rock or other foundations previously used to support similar loads, within reason.
Items 816.01, 816.02, and 816.03 (Continued)

The Contractor shall provide a set of calculations, stamped by a Structural Engineer registered in the Commonwealth of Massachusetts, along with plans and specifications for review by the Project Engineer.

No separate payment will be made for work considered incidental to the excavation, including but not limited to, mast arm foundation, dewatering, etc. but all costs in connection therewith shall be included in the lump sum prices.

Foundations shall not obstruct a sidewalk or crosswalk so that passage by physically-challenged persons is not impaired.

**Signal Heads**

Signal heads mounted on mast arms shall be rigidly attached to the mast arms. All signal heads mounted overhead on mast arms shall be installed, with the bottom of the signals at the same height. All traffic signal lenses shall be 12 inches in diameter. Louvered backplates shall be 5 inches provided on all signal heads as noted on the plans. All signal heads shall be equipped with ball and/or arrow light emitting diode (LED) modules and tunnel visors.

All backplates shall include 2-inch-wide, yellow reflective micro-prismatic retroreflective sheeting conforming to ASTM D4956 Type VIII of better on the outside edge of the backplates.

**Red, Yellow, And Green LED Vehicle Signal Module**

Any equipment that has been type-tested and approved per Section 815.21 of the Standard specifications prior to the date of award of this contract will be considered as meeting these specifications.

All Red, Yellow, and Green signal displays shall conform to the following:


Yellow LED signal modules shall conform to the above specifications with the exception that yellow modules shall meet maintained Minimum Luminous Intensity values of Table 1, Section 4 of the above referenced ITE specification of compliant green signal modules at 25 degrees Celsius at 120 volts AC, throughout the useful life based on normal use in traffic signal operation over the operating temperature range.
Items 816.01, 816.02, and 816.03 (Continued)

All signal modules shall conform to the following: (In case of a conflict, the following special provision shall overrule.)

An independent laboratory shall certify that the LED signal module complies with Section 6 Quality Assurance of the above stated ITE LED Purchase Specification.

LED signal modules must be type tested and approved by MassDOT per the requirements of Subsection 815.21 of the Standard Specifications for Highways and Bridges.

On the backside of the LED signal module there shall be a permanently marked “up” arrow to aid in the proper orientation of the module during installation.

The manufacturer’s name, trademark, serial number and other necessary identification shall be permanently marked on the backside of the LED signal module.

Physical and Mechanical Requirement: LED signal modules shall fit without modifications into existing traffic signal housings conforming to “Vehicle Traffic Control Signal Heads” (VTCSH) published in the Equipment and Materials Standards of the Institute of Transportation Engineers. The LED signal module shall be a single, self-contained device, not requiring on-site assembly for installation. The LED signal assembly construction shall conform to the applicable ASTM specifications for the materials used to fabricate the module. Each LED signal module shall comprise a smooth surfaced Red, Yellow, or Green UV stabilized polycarbonate outer shell, multiple LED light sources, a power supply and a polycarbonate back cover assembled in a gasketed or silicon sealed unit.

Optical and Light Output Requirement: The minimum luminous intensity values and light output shall be maintained within the rated input voltage of 117 Volts AC. LED signal modules shall not be allowed to fall short of the minimum intensity values at any of the 44 measuring points of the standard when lamp is turned on cold for measurements and after a 30-minute warm-up time period at 100% duty cycle.

Electrical: The maximum wattage for 12-inch ball shall be 20 Watts and 10 Watts for the 12-inch arrow. The LED sources shall not be powered above 70% of the manufacturer’s specified rated load. This shall be clearly shown in layman’s terms through calculations, schematics, catalogue cuts, etc.

The LED sources shall be made of the AlInGap type shown clearly in a catalogue cut or similar literature.

Warranty: The LED signal module will be replaced or repaired by the manufacturer if it exhibits a failure due to workmanship or material defects within the first 60 months of field operation.

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Items 816.01, 816.02, and 816.03 (Continued)

The LED signal module will be replaced or repaired by the manufacturer if it exhibits either a greater than 40 percent light output degradation or a fall below the minimum intensity levels within the first 36 months of field operation.

Pedestrian Heads with Countdown Timers

All pedestrian heads shall be 16 inch, single units, with countdown timers. Pedestrian head indications shall be illuminated L.E.D. type displaying graphical symbols of a walking person and/or upraised hand. The countdown module display shall only begin at the start of the flashing “DON’T WALK” and shall exhibit the number of seconds remaining throughout the flashing “DON’T WALK” interval, and blank out during the steady “DON’T WALK” interval. The countdown module shall be automatically set by the intersection controller based upon the “DON’T WALK” signal intervals only.

The countdown module shall continuously monitor the intersection controller for any changes to the pedestrian phase timing, and reprogram itself automatically. All LED indications on the pedestrian signal shall have an automatic dimming circuit for night illumination to reduce long-term degradation to the LEDs

Signal Posts and Bases

Signal posts and bases shall be anodized aluminum shafts and transformer bases.

Signal base foundations shall not obstruct a sidewalk or crosswalk so that passage by physically-challenged persons is impaired.

Accessible Pedestrian Signal Pushbuttons

The Accessible Pedestrian Signal (APS) pushbuttons shall provide information in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces). The APS pushbuttons shall be compliant with the 2009 MUTCD. At a minimum the APS pushbuttons shall be provided with the following features:

- Pushbutton locator tone
- A visible and audible indicator that the button press has occurred
- A vibro-tactile arrow
- A speech walk message for the “WALKING PERSON” indication

The APS pushbuttons shall provide visually disabled pedestrians with a locator tone that will allow them to find the pushbutton to activate the walk signal. Once the pushbutton call has been placed, the signal will provide both an audible and tactile response during the related “WALK” portion of the cycle. A sunlight visible LED latches “ON” to confirm the button has been pushed. The audible response shall be a speech message, indicating the name of the street crossing, and when the phase is started.

TS-98
Items 816.01, 816.02, and 816.03 (Continued)

Housing and Pushbutton Unit shall meet the following minimum requirements:

- Constructed of cast aluminum with a powder coated finish.
- Highly vandal resistant and pressure activated with essentially no moving parts.
- Pushbutton must be able to withstand an impact from a baseball bat or hammer.
- Operating temperature range -34 degrees Celsius to 65 degrees Celsius.
- Operating voltage range 12 to 36 VDC.
- Button cap must be made of solid 316 stainless steel.
- Pushbutton must active with 5 lbs of force or less.
- Unit must have an LED display to give indication that of pushbutton being pushed.
- Pushbutton must fully operate immediately after being completely immersed in water for 5 minutes (electrical terminals isolated from water).
- Pushbutton must not allow ice to form such that it would impede function of pushbutton or pushbutton cap.
- All switch electronics must be sealed within the housing.
- All sounds shall emanate from the back of the of the APS pushbutton unit via a weatherproof speaker that is protected by a vandal resistant screen.

Tactile Arrows and Locator Tones shall meet the following minimum requirements:

- APS pushbuttons shall incorporate a locator tone at the pushbutton the locator tone, measured at 3 feet from the APS pushbutton, shall be 2dB minimum and 5dB maximum above ambient noise level in standard operation and shall be responsive to ambient noise level changes. Tones shall consist of multiple frequencies with a dominant component of 880Hz. The duration of the locator tone shall be 0.15s and shall repeat at intervals of 0.15s.

- APS pushbuttons shall be a minimum of 2 inches across in diameter and shall contract visually with their housing and mounting.

- APS pushbuttons shall include a vibro-tactile arrow aligned parallel to the crosswalk direction. The arrow shall be raised 0.03 inches minimum and shall be 1.5 inches minimum in length. The arrow head shall be open at 45 degrees to the shaft and shall be 33 percent of the length of the shaft. Stroke width shall be 10 percent minimum and 15 percent maximum of arrow length. The arrow shall contrast with the background.

- The arrow shall vibrate during the “WALK” portion of the cycle.
**Items 816.01, 816.02, and 816.03 (Continued)**

Speech Walk Message – The speech walk message shall be audible from the beginning of the associated crosswalk. The speech walk message and associate APS pushbuttons shall be as follows:

**TABLE 3**

<table>
<thead>
<tr>
<th>PEDESTRIAN PUSHBUTTONS</th>
<th>SPEECH WALK MESSAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 816.01</td>
<td></td>
</tr>
<tr>
<td>P1 thru P6</td>
<td>Walk sign is on for all crossings</td>
</tr>
<tr>
<td>Item 816.02</td>
<td></td>
</tr>
<tr>
<td>P1 thru P6</td>
<td>Walk sign is on for all crossings</td>
</tr>
<tr>
<td>Item 816.03</td>
<td></td>
</tr>
<tr>
<td>P1 thru P4</td>
<td>Walk sign is on for all crossings</td>
</tr>
</tbody>
</table>

Mounting Requirements - A maximum mounting height of 42 inches above the finish sidewalk grade shall be used for APS pedestrian pushbuttons.

The Contractor is hereby notified that they are ultimately responsible for constructing all pedestrian push button elements (clear ground space, forward and side arm reaches) in strict compliance with the current AAB rules, regulations and standards. The Contractor shall use extension brackets to mount pedestrian pushbuttons to obtain the minimum forward reach or side reach, if approved or directed by the City.

All construction elements in this project associated with pedestrian push buttons are controlled by 521CMR – Rules and Regulations of the Architectural Access Board.

The Contractor shall establish clear ground space at all pedestrian push button locations, and shall set arm reach lengths according to the AAB rules (or to the details shown on the plans).

The project has been designed to conform to all AAB rules, and the Engineer is not aware of any required variances for the work presented on the design plans. The Contractor shall notify the Engineer of any project element related to the pedestrian push buttons that will not comply with 521 CMR prior to constructing said pedestrian push button elements.
Items 816.01, 816.02, and 816.03 (Continued)

Installation - The APS pushbuttons shall be installed by Contractor and as recommended by the manufacturer and documented in installation materials provided by the manufacturer. The Contractor shall be responsible for the proper programming of the APS pushbuttons, orientation of the pushbuttons, and all other work necessary to provide a complete and operational APS pushbutton system. The Contractor may be required to adjust volume levels as directed by the Engineer. When the setup is complete and the APS pushbuttons are ready for operation, the values of all parameters that were set during the process shall be delivered to the Engineer in printed and computer-readable form.

Configuration Unit - The Contractor shall supply one (1) hand-held, remote configuration unit, to the City to allow future configuration of custom locator tones, information messages, and custom walk sounds. The configuration unit shall use infrared technology with an LCD display to program the APS pushbuttons. The configuration unit shall be password protected. The configuration unit shall be capable of setting all volumes and features of the APS pushbuttons. The configuration unit shall be capable of setting/updating a single APS pushbutton or all (Global updating) APS pushbuttons on the intersection for most functions. The configuration unit shall have the ability to save 4 user defined and 3 factory pre-set program configurations.

Training - The Contractor or supplier shall provide 4 hours of training at a location to be provided by the City. The Contractor or supplier shall submit a syllabus to the City for approval prior to training.

Warranty - Each APS pushbutton shall be warranted free from defects in material and workmanship for a period of at least 2 years from the date of installation by the Contractor and acceptance from the City.

During the warranty period, technical support shall be available from the supplier to the City via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory-certified personnel without charge.

Software

All local controller, malfunction management unit, camera unit, and preemption unit software shall be supplied with the latest available revision. Any software upgrades released by the manufacturer shall be supplied at no charge to the City for a period of five years after acceptance of the traffic signal installations.

Data Base Programming

Each programmable local hardware component (i.e., controller, malfunction management unit, preemption unit) shall be initially programmed by the Contractor based on information contained on the plans. Three sets of hard copy programming per device shall be supplied by the Contractor.
Items 816.01, 816.02, and 816.03 (Continued)

Equipment Finish and Color

All proposed traffic signal equipment including but not limited to signal posts, bases, signal heads, visors (outside), doors, mast arms, pushbutton saddles, service meter socket box, optical preemption detectors, hardware, and rigid mounting brackets for signals and signs shall be colored GLOSS BLACK and subject to the approval of the City of Lowell. The Contractor shall submit to the Engineer, and the City for approval, paint chips and sample finishes on steel and aluminum of the intended color prior to any work being done under this heading.

Signal heads, doors, visors, mounting brackets, and hardware supplied direct from the manufacturer in the color stipulated above may be acceptable provided it meets or exceeds the finish process for the material indicated below.

Steel Equipment

Galvanizing

All bolts, screws, nuts, rods and washers shall be galvanized in accordance with AASHTO M232 and the Standard Specifications. The hardened machine screws may be electroplate galvanized. Stainless steel studs, bolts, screws, nuts, straps and washers shall not be galvanized. Galvanized hardware need not be painted; however, the ends of bolts, nuts, and washers shall be painted in the field according to section “Touch-up and Repairs.” Immediately prior to galvanizing, the steel shall be immersed in a bath of zinc ammonium chloride. The dry kettle galvanizing process shall be used.

All steel components, other than above, shall be galvanized after fabrication in accordance with AASHTO M111. The galvanizing bath shall contain nickel (0.05% to 0.09% by weight).

Galvanized members requiring shop assembly shall be welded and drilled prior to galvanizing.

Coating Over Galvanized Steel

Prior to painting, the applicator shall ensure that all components are smooth and without sharp protrusions that would present and injury hazard to pedestrians. Also, the fabricator shall ensure that all welds shall be cleaned thoroughly in accordance with good practice and per AWD D1.5 and ASTM A123-89a and shall have a suitable surface to accept the galvanizing.

In preparation for the two-coat painting system, the surface shall be blast cleaned in accordance with the requirements of SSPC SP7 “Brush-Off Blast Cleaning” or other method producing equivalent results and uniform profile, to achieve a 1.0 to 1.5 mils anchor profile as indicated be a Keane Tator profile comparator or similar device. The creation of the anchor profile shall be performed prior to the formation of “white rust” on the galvanized surface.

Following blast cleaning, the zinc coating thickness shall be measured to verify that the coating thickness is in accordance with AASHTO M111.
**Items 816.01, 816.02, and 816.03 (Continued)**

A two-coat painting system shall be applied by the Galvanizer in his own facility within twelve hours of galvanizing the steel components.

The prime coat material shall be a polyamide epoxy applied to minimum dry film thickness of 2.0 to 4.0 mils (0.002-0.004 in.) and force cured as given below for the finish coat.

The finish coat material shall be a two component, catalyzed aliphatic urethane applied by airless spray to a minimum dry film thickness of 4.0 mils.

The color shall be **GLOSS BLACK** as noted above. The fabricator shall submit to the Engineer for approval, paint chips of the intended color prior to any work being done under this heading.

All finish coat material shall be applied under conditions within the following tolerances:

- **Air Temperature**: 50°F min., 90°F max.
- **Surface Temperature**: 50°F min., 100°F max.

Surface temperature must be at least 5°F above the dew point.

The finish coat shall be cured in a booth capable of maintaining 150°F for 2-4 hours.

**Touch-up and Repairs**

Should any damage occur to the galvanized coating during shipping or handling at the job site, the Contractor shall repair and touch-up any damaged areas to the satisfaction of the Engineer and the following:

Touch-up of galvanizing before the finish coat is applied shall be accomplished by applying galvanizing repair paint. The dry film thickness of the applied repair paint shall not be less than 4.0 mils.

Applications shall be in accordance with the manufacturer’s instruction.

Field touch-up procedures shall conform to the recommendations of the Galvanizer. Touch-up of the finish coat shall be by applying a coating of a two-part urethane, as supplied by the Galvanizer, to achieve a dry film thickness of at least 4.0 mils. Prior to the application of the paint, remove all damaged coatings down to a solidly adhered coating and apply galvanizing repair paint as primer.

Allow the primer to dry for at least 4 hours prior to top coating.

The Contractor shall also use the touch-up paint material and procedures to paint the galvanized hardware used in field erection that has not been finish coated previously.
**Items 816.01, 816.02, and 816.03 (Continued)**

**Aluminum Equipment**

All aluminum equipment called for shall have a powder coat finish **GLOSS BLACK** as noted above, in color. The coating shall be a polyester-TGIC (triglycidyl isocyanurat) resin system conforming to the following:

<table>
<thead>
<tr>
<th>Quality</th>
<th>Test</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abrasion</td>
<td>Taber abraser CS-10, 1000 gram load, 1000 cycle, ASTM D4060</td>
<td>100 mg. Maximum weight loss</td>
</tr>
<tr>
<td>Adhesion</td>
<td>ASTM D.59 Initial 1000 hours</td>
<td>5A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5A</td>
</tr>
<tr>
<td>Gloss</td>
<td>ASTM D 523 60° - 600 hours</td>
<td>82% retention</td>
</tr>
<tr>
<td></td>
<td>60° - 1000 hours</td>
<td>90% retention (washed)</td>
</tr>
<tr>
<td>Hardness</td>
<td>ASTM D 3363</td>
<td>2H – No Gouge</td>
</tr>
<tr>
<td>Impact</td>
<td>ASTM D 2794 Direct</td>
<td>Pass 80 inch-lb.</td>
</tr>
<tr>
<td>Salt Spray</td>
<td>ASTM B 177 Direct</td>
<td>Table 2-10</td>
</tr>
<tr>
<td>Resistance</td>
<td>ASTM D 1654 Unscribed 1000 hours</td>
<td>Table 1-10</td>
</tr>
<tr>
<td></td>
<td>400 hours scribed</td>
<td></td>
</tr>
<tr>
<td>Weather Resistant</td>
<td>ASTM G 23, 1000 hours, 18 min. waterspray, 102 min. light</td>
<td>No film failure</td>
</tr>
<tr>
<td>Color</td>
<td>Gloss Black</td>
<td></td>
</tr>
<tr>
<td>Identify</td>
<td>Infrared fingerprint</td>
<td>Match</td>
</tr>
<tr>
<td>Flexibility</td>
<td>180° bend; ½” dia, mandrel within 10 seconds</td>
<td>No breaks, flaking or cracks. Tested with a Q-panel with 2 mils or less of coating</td>
</tr>
<tr>
<td>Humidity</td>
<td>ASTM D 2247, 1000 hours</td>
<td>No blister or film failure</td>
</tr>
<tr>
<td>Thickness</td>
<td>4 mils +/- 1 mils</td>
<td></td>
</tr>
<tr>
<td>Mar Resistance</td>
<td>Good</td>
<td></td>
</tr>
</tbody>
</table>
Items 816.01, 816.02, and 816.03 (Continued)

A Certificate of Compliance of the powder coating system is required for the Engineer’s approval.

Manuals and Keys

The Contractor shall supply two (2) copies of operating and maintenance manuals (i.e., controller, malfunction management unit, preemption unit, video unit) and two (2) sets of cabinet keys to the City.

Ownership and Maintenance

Upon acceptance of the traffic signal systems by the City of Lowell, the Contractor shall turn over all guarantees and warranties to the City, where applicable. In turn, the City shall assume ownership and maintenance of the signal systems.

Basis of Payment

The work under Items 816.01, 816.02, and 816.03 will be paid for at the respective Contract lump sum prices, which prices shall include all labor, material, equipment and incidental costs required to complete the work.

No separate payment will be made for maintenance of existing installation, and the removal, stacking, and transporting of existing traffic signal equipment, but all costs in connection therewith shall be included in the lump sum price bid for Items 816.01, 816.02, and 816.03.

No separate payment will be made for adjusting existing and temporary signal heads, wiring, fittings, cabling and all other materials and labor required to ensure complete and operating traffic signals during construction, but all costs in connection therewith shall be included in the lump sum price bid for Items 816.01, 816.02, and 816.03.

No separate payment will be made for work considered incidental to the excavation, including but not limited to, mast arm foundations, dewatering, etc., but all costs in connection therewith shall be included in the price bid for Items 816.01, 816.02, and 816.03.

Conduit will be paid for separately under Item 804.3, 3-Inch Electrical Conduit Type NM Plastic (UL).

Pull boxes will be paid for separately under Item 811.31, Pull Box 12 x 12 Inches – SD.031.

Soil borings to determine the existing soil conditions will be paid for separately under Item 191, Mast Arm Soil Boring.
ITEM 821.16 ORNAMENTAL LIGHTING POLE EACH
SINGLE ARM BRACKET

ITEM 821.26 ORNAMENTAL LIGHTING POLE EACH
TWIN ARM BRACKET

ITEM 823.10 ORNAMENTAL LIGHTING LUMINAIRE EACH

The work to be done under these items consists of furnishing and installing a new street lighting system at the locations shown on the plans and as specified herein.

All work performed shall be in accordance with Section 820, HIGHWAY LIGHTING, of the Standard Specifications, and as specified herein.

General:
Provide light pole, bracket arm(s), anchor base wrap and luminaire assemblies as shown on the Drawings.

The Drawings show in general, the location of the roadway lighting systems. They are diagrammatic only, but shall be followed as closely as actual conditions that the site will permit.

All lighting standards shall be set plumb, with vertical plane of arms perpendicular to the roadway centerline.

All work shown on the contract drawings shall be installed by a Massachusetts Licensed Electrician.

Submittals:
The contractor shall submit shop drawings and catalog data for the pole, base, bracket arm and luminaire as a complete and coordinated submittal indicating all mounting provisions of the various items, dimensioned.

Materials:
Lighting poles, decorative base wrap, bracket arms, and luminaires shall be furnished complete, of the type specified on the drawings, and shall conform to fixture dimensions shown on the drawings. No exceptions.

The complete assembly of the pole shaft, pole base, bracket arm(s) and luminaire shall be rated for the design wind speed of 130 MPH per Subsection 820.41. AASHTO breakaway requirements shall not apply. Shop drawings and calculations shall be submitted, stamped by a professional engineer registered in the Commonwealth of Massachusetts.

Miscellaneous Hardware: All screws, nuts, bolts, washers and associated small hardware, except high strength bolts, shall be galvanized steel.
Poles shall be erected and secured to foundations in a manner as described herein. The exterior of the pole components shall be free of protuberances, dents, cracks, discolorations and other imperfections marring their appearance.

**Construction Methods:**

The Contractor shall exercise special care in erecting fluted light posts to ensure that they are firmly secured to the concrete foundation and plumbed in accordance with the details shown on the plans. The shims furnished with the pole shall be used if necessary. The street light pole shall not be installed until the related control cabinet and related underground wiring has been completed and tested.

When installing a fluted pole, the following procedure for bonding shall be used. A 12mm by 1.75 threaded hole with a servit post type grounding connector shall be installed in the post top tenon. The bonding lug shall be attached to the inside of the neck and the incoming green bonding lead shall be secured to it. All bonding leads from the luminaires and bracket arms (when specified) shall be crimped together and a single green lead shall be secured to the bonding lug.

The bracket arm shall be secured to the light standard shaft in accordance with manufacturer's recommendations. The bracket arm shall be oriented so that it is perpendicular to the centerline of roadway with which it is associated.

A luminaire of the size and type indicated on the Drawings shall be installed on its respective lighting standard as shown. The luminaire shall be installed on the bracket arms with the luminaire parallel to the roadway grade. Pole and bracket cable shall be installed through the pole bracket arm and connected to the luminaire terminals. Adequate slack pole and bracket cable shall be left at the base of the pole to permit connections to the roadway lighting circuits. A lamp of the type and size specified shall be installed in each luminaire. Install fuse and fuse holder at base.

**Wiring Grounding and Service Connections**

All wiring, splices, grounding, fuses and connections installed within the light pole, base, and luminaire shall meet the requirements of Section 813 of the Standard Specifications.

This work shall consist of furnishing and installing wire and cable of the type and size indicated for highway lighting and related electrical systems, equipment grounding systems, new ground electrodes or connections to existing ground electrodes and all materials and equipment necessary to deliver power to highway lighting and related electrical systems.

Secondary electric service grounding electrode and equipment grounding conductors shall be sized as indicated on the contract plans. Bare conductors shall be “tinned”. Materials shall meet the requirements of Section M8.16.7 except as noted herein.

Splices shall be made only in hand holes, Street Light and Power Cabinets, Light Poles and Luminaries.
Conductors shall be joined in Light Standards (Light Poles), Light Fixtures (Luminaries’), and Street Light and Power Control Cabinet wire ways using a crimp type connector with insulated cap by Buchanan, IDEAL or other approved manufacturer. Conventional wire nuts or wago type insertion connectors shall not be allowed.

Insulated equipment grounding conductors in Hand holes shall be terminated with Burndy compression type H copper splice with cover. Connections shall be dressed with an oxide inhibiting compound. Splices to be insulated using Burndy splice covers.

Insulated equipment grounding conductors in Light Standard (Light Pole) Hand holes shall be terminated with insulated ring tongue compression connectors. Connections shall be dressed with an oxide inhibiting compound.

Secondary electrical bare grounding electrode conductors shall be exothermically welded and/or terminated with copper compression lugs. All lug connection hardware shall be durium bronze. Connections shall be dressed with an oxide inhibiting compound.

A green insulated equipment grounding conductor shall be run with each Street Light and Power cable /wire run, to which equipment shall be bonded in accordance with Article 250 of 527CMR 12.0.

**Operation/Testing:**

Upon completion of the installation, an operating test shall be conducted to demonstrate that the roadway lighting systems and associated equipment operate in accordance with the requirements of this Section.

The Contractor shall demonstrate that the lighting system operates correctly in the presence of the Engineer.

Prior to acceptance, the Contractor shall operate the roadway lighting system, sunset to sunrise, for five consecutive days without interruption or failure. If a lamp or ballast should fail, it shall be immediately replaced. This shall not require a restart of the test. The Contractor shall record each fault, the method and date of correction of each, and the beginning and end of the 5-day test. After the 5-day test, the Contractor shall put the lighting control system into automatic mode and test the system in automatic mode for 7 consecutive days without interruption or failure. The Contractor shall restart the test if the system fails during the 7 days. The Contractor shall provide all labor and material to maintain and repair the system during testing. The Contractor shall provide qualified personal to repair system at night in the event of failure during darkness.

**Measurement and Payment:**

Ornamental Lighting Poles and Luminaires will be measured and paid for at the Contract unit price per each, which price shall be full compensation for all labor, materials, equipment and incidental costs required for the work.

No separate payment shall be made for all wiring, splices, fusing, grounding and connections installed within the light pole, base, bracket arm, luminaire, and adjacent handhole, but all costs in connection therewith shall be included in the Contract unit price bid.
ITEM 823.71   HIGHWAY LIGHTING POLE AND LUMINAIRE   EACH
REMOVED AND STACKED

Work under this Item shall conform to the relevant provisions of Section 800 of the Standard Specifications and the following:

General

The work shall include, but not be limited, to the disconnection, dismantling, removal, transportation and disposal off site of existing City of Lowell Street lighting fixtures and underground conduit and wiring along Thorndike Street as indicated on the contract plans. In conjunction with this work, the Contractor shall provide the necessary supervision, material and labor to coordinate with the City of Lowell Department of Public Works to maintain the installation and operation of the associated remaining existing Street Lighting fixtures along Thorndike Street and make safe any existing wiring attached to the remaining fixtures from those being disconnected and removed. No record drawings of the existing underground circuitry for these fixtures are available. The existing circuitry as shown on the contract drawings for these fixtures has been assumed for the purposes of providing a work scope to be bid. The actual circuitry must be verified in the field with the City of Lowell Department of Public works and National Grid.

Existing light poles are owned and operated by National Grid. The Contractor must provide the necessary coordination with National Grid for the removal of existing Cobra Head type light fixtures and circuitry along Thorndike Street. The Contractor shall notify National Grid prior to and at the completion of the above work. Lighting poles that are to be retained shall be selected by National Grid and the location of the stacked light pole shall be coordinated with National Grid. All poles and luminaires not selected to be retained will become property of the Contractor and removed from the project with no additional compensation.

Any light pole, luminaire, or hardware selected to be retained that is damaged or lost either directly or indirectly as a result of the Contractor's operations shall be replaced by the Contractor at his own expense.

The contractor is responsible for any electrical work required in order to remove the light pole connections. Lighting poles and luminaires shall be disconnected by a licensed electrician, licensed in the Commonwealth of Massachusetts.

Included in this item is the removal and disposal of the existing supports and foundations from which the existing poles are removed. The existing foundations of lights within the City layout shall either be removed completely or the excavation shall be to a depth of at least 12" below the existing or proposed ground level, whichever is lower unless otherwise approved by the City of Lowell. The remaining foundation hole shall be backfilled with compacted gravel and the ground surface restored or replaced in kind to match adjacent surface materials.
ITEM 823.71 (Continued)

Method of Measurement

Removal and stacking of lighting poles and luminaires will be measured by the unit price per Each in accordance with the Plans or as directed by the Engineer.

Basis of Payment

Removal and stacking of lighting poles and luminaires will be paid for at the contract unit price per Each as listed in the Proposal. The price shall constitute full and complete compensation for all labor, tools, materials and equipment, excavation, cleaning, stockpiling backfill, compaction and all other incidentals required to finish the work, complete in place and accepted by the Engineer.
ITEM 852.1  TEMPORARY PEDESTRIAN MANAGEMENT GUIDANCE SYSTEM

Work under this item shall consist of installing a system to guide pedestrians around closed sidewalk and curb ramp work locations and/or across the roadway as required.

Layout and materials must meet the requirements of the Americans with Disabilities Act (ADA) and the Massachusetts Architectural Access Board (MAAB) as well as the rules and regulations for temporary traffic control devices in the Manual on Uniform Traffic Control Devices (MUTCD). The system must have a continuous bottom rail or edge no more than two (2) inches above the ground and six (6) inches in height (minimum) to accommodate cane users, have a smooth and continuous top edge no less than 32 inches above the ground to facilitate “hand trailing” and not obstruct or project into the pedestrian path of travel. All elements of the pedestrian guidance system should be nearly vertical and generally within the same plane.

Elements of the system may include temporary portable pedestrian barricade, modular or pre-fab temporary curb ramps, or temporary hot mix asphalt curb ramps, and associated modifications and appurtenances. The guidance system is to prevent pedestrians from entering the work area, or entering into vehicle travel lane and channelizing them in conformance with ADA/MAAB requirements.

The Contractor may use either modular/pre-fab temporary curb ramps or hot mix asphalt to construct temporary ramps for pedestrian accommodation. Regardless of temporary ramp type, each location is required to have an approved Temporary Pedestrian Management Guidance System.

Prior to deploying the Temporary Pedestrian Management Guidance System, the Contractor shall prepare a sketch plan of the system for the work site showing the temporary portable pedestrian barricade system, the width of path of travel, the location and types of signs, and the location of temporary pedestrian curb ramps. This will be reviewed and approved by the District prior to its set up. Any material that is damaged during the deployed period shall be replaced at the direction of the Engineer at no additional cost.

It is the intent of this Item to reuse the placed pedestrian guidance system in many locations. The contractor shall maintain the integrity of the guidance system throughout the project duration. Special care shall be taken by the Contractor removing and resetting of the guidance system not to damage any piece of the system. The system shall remain in working order throughout construction.

There shall be no compensation made for any damaged section. The removal, and the resetting/modifying of the pedestrian management system shall be considered incidental to this item. The lump sum shall be partially paid for throughout the project based upon construction staging operations.
ITEM 854.014    TEMPORARY PAVING MARKINGS    FOOT
4 INCH (PAINTED)

ITEM 854.034    TEMPORARY PAVING MARKINGS    FOOT
4 INCH (REMOVABLE TAPE)

The work under these items shall conform to the relevant provisions of Section 850 of the Standard Specifications and the following:

Temporary pavement markings shall be 4 inches.

Where the plans call out for 12 inch lines, the contractor shall be paid three (3) times the line length to create the 12 inch width.

Temporary pavement markings will be paid for at the Contract unit price per foot. The price shall include all equipment and incidental costs required to complete the work.
The work under these items shall conform to the relevant provisions of Section 828 of the Standard Specifications and the following:

The work shall include the careful removal of existing traffic signs, attached hardware and supports from locations shown on the plans, and as directed by the Engineer. Also included is the resetting or transporting and stacking of existing traffic signs at the discretion of the Engineer, at locations to be coordinated with the City.

Traffic signs not required to be removed and reset or stacked, shall become the property of the Contractor and shall be removed from the site during the construction period and legally disposed of.

The Contractor shall carefully remove and reset at new locations all existing signs, attachment hardware and sign support posts not included under other sign items as shown on the drawings and as directed by the Engineer. Signs, attachment hardware and sign support posts shall be satisfactorily stored and protected until reset in the proposed work.

Signs, attachment hardware and sign support posts lost, damaged or otherwise made unsuitable for reuse while being removed, transported, stored or reset shall be replaced with new materials at no additional cost to the Owner. New attachment hardware shall be furnished and installed as necessary to replace any missing or unusable existing hardware.

Existing signs shall remain in place until proposed new signs are in place unless otherwise directed by the Engineer.

Street sign removed and reset and traffic sign removed and stacked will be paid for at the respective Contract unit prices per each, which price shall be full compensation for dismantling, removing and transporting and stacking of the signs, removal and stacking of posts, resetting of signs, excavation and stacking or disposal of the existing foundation, supplying and placing of gravel backfill, gravel compaction and the restoration or replacement in kind of disturbed surfaces.
APPENDIX A

MASSACHUSETTS PREVAILING WAGE REPORTS