

DOCUMENT A00801*Put-In Revised 06/08/2018***SPECIAL PROVISIONS****ACTON AND CONCORD****Federal Aid Project Number: XXXXX****Bruce Freeman Rail Trail Phase 2B,****Bridge over Rte 2: C-19-039(BUJ)****Bridge of Nashoba Brook: C-19-037(BF4)****Wildlife Corridor: C-19-040(BUK)**

Labor participation goals for this Project shall be 15.3% for minorities and 6.9% for women for each job category. The goals are applicable to both Contractor's and Subcontractor's on-site construction workforce. Refer to Document 00820 for details.

SCOPE OF WORK

The project consists of the construction of Phase 2B of the Bruce Freeman Rail Trail (BFRT). The project begins in the north at the terminus of Phase 2A near Teamworks Acton, continues in a southerly direction approximately 4,675 feet to the northerly terminus of Phase 2C just approximately 380 feet north of Commonwealth Avenue. Approximately 1,450 feet of the trail are in Acton and 3,225 feet of the trail are in Concord. The proposed rail trail will run in a north-south direction and crosses over Route 2 just after crossing the Acton/Concord town line and crosses Nashoba Brook just south of Route 2. A proposed culvert crossing under Route 2 is provided for wildlife passage.

The work includes clearing and grubbing, track removal, earth excavation, full depth hot mix asphalt pavement, drainage improvements, fence and guardrail installation, retaining wall construction, new steel girder bridge with center pier, steel girder bridge replacement, new wildlife culvert, landscaping, traffic signing, traffic control management, and other street improvements.

All work under this contract shall be done in conformance with the *Standard Specifications for Highways and Bridges* dated 1988, the *Supplemental Specifications dated July 1, 2015*, and the *Interim Supplemental Specifications* contained in this contract; the *2016 Construction Standard Details*, the *1990 Standard Drawings for Signs and Supports*; the *1996 Construction and Traffic Standard Details* (as relates to the Pavement Markings details only); *The 2015 Overhead Signal Structure and Foundation Standard Drawings*, the *2009 Manual on Uniform Traffic Control Devices (MUTCD) with Massachusetts Amendments* and the *Standard Municipal Traffic Code*; the *1968 Standard Drawings for Traffic Signals and Highway Lighting*; the latest edition of *American Standard for Nursery Stock*; the *LRFD Bridge Manual – 2013 Edition*; *AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition*; *The Guide for the Development of Bicycle Facilities 2012 Edition*, the Plans and these Special Provisions.

CONTRACTOR QUESTIONS AND ADDENDUM ACKNOWLEDGEMENTS

Prospective bidders are required to submit all questions to the Construction Contracts Engineer by 1:00 P.M. on the Thursday before the scheduled bid opening date. Any questions received after this time will not be considered for review by the Department.

Contractors should email questions and addendum acknowledgements to the following email address massdotSpecifications@dot.state.ma.us The MassDOT project file number and municipality is to be placed in the subject line.

SUBSECTION 7.05 INSURANCE REQUIREMENTS

B. Public Liability Insurance

The insurance requirements set forth in this section are in addition to the requirements of the Standard Specifications and supersede all other requirements.

Paragraphs 1 and 2

The Massachusetts Department of Transportation and applicable railroads shall be named as additional insureds.

ACCESS MASSDOT HIGHWAY INFORMATION ON WEBSITE

Access MassDOT Highway Information related to Construction, Design/Engineering, Contractor/Vendor Information, Approved Materials and Fabricators, Manuals, Publications and Forms at:

<http://www.mass.gov/massdot/highway>
Select Doing business with us

CONTRACTOR/SUBCONTRACTOR CERTIFICATION – CONTRACT COMPLIANCE

(Revision 03-23-10)

Pursuant to 23 C.F.R. § 633.101 et seq., the Federal Highway Administration requires each contractor to “insert in each subcontract, except as excluded by law or regulation, the required contract provisions contained in Form FHWA–1273 and further requires their inclusion in any lower tier subcontract that may in turn be made. The required contract provisions of Form FHWA–1273 shall not be incorporated by reference in any case. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the requirements contained in the provisions of Form FHWA–1273.” The prime contractor shall therefore comply with the reporting and certification requirements provided in MassDOT’s CONTRACTOR/SUBCONTRACTOR CERTIFICATION Form (DOT-DIST-192) certifying compliance with 23 C.F.R. § 633.101 for each subcontract agreement entered into by the contractor. The contractor shall provide a fully executed original copy of said CONTRACTOR/SUBCONTRACTOR CERTIFICATION Form to MassDOT upon execution of any subcontract agreement. Failure to comply with the reporting and certification requirement of the CONTRACTOR/SUBCONTRACTOR CERTIFICATION Form may result in action against the prequalification status of the prime contractor with MassDOT.

SUBSECTION 4.04 CHANGED CONDITIONS

This Subsection is revised by deleting the two sequential paragraphs near the end that begin “The Contractor shall be estopped...” and “Any unit item price determined ...” (1/6/2006).

PROTECTION OF UNDERGROUND FACILITIES

The Contractor's attention is directed to the necessity of making his own investigation in order to assure that no damage to existing structures, drainage lines, traffic signal conduits, etcetera, will occur.

The Contractor shall notify Massachusetts DIG SAFE and procure a Dig Safe Number for each location prior to disturbing existing ground in any way. Contact the Dig Safe Call Center by dialing 811 or 1-888-344-7233 or online at www.digsafe.com.

DESIGNER/PROJECT MANAGER

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Matthew Kearney, P.E.
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PROCEDURE FOR RELEASING AUTOCAD FILES TO THE GENERAL CONTRACTOR

After the bid opening the low bidder may submit the Request for Release of MassDOT AutoCAD Files Form to the Highway Design Engineer. When the Highway Design Section has received both the AutoCAD files from the designer and the Request for Release of MassDOT AutoCAD Files Form from the Contractor, Highway Design will email the contractor a link through Dropbox.com with a reminder disclaimer of use (copy to Project Manager and District Construction Engineer).

HOLIDAY WORK RESTRICTIONS FOR CALENDAR YEAR 2018 (Supplementing Subsection 7.09)

The District Highway Director (DHD) may authorize work to continue during these specified time periods if it is determined by the District that the work will not negatively impact the traveling public.

Below are the holiday work restrictions for the calendar year 2018.

New Years Day (Federal Holiday)

Monday, January 1, 2018:

No work on major arterial roadways from noon on Friday, December 29, 2017 until the normal start of business on Tuesday, January 2, 2018. No work on local roadways on the holiday without permission by the DHD and the local police chief.

Martin Luther King's Birthday (Federal Holiday)

Monday, January 15, 2018:

No work restrictions due to traffic concerns however work on local roadways requires permission by the DHD and local police chief.

President's Day (Federal Holiday)

Monday, February 19, 2018:

No work restrictions due to traffic concerns however work on local roadways requires permission by the DHD and local police chief.

Evacuation Day (Suffolk County State Holiday)

Saturday, March 17, 2018:

No work restrictions due to traffic concerns.

Patriot's Day (State Holiday)

Monday, April 16, 2018:

Work restrictions will be in place for Districts 3, 4 and 6 along the entire Boston Marathon route and any other locations that the DHD in those districts determine are warranted so as to not to impact the marathon. All other districts work restrictions will be as per DHD.

HOLIDAY WORK RESTRICTIONS FOR CALENDAR YEAR 2018 (Continued)

Mother's Day

Sunday, May 13, 2018:

No work on Western Turnpike and Metropolitan Highway System from noon on Friday, May 11, 2018 until the normal start of business on Monday, May 14, 2018.

Memorial Day (Federal Holiday)

Monday, May 28, 2018:

No work on major arterial roadways from noon on Friday, May 25, 2018 until the normal start of business on Tuesday, May 29, 2018.

Bunker Hill Day (Suffolk County State Holiday)

Sunday, June 17, 2018:

No work restrictions due to traffic concerns.

Independence Day (Federal Holiday)

Wednesday, July 4, 2018:

No work on major arterial roadways from noon on Tuesday, July 3, 2018 until the normal start of business on Thursday, July 5, 2018.

Labor Day (Federal Holiday)

Monday, September 3, 2018:

No work on major arterial roadways from noon on Friday, August 31, 2018 until the normal start of business on Tuesday, September 4, 2018.

Columbus Day (Federal Holiday)

Monday, October 8, 2018:

No work on major arterials from noon time on Friday, October 5, 2018 until the normal start of business on Tuesday, October 9, 2018. DHD may allow work in those areas on a case by case basis and where work is behind barrier and will not impact traffic.

Veterans' Day (Federal Holiday)

Sunday, November 11, 2018:

No work restrictions due to traffic concerns.

Thanksgiving Day (Federal Holiday)

Thursday, November 22, 2018:

No work on major arterials from noon on Wednesday, November 21, 2018 until the normal start of business on the Monday, November 26, 2018.

Christmas Day (Federal Holiday)

Tuesday, December 25, 2018:

No work on major arterial roadways from noon on Friday, December 21, 2018 until the normal start of business on Wednesday, December 26, 2018.

PROMPT PAYMENT

Contractors are required to promptly pay Subcontractors under this Prime Contract within ten (10) business days from the receipt of each payment the Prime Contractor receives from MassDOT. Failure to comply with this requirement may result in the withholding of payment to the Prime Contractor until such time as all payments due under this provision have been received by the Subcontractor(s) and/or referral to the Prequalification Committee for action which may affect the Contractor's prequalification status.

NORTHERN LONG-EARED BAT PROTECTION

The U.S. Fish and Wildlife Service has listed the northern long-eared bat as threatened under the Endangered Species Act (ESA) and the following requirements exist to protect the bat and its habitat. This project has been reviewed by MassDOT Highway Division's Environmental Services Section, and has been determined to have "No Effect" to the northern long-eared bat. No time of year restrictions are required for the project at this time. If additional cutting is proposed by the Contractor that is outside the scope of this contract, additional review is required by the MassDOT Highway Division's Environmental Services Section, and time of year restrictions may apply to such tree cutting.

SUBSECTION 8.14 UTILITY COORDINATION, DOCUMENTATION, AND MONITORING RESPONSIBILITIES

A. GENERAL

In accordance with the provisions of Section 8.00 Prosecution and Progress, utility coordination is a critical aspect to this Contract. This section defines the responsibility of the Contractor and MassDOT, with regard to the initial utility relocation plan and changes that occur as the prosecution of the Work progresses. The Engineer, with assistance from the Contractor shall coordinate with Utility companies that are impacted by the Contractor's operations. To support this effort, the Contractor shall provide routine and accurate schedule updates, provide notification of delays, and provide documentation of the steps taken to resolve any conflicts for the temporary and/or permanent relocations of the impacted utilities. The Contractor shall provide copies to the Engineer of the Contractor communication with the Utility companies, including but not limited to:

- Providing advanced notice, for all utility-related meetings initiated by the Contractor.
- Providing meeting minutes for all utility-related meetings that the Contractor attends.
- Providing all test pit records.
- Request for Early Utility work requirements of this section (see below).
- Notification letters for any proposed changes to Utility start dates and/or sequencing.
- Written notification to the Engineer of all apparent utility delays within seven (7) Calendar Days after a recognized delay to actual work in the field – either caused by a Utility or the Contractor.
- Any communication, initiated by the Contractor, associated with additional Right-of-Way needs in support of utility work.
- Submission of completed Utility Completion Forms.

B. PROJECT UTILITY COORDINATION (PUC) FORM

The utility schedule and sequence information provided in the Project Utility Coordination Form (if applicable) is the best available information at the time of the bid and has been considered in setting the contract duration. The Contractor shall use all of this information in developing the bid price and the Baseline Schedule Submission, inclusive of the individual utility durations sequencing requirements, and any work that has been noted as potentially concurrent utility installations.

C. INITIATION OF UTILITY WORK

The Engineer will issue all initial notice-to-proceed dates to each Utility company based on either the:

- 1) Contractor's accepted Baseline Schedule
- 2) An approved Early Utility Request in the form of an Early Utility sub-net schedule (in accordance with the requirements of this Subsection)
- 3) An approved Proposal Schedule

C.1 - BASELINE SCHEDULE – UTILITY BASIS

The Contractor shall provide a Baseline Schedule submission in accordance with the requirements of Subsection 8.02 and inclusive of all of the information provided in the PUC Form that has been issued in the Contract documents. This is to include the utility durations, sequencing of work, allowable concurrent work, and all applicable considerations that have been depicted on the PUC Form.

SUBSECTION 8.14 (Continued)

C.2 – EARLY UTILITY REQUEST – (aka SUBNET SCHEDULE) PRIOR TO THE BASELINE
All early utility work is defined as any anticipated/required utility relocations that need to occur prior to the Baseline Schedule acceptance. In all cases of proposed early utility relocation, the Contractor shall present all known information at the pre-construction conference in the form of a ‘sub-net’ schedule showing when each early utility activity needs to be issued a notice-to-proceed. The Contractor shall provide advance notification of this intent to request early utility work in writing at or prior to the Pre-Construction meeting. Prior to officially requesting approval for early utility work, the Contractor shall also coordinate with MassDOT and all utility companies (private, state or municipal) which may be impacted by the Contract. If this request is acceptable to the Utilities and to MassDOT, the Engineer will issue a notice-to-proceed to the affected Utilities, based on these accepted dates.

C.3 – PROPOSAL SCHEDULE - CHANGES TO THE PUC FORM

If the Contractor intends to submit a schedule (in accordance with MassDOT Standard Specifications, Division I, Subsection 8.02) that contains durations or sequencing that vary from those provided in the Project Utility Coordination (PUC) Form, the Contractor must submit this as an intended change, in the form of a Proposal Schedule and in accordance with MassDOT Standard Specifications, Division I, Subsection 8.02. These proposed changes are subject to the approval of the Engineer and the impacted utilities, in the form of this Proposal Schedule and a proposed revision to the PUC form. The Contractor shall not proceed with any changes of this type without written authorization from the Engineer, that references the approved Proposal Schedule and PUC form changes. The submission of the Baseline Schedule should not include any of these types of proposed utility changes and should not delay the submission of the Baseline Schedule. As a prerequisite to the Proposal Schedule submission, and in advance of the utility notification(s) period, the Contractor shall coordinate the proposed utility changes with the Engineer and the utility companies, to develop a mutually agreed upon schedule, prior to the start of construction.

D. UTILITY DELAYS

The Contractor shall notify the Engineer upon becoming aware that a Utility owner is not advancing the work in accordance with the approved utility schedule. Such notice shall be provided to the Engineer no later than seven (7) calendar days after the occurrence of the event that the Contractor believes to be a utility delay. After such notice, the Engineer and the Contractor shall continue to diligently seek the Utility Owner’s cooperation in performing their scope of Work.

In order to demonstrate that a critical path delay has been caused by a third-party Utility, the Contractor must demonstrate, through the requirements of the monthly Progress Schedule submissions and the supporting contract records associated with Subsection 8.02, 8.10 and 8.14, that the delays were beyond the control of the Contractor.

SUBSECTION 8.14 (Continued)

All documentation provided in this section is subject to the review and verification of the Engineer and, if required, the Utility Owner. In accordance with MassDOT Specifications, Division I, Subsection 8.10, a Time Extension will be granted for a delay caused by a Utility, only if the actual duration of the utility work is in excess of that shown on the Project Utility Coordination Form, and only if;

- 1) proper Notification of Delay was provided to MassDOT in accordance with the time requirements that are specified in this Section
- 2) the utility delay is a critical path impact to the Baseline Schedule (or most recently approved Progress Schedule)

E. LOCATION OF UTILITIES

The locations of existing utilities are shown on the Contract drawings as an approximation only. The Contractor shall perform a pre-construction utility survey, including any required test pits, to determine the location of all known utilities no later than thirty (30) calendar days before commencing physical site work in the affected area.

F. POST UTILITY SURVEY – NOTIFICATION

Following completion of a utility survey of existing locations, the Contractor will be responsible to notify the Engineer of any known conflicts associated with the actual location of utilities prior to the start of the work. The Engineer and the Contractor will coordinate with any utility whose assets are to be affected by the Work of this Contract. A partial list of utility contact information is provided in the Project Utility Coordination Form.

G. MEETINGS AND COOPERATION WITH UTILITY OWNERS

The Contractor shall notify the Engineer in advance of any meeting they initiate with a Utility Owner's representative to allow MassDOT to participate in the meeting if needed.

Prior to the Pre-Construction Meeting, the Contractor should meet with all Utility Owners who will be required to perform utility relocations within the first 6 months of the project, to update the affected utilities of the Project Utility Coordination Form and all other applicable Contract requirements that impact the Utilities. The Contractor shall copy the Engineer on any correspondence between the Utility Owner and the Contractor.

H. FORCE ACCOUNT / UTILITY MONITORING REQUIREMENTS

The Engineer will be responsible for recording daily Utility work force reports. The start, suspension, re-start, and completion dates of each of the Utilities, within each phase of the utility relocation work, will be monitored and agreed to by the Engineer and the Contractor as the work progresses.

I. ACCESS AND INSPECTION

The Contractor shall be responsible for allowing Utility owners access to their own utilities to perform the relocations and/or inspections. The Contractor shall schedule their work accordingly so as not to delay or prevent each utility from maintaining their relocation schedule.

SUBSECTION 8.02 SCHEDULE OF OPERATIONS

Replace this subsection with the following:

An integrated cost and schedule controls program shall be implemented by the Contractor to track and document the progress of the Work from Notice to Proceed (NTP) through the Contractor Field Completion (CFC) Milestone. The Contractor's schedules will be used by the Engineer to monitor project progress, plan the level-of-effort required by the Department's work force and consultants and as a critical decision-making tool. Accordingly, the Contractor shall ensure that it complies fully with the requirements specified herein and that its schedules are both accurate and updated as required by the specification throughout the life of the project. Detailed requirements are provided in Division II, Section 722 Construction Scheduling.

SECTION 722 CONSTRUCTION SCHEDULING

DESCRIPTION

722.20 General

The Contractor's approach to prosecution of the Work shall be disclosed to the Department by submission of a Critical Path Method (CPM) schedule and a cost/resource loaded Construction Schedule when required in this Subsection. These requirements are in addition to, and not in limitation of, requirements imposed in other sections.

The requirements for scheduling submissions are established based on the Project Value at the time of the bid and are designated as Type A, B, C or D. The definitions of these Schedule Requirement Types are summarized below. Complete descriptions of all detailed requirements are established elsewhere in this specification.

Type A – for all Site-Specific Contracts with a Project Value over \$20 Million

- Schedule Planning Session
- Baseline CPM Schedule
- Monthly Update CPM Schedule
- Short-term Construction Schedule
- Contract Schedule Update Meeting
- Resource-Loading
- Resources Graphic Reporting
- Cash Flow Projections from the CPM
- Cash Flow Charts
- Cost-loaded CPM
- Contractor-furnished CPM software, computer and training

Type B – for all Site-Specific Contracts with a Project Value between \$10 Million and \$20 Million

- Schedule Planning Session
- Baseline CPM Schedule
- Monthly Update CPM Schedule
- Short-term Construction Schedule
- Contract Schedule Update Meeting
- Cost-loaded CPM
- Resource-Loading
- Monthly Projected Spending Report (PSR)
- Contractor-furnished CPM software, computer and training

SECTION 722 (Continued)

Type C – for all Site-Specific Contracts with a Project Value between \$3 Million and \$10 Million

- Schedule Planning Session
- Baseline CPM Schedule
- Monthly Update CPM Schedule
- Short-term Construction Schedule
- Contract Schedule Update Meeting
- Monthly Projected Spending Report (PSR)
- Contractor-furnished CPM software, computer and training

Type D - for all contracts with a Project Value less than \$3 Million; various locations contracts of any dollar amount; contracts with durations less than one-hundred and eighty (180) Calendar Days; and other contracts as determined by the Engineer.

- Bar chart schedule updated monthly or at the request of the Engineer (See Section 722.62.B - Bar Charts.)
- Monthly Projected Spending Report (PSR) (See Section 722.62.F - Projected Spending Reports.)

MATERIALS, EQUIPMENT, PERSONNEL**722.40 General****A. Software Requirements** (Types A, B and C)

The Contractor shall use Primavera P6 computer scheduling software.

In addition to the requirements of Section 740 – Engineer’s Field Office and Equipment, the Contractor shall provide to the Department one (1) copy of the scheduling software, one (1) software license and one (1) computer capable of running the scheduling software for the duration of the Contract. This computer and software shall be installed in the Engineer’s Field Office within twenty-eight (28) Calendar Days after Notice to Proceed. The computer and software shall be maintained and serviced as recommended by the computer manufacturer and/or as required by the Engineer during the duration of the Contract at no additional cost to the Department. The Contractor shall provide professional training in the basic use of the software for up to eight (8) Department employees. The trainer shall be approved by the Engineer. This training shall be provided within twenty-eight (28) Calendar Days after Notice to Proceed.

B. Scheduler Requirements

For all schedule types, if the Contractor plans to use outside scheduling services, the scheduler shall be approved as a subcontractor by the Engineer.

For Type A, B and C Schedules the name of the Contractor’s Project Scheduler together with his/her qualifications shall be submitted to the Department for approval by the Engineer within seven (7) Calendar Days after NTP. The Project Scheduler shall have a minimum of five [5] years of project CPM scheduling experience, three [3] years of which shall be on projects of similar scope and value as the project for which the Project Scheduler is being proposed. References shall be provided from past projects that can attest to the capabilities of the Project Scheduler.

SECTION 722 (Continued)**CONSTRUCTION METHODS****722.60 General****A. Schedule Planning Session**

(Types A, B and C)

The Contractor shall conduct a schedule planning session within seven (7) Calendar Days after the Contractor receives the NTP and prior to submission of the Baseline Schedule. This session will be attended by the Department and its consultants. During this session, the Contractor shall present its planned approach to the project including, but not limited to:

1. the Work to be performed by the Contractor and its subcontractors;
2. the planned construction sequence and phasing; planned crew sizes;
3. summary of equipment types, sizes, and numbers to be used for each work activity;
4. all early work related to third party utilities;
5. identification of the most critical submittals and projected submission timelines;
6. estimated durations of major work activities;
7. the anticipated Critical Path of the project and a summary of the activities on that Critical Path;
8. a summary of the most difficult schedule challenges the Contractor is anticipating and how it plans to manage and control those challenges;
9. a summary of the anticipated quarterly cash flow over the life of the project.

This will be an interactive session and the Contractor shall answer all questions that the Department and its consultants may have. The Contractor shall provide a minimum of five (5) copies of a written summary of the information presented and discussed during the session to the Engineer. The Contractor's Baseline Schedule and accompanying Schedule Narrative shall incorporate the information discussed at this Schedule Planning Session.

B. Schedule Reviews by the Department (All Types)

1. Baseline Schedule Reviews

The Engineer will respond to the Baseline Schedule Submission within thirty (30) Calendar Days of receipt providing comments, questions and/or disposition that either accepts the schedule or requires revision and resubmittal. Baseline Schedules shall be resubmitted within fifteen (15) Calendar Days after receipt of the Engineer's comments.

2. Contract Progress Schedule / Monthly Update Reviews

The Engineer will respond to each submittal within twenty one (21) Calendar Days. Schedules shall be resubmitted by the Contractor within five (5) Calendar Days after receipt of the Engineer's comments.

Failure to submit schedules as and when required could result in the withholding of full or partial pay estimate payments by the Engineer.

SECTION 722 (Continued)**722.61 Schedule Content and Preparation Requirements**
(Types A, B and C unless otherwise noted)

Each Contract Progress Schedule shall fully conform to these requirements.

A. LOGIC

The schedules shall divide the Work into activities with appropriate logic ties to show:

1. conformance with the requirements of this Section and Division I, Subsection 8.02 - Schedule of Operations
2. the Contractor's overall approach to the planning, scheduling and execution of the Work
3. conformance with any additional sequences of Work required by the Contract Documents, including, but not limited to, Subsection 8.03 - Prosecution of Work and Subsection 8.06 – Limitations of Operations.

B. ACTIVITIES

The schedules shall clearly define the progression of the Work from NTP to Contractor Field Completion (CFC) by using separate activities for each of the following items:

1. NTP
2. Each component of the Work defined by specific activities
3. Detailed activities to satisfy permit requirements
4. Procurement of fabricated materials and equipment with long lead times, including time for review and approval of submittals required before purchasing
5. The preparation and submission of shop drawings, procedures and other required submittals, with a planned duration that is to be demonstrated to the Engineer as reasonable
6. The review and return of shop drawings, procedures and other required submittals, approved or with comments, the duration of which shall be thirty (30) Calendar Days, unless otherwise specified or as approved by the Engineer
7. Interfaces with adjacent work, utility companies, other public agencies, sensitive abutters, and/or any other third party work affecting the Contract
8. The Critical Path, clearly defined and organized
9. Float shall be clearly identified
10. Access Restraints – restrictions on access to areas of the Work that are defined by the Department in the bid package, in Subsection 8.06 – Limitations of Operations or elsewhere in the Contract
11. Milestones listed in Subsection 8.03 - Prosecution of Work or elsewhere in the Contract Documents
12. Subcontractor approvals at fifteen (15) Calendar Days from submittal to response
13. Full Beneficial Use (FBU) Contract Milestone per the requirements of Subsection 8.03 - Prosecution of Work
14. Contractor's request for validation of FBU (ready to open to traffic)
15. The Department's confirmation of completed work to allow for FBU

SECTION 722 (Continued)

16. Substantial Completion Contract Milestone per the requirements of Subsections 7.15 - Claims Against Contractors for Payment of Labor, Materials and Other Purposes and 8.03 - Prosecution of Work
17. Contractor's request for validation of Substantial Completion
18. Punchlist Completion Period of at least thirty (30) Calendar Days per the requirements of Subsections 5.11 - Final Acceptance, 7.15 - Claims Against Contractors for Payment of Labor, Materials and Other Purposes and 8.03 - Prosecution of Work
19. Contractor confirmation that all punchlist work and documentation has been completed
20. Physical Completion of the Work Contract Milestone per the requirements of Subsections 5.11 - Final Acceptance and 8.03 - Prosecution of Work
21. Documentation Completion per the requirements of Subsections 5.11 - Final Acceptance and 8.03 - Prosecution of Work
22. Contractor Field Completion Contract Milestone per the requirements of Subsections 5.11 - Final Acceptance and 8.03 - Prosecution of Work
23. Utility work to be performed in accordance with the Project Utility Coordination (PUC) Form as provided in Section 8.14 - Utilities Coordination, Documentation and Monitoring Responsibilities
24. Traffic work zone set-up and removal, night work and phasing
25. Early Utility Relocation (by others) that has been identified in the Contract
26. Right-of-Way (ROW) takings that have been identified in the Contract
27. Material Certifications
28. Work Breakdown Structure in accordance with the MassDOT-Highway Division Contractor Construction Schedule Toolkit located on the MassDOT-Highway Division website at:
<http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/Construction/ConstructionScheduleToolkit.aspx>
29. For Type A and B Contracts only: All items to be paid, including all Unit Price and Lump Sum pay items, shall be identified by activity. This shall include all non-construction activities such as engineering work; purchase of permanent materials and equipment, purchase of structural steel stock, equipment procurement, equipment delivery to the site or storage location and the representative amount of overhead/indirect costs that was included in the Contractor's Bid Prices.

C. EARLY AND LATE DATES

Early Dates shall be based on proceeding with the Work or a designated part of the Work exactly on the date when the corresponding Contract Time commences. Late Dates shall be based on completing the Work or a designated part of the Work exactly on the corresponding Contract Time, even if the Contractor anticipates early completion.

SECTION 722 (Continued)**D. DURATIONS**

Activity durations shall be in Work Days. Planned Original Durations shall be established with consideration to resources and production rates that correspond to the Contractor's Bid Price. Within all of the Department-required schedules, the Contractor shall plan the Work using durations for all physical construction activities of no less than one (1) Work Day and no greater than fourteen (14) Work Days, unless approved by the Engineer as part of the Baseline Schedule Review.

Should there be an activity with a duration that is determined by the Engineer to be unreasonable, the Contractor will be asked to provide a basis of the duration using bid documents, historic production rates for similar work, or other form of validation that is acceptable to the Engineer. Should the Contractor and the Engineer be unable to agree on reasonable activity durations, the Engineer will, at a minimum, note the disagreement in the Baseline Schedule Review along with a duration the Engineer considers reasonable and the basis for that duration. A schedule that contains a substantial number of activities with durations that are deemed unreasonable by the Engineer will not be accepted.

E. MATERIALS ON HAND (for Types A and B only)

The Contractor shall identify in the Baseline Schedule all items of permanent materials (Materials On Hand) for which the Contractor intends to request payment prior to the incorporation of such items into the Work.

F. ACTIVITY DESCRIPTIONS

The Contractor shall use activity descriptions in all schedules that clearly describe the work to be performed using a combination of words, structure numbers, station numbers, bid item numbers, work breakdown structure (WBS) and/or elevations in a concise and compact label as specified in the MassDOT-Highway Division Contractor Construction Schedule Toolkit located on the MassDOT-Highway Division website at:

<http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/Construction/ConstructionScheduleToolkit.aspx>

G. ACTIVITY IDENTIFICATION NUMBERS

The Contractor shall use the activity identification numbering system specified in the MassDOT-Highway Division Contractor Construction Schedule Toolkit located online at the address above.

H. ACTIVITY CODES

The Contractor shall use the activity codes specified in the MassDOT-Highway Division Contractor Construction Schedule Toolkit located online at the address above.

I. CALENDARS

Different calendars may be created and assigned to all activities or to individual activities. Calendars define the available hours of work in each Calendar Day, holidays and general or project-specific non-Work Days such as Fish Migration Periods, time of year (TOY) restrictions and/or area roadway restrictions.

SECTION 722 (Continued)

Examples of special calendars include, but are not limited to:

- Winter Shutdown Period, specific work is required by separate special provision to be performed during the winter. See Special Provision 8.03 (if applicable)
- Peak traffic hours on heavily traveled roadways. This shall be from 6:30 am to 9:30 am and from 3:30 pm to 7:00 pm, unless specified differently elsewhere in the Contract.
- Special requirements by sensitive abutters, railroads, utilities and/or other state agencies as defined in the Contract.
- Cape Cod and the Islands Summer Roadway Work Restrictions: A general restriction against highway and bridge construction is enforced between Memorial Day and Labor Day, unless otherwise directed by the Engineer. Refer to the Project Special Provisions for specific restrictions.
- Cape Ann Summer Roadway Work Restrictions: While there are no general restrictions for Cape Ann as there are for Cape Cod and the Islands, project-specific restrictions may be enforced. Refer to the Project Special Provisions for specific restrictions.
- Turtle and/or Fish Migration Periods and/or other in-water work restrictions: Refer to the Project Special Provisions for specific restrictions.
- Working over Waterways Restricted Periods: Refer to the Project Special Provisions for specific restrictions.
- Night-time paving and striping operations, traffic and temperature restrictions: Refer to the Project Special Provisions for specific restrictions.
- Utility Restrictions shall be as specified within the Contract.

J. FLOAT

For the calculation of float in the CPM schedule, the setting for *Retained Logic* is required for all schedule submissions, starting with the Baseline Schedule Submission. Should the Contractor have a reason to propose that an alternative calculation setting such as *Progress Override* be used, the Contractor shall obtain the Engineer's approval prior to modifying to this setting.

K. COST AND RESOURCE LOADING (Types A and B only)

For all Type A and B Schedules, the Contractor shall provide a cost and resource-loaded schedule with an accurate allocation of the costs and resources necessary to complete the Work. The costs and resources shall be assigned to all schedule activities in order to enable the Contractor to efficiently execute the Contract requirements and the Engineer to validate the original plan, monitor progress, provide cash flow projections and analyze delays.

1. Each schedule activity shall have an assigned cost that accurately represents the value of the Work. Each schedule activity shall have its resources assigned to it by craft and the anticipated hours to accomplish the work. Each schedule activity's equipment resources shall be assigned to it by equipment type and hours operated. Front-loading or other unbalancing of the cost distribution will not be permitted.
2. The sum of the cost of all schedule activities shall be equal to the Contractor's Bid Price.
3. Indicating the labor hours per individual, per day, by craft and equipment hours/day will be acceptable.

SECTION 722 (Continued)

4. The Engineer reserves the right to use the cost-loading as a means to resolve changes, disputes, time entitlement evaluations, increases or decreases in the scope of Work, unit price renegotiations and/or claims.
5. For all Type A and B Schedules, all subnets, fragnets, Proposal Schedules, and Recovery Schedules shall be cost and resource- loaded to help to quickly validate and monitor the duration of the Work to be performed.
6. For Type A Schedules, cost-loading of the schedule will also be used for cash flow projection purposes.
7. The cost-loading of each activity shall indicate the portion of the cost for that activity that is applicable to a specific bid item (cost account.) The total cost for each cost account must equal the bid item price.
8. For Type A Schedules, each month, the Contractor will be paid using the Cost-loaded CPM activities for Lump Sum payment items. This requirement supersedes any requirements elsewhere in this Contract regarding partial payments of schedule-of-values for all Lump Sum items.

L. NOT TO BE USED IN THE CONTRACTOR'S CPM SCHEDULE

1. Milestones or constraint dates not specified in the Contract
2. Scheduled work not required for the accomplishment of a Contract Milestone
3. Use of activity durations, logic ties and/or sequences deemed unreasonable by the Engineer
4. Delayed starts of follow-on trades
5. Float suppression techniques

722.62 Submittal Requirements

All schedules shall be prepared and submitted in accordance with the requirements listed below.

Each monthly Contract Progress Schedule submittal shall be uniquely identified.

Except as stated elsewhere in this subsection, schedule submittals shall include each of the documents listed below, prepared in two formats, for distribution as follows:

- a. four (4) compact discs (CD); one (1) each for the Office of Project Controls and Performance Oversight (O-PC&PO), the Boston Construction Section Office, the District Construction Office and the Resident Engineer's Office. Additional copies shall be required if the work is performed in more than one district.
- b. two (2) hard copies plotted in color on 24" X 36" paper; one (1) copy each for the District Construction Office and the Resident Engineer's Office. No copies for the O-PC&PO and the Boston Construction Section Office. Additional copies shall be required if the work is performed in more than one district.

SECTION 722 (Continued)**A. Narratives**

A written narrative shall be submitted with every schedule submittal. The narrative shall:

1. itemize and describe the flow of work for all activities on the Critical Path in a format that includes any changes made to the schedule since the previous Contract Progress Schedule / Monthly Update or the Baseline Schedule, whichever is most recent;
2. provide a description of any specification requirements that are not being followed. Identify those that are improvements and those that are not considered to be meeting the requirements;
3. provide all references to any Notice of Delay that has been issued, within the time period of the Contract Progress Schedule Update, by letter to the Engineer. Note that any Notice of Delay that is not issued by letter will not be recognized by the Engineer. See Subsection 722.64.A - Notice of Delay;
4. provide a description of each third-party utility's planned vs. actual progress and note any that are trending late or are late per the durations and commitments as provided in the PUC Form; provide a description of the five (5) most important responses needed from the Department and the need date for the responses in order to maintain the current Schedule of Record;
5. provide a description of all critical issues that are not within the control of the Contractor or the Department (third party) and any impact they had or may have on the Critical Path;
6. provide a description of any possible considerations to improve the probability of completing the project early or on-time;
7. compare Early and Late Dates for activities on the Critical Path and describe reasons for changes in the top three (3) most critical paths ;
8. describe the Contractor's plan, approach, methodologies and resources to be employed for completing the various operations and elements of the Work for the top three (3) most critical paths. For update schedules, describe and propose changes to those plans and verify that a Proposal Schedule is not required;
9. describe, in general, the need for shifts that are not 5 days/week, 8 hours/day, the holidays that are inserted into each calendar and a tabulation of each calendar that has been used in the schedule;
10. describe any out-of-sequence logic and provide an explanation of why each out-of-sequence activity does not require a correction, if one has not been provided, and an adequate demonstration that these changes represent the basis of how these activities will be built, including considerations for resources, dependencies and previously-approved production rates;
11. identify any possible duration increases resulting from actual or anticipated unit price item quantity overruns as compared to the baseline duration, with a corresponding suggestion to mitigate any possible delays to the Critical Path. If the delay is anticipated to impact the Critical Path, refer to Subsections 4.06 - Increased or Decreased Contract Quantities and 8.10 - Determination and Extension of Contract Time for Completion and submit a letter to the Engineer notifying of a potential delay;
12. include a schedule log consisting of the name of the schedule, the data date and the date submitted.

SECTION 722 (Continued)**B. Bar Charts (Types A, B, C and D)**

One (1) time-scaled bar chart containing all activities shall be prepared and submitted using a scale that yields readable plots and that meets the requirements of Subsection 722.61 - Schedule Content and Preparation Requirements. Activities shall be linked by logic ties and shown on their Early Dates. Critical Paths shall be highlighted and Total Float shall be shown for all activities.

A second time-scaled bar chart shall also be prepared containing only the Critical Path or, if the Critical Path is not the longest path, the Longest Path using a scale that yields readable plots and that meets the requirements of Subsection 722.61 - Schedule Content and Preparation Requirements. Activities shall be linked by logic ties and shown on their Early Dates. Total Float shall be shown for all activities.

Bar Charts shall be printed in color and submitted on 11" X 17" paper or, if approved by the Engineer, as a .pdf file.

C. Detailed Activity Schedule Comparisons

A Detailed Activity Schedule Comparison (DASC) is a simple reporting tool in the format of a graphical report that will provide Resident Engineers with immediate, timely and up-to-date information. The DASC consists of an updated bar chart that overlays the current time period's bar chart onto the previous time period's bar chart for an easily-read comparison of progress during the present and previous reporting periods. The DASC shall be prepared and submitted in accordance with the instructions contained in the Construction Schedule Toolkit located on the MassDOT-Highway Division website at:

<http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/Construction/ConstructionScheduleToolkit.aspx>

The reports described in Subsections D, E and F below shall be submitted with all of the schedules listed in Subsection 722.20 - General:

D. Activity Cost Report and Monthly Cash Flow Projections (Type A only)

With each Contractor Quantity Estimate (CQE), the Contractor shall submit an Activity Cost Report and Cash Flow Projection that includes all activities grouped by Contract Bid Item.

The Activity Cost Report shall be generated from the Schedule of Record and shall be the basis of the Monthly Cash Flow Projection. Within each contract Bid Item, activities shall be sequenced by ascending activity identification number and shall show:

1. activity ID and description,
2. forecast start and finish dates for each activity and,
3. when submitted as a revised schedule, actual start and finish dates for each completed activity.

For Unit Price pay items, in addition to the above, estimates to complete and any variance to the estimated Contract quantity shall be shown.

E. Resource Graphs (Type A only)

Monthly and cumulative resource graphs for the remaining Contract period using the Early Dates and Late Dates in the Contract Progress Schedule shall be included as part of each schedule submittal.

SECTION 722 (Continued)**F. Projected Spending Reports (Types B, C and D)**

A Projected Spending Report (PSR) shall be prepared and submitted in accordance with the instructions listed at the end of this section. The PSR shall indicate the monthly spending (cash flow) projection for each month from NTP to Contractor Field Completion (CFC). Each month's actual spending shall be calculated using all CQEs paid during that month. If the difference between the Contractor's monthly projections vs. the actual spending is greater than 10%, the Contractor's monthly spending projection shall be revised and resubmitted within fifteen (15) Calendar Days.

The Projected Spending Report (PSR) shall be depicted in a tabular format and printed in color on 11 x 17-sized paper or larger as approved by the Engineer. For additional instructions and a template for preparing the Projected Spending Report (PSR), refer to the Contractor's Construction Schedule Toolkit located on the MassDOT-Highway Division website at:

<http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/Construction/ConstructionScheduleToolkit.aspx> or consult with the District Construction Scheduler.

722.63. Progress Schedule Requirements**A. Baseline Schedule**

The Baseline Schedule shall be due thirty (30) Calendar Days after Notice to Proceed (NTP.) The Baseline Schedule shall only reflect the Work awarded to the Contractor and shall not include any additional work involving Extra Work Orders or any other type of alleged delay. The Baseline Schedule shall be prepared and submitted in accordance with Subsections 722.61 - Schedule Content and Preparation Requirements and 722.62 - Submittal Requirements. Once the Baseline Schedule has been accepted by the Engineer, with or without comments, it shall represent the as-planned schedule for the Work and become the Contract Progress Schedule of Record until such time as the schedule is updated or revised under Subsections 722.63.C - Contract Progress Schedules / Monthly Updates, 722.64.C - Recovery Schedules and 722.64.D - Proposal Schedules.

The Cost and Resource-Loading information (Types A and B only) shall be provided by the Contractor within forty-five (45) Calendar Days after NTP.

The Engineer's review comments on the Baseline Schedule and the Contractor's responses to them will be maintained for the duration of the Contract and will be used by the Engineer to monitor the Contractor's work progress by comparing it to the Contract Progress Schedule / Monthly Update.

B. Interim Progress-Only Schedule Submissions

The first monthly update of the Contract Progress Schedule/Monthly Update is due within seventy (70) Calendar Days after Notice to Proceed (NTP.) The Baseline Schedule review period ends at sixty (60) Calendar Days after NTP, see Subsection 722.60.B - Schedule Reviews by the Department. If the Baseline Schedule has not been accepted within sixty (60) Calendar Days after NTP, an Interim Progress-Only Schedule shall be due within seventy (70) Calendar Days after NTP. The purpose of the Interim Progress-Only Schedule is to document the actual progress of all activities, including non-construction activities, from NTP until the Baseline Schedule is accepted.

SECTION 722 (Continued)**C. Contract Progress Schedules / Monthly Updates** (Types A, B, C and D)

The first Contract Progress Schedule shall be submitted by the Contractor no later than seventy (70) Calendar Days after NTP. The data date for this first Progress Schedule shall be sixty (60) Calendar Days after NTP. Subsequent Progress Schedules shall be submitted monthly.

Each Contract Progress Schedule shall reflect progress up to the data date. Updated progress shall be limited to as-built sequencing and as-built dates for completed and in-progress activities. As-built data shall include actual start dates, remaining Work Days and actual finish dates for each activity, but shall not change any activity descriptions, the Original Durations, or the Original Resources (as planned at the time of bid), without the acceptance of the Engineer. If any activities have been completed out-of-sequence, the Contractor shall propose new logic ties for affected in-progress and future activities that accurately reflect the previously-approved sequencing. Alternatively, the Contractor may submit to the Engineer for approval an explanation of why an out-of-sequence activity does not require a correction and an adequate demonstration that the changes accurately represent how the activities will be built, including considerations for resources, dependencies and previously approved production rates. Once approved by the Engineer, the Contractor may incorporate the changes in the next Contract Progress Schedule/Monthly Update with the affected activities clearly identified and explained in the Schedule Narrative.

No revisions to logic ties; sequence, description or duration of future activities; or planned resource costs shall be made without prior approval by the Engineer.

Any proposed logic changes for in-progress or future activities shall be submitted to the Engineer for approval before being incorporated into a Contract Progress Schedule. The logic changes must be submitted using a Proposal Schedule or a schedule fragment submission. Once approved by the Engineer, the Contractor may incorporate the logic in the next Contract Progress Schedule/Monthly Update with the affected activities clearly identified and explained in the Schedule Narrative.

For any proposed changes to the original sequence, description or duration of future activities, the Contractor shall submit to the Engineer for approval an explanation of how the proposed description or duration change reflects how the activity will be progressed, including considerations for resources and previously approved production rates. Any description or duration change that does not accurately reflect how the activity will be progressed will not be approved by the Engineer. Once approved by the Engineer, the Contractor may incorporate the changes in the next Contract Progress Schedule/Monthly Update with the affected activities clearly identified and explained in the Schedule Narrative.

Except as otherwise designated by a Contract Modification, no Contract Progress Schedule that extends performance beyond the Contract Time and/or beyond any Contract Milestone shall be approved by the Engineer. The Contractor shall submit a Recovery Schedule if any Contract Progress Schedule/Monthly Update indicates a failure to meet the Contract Dates.

D. Short-Term Construction Schedule

The Contractor shall provide a Short-Term Construction Schedule that details daily work activities, including any multiple shift work that the Contractor intends to conduct, in a bar chart format. The daily activities shall directly correspond to the Contract Progress Schedule activities, with a matching reference to the activity identification number in the Contract Progress Schedule, and may be at a greater level of detail.

SECTION 722 (Continued)

The Short-Term Construction Schedule shall be submitted every two weeks. It shall display all work for a thirty-five (35) Calendar Day period consisting of completed work for the two (2) week period prior and all planned work for the following three (3) week period. The initial submission shall be provided no later than thirty (30) Calendar Days after NTP or as required by the Engineer.

The Contractor shall be prepared to discuss the Short-Term Construction Schedule, in detail, with the Engineer in order to coordinate field inspection staff requirements, the schedule of work affecting abutters and any corresponding work with affected utilities. Short-Term Construction Schedules shall be prepared and submitted in accordance with Subsections 722.61 - Schedule Content and Preparation Requirements and 722.62 - Submittal Requirements.

Failure to submit Short-Term Construction Schedules every two (2) weeks may result in withholding of full or partial payments by the Engineer.

722.64 Impacted Schedule Requirements**A. Notice of Delay**

The Contractor shall notify the Engineer in writing, with copies to the District and State Construction Engineers, within three (3) Calendar Days of the start of any delays to the Critical Path that are caused by actions or inactions that were not within the control of the Contractor. Delay notifications that are not provided in a letter to the Engineer, such as a delay notification in the schedule narrative, will not be recognized as contractual notice in the determination of any Time Extension related to the impacts to the work associated with this specific alleged delay. Should such delay continue for more than one (1) week, the Contractor shall note it in the Schedule Narrative until the delay is no longer impacting the Critical Path for the completion of the Contract Milestones. The Engineer will evaluate the alleged delay and its impact and will respond to the Contractor within ten (10) Calendar Days after receipt of a notice of delay.

B. Time Entitlement Analysis

A Time Entitlement Analysis (TEA) shall consist of a descriptive narrative, prepared in accordance with Subsection 722.62.A - Narratives, and an as-built CPM schedule, which may be in the form of a schedule fragnet (that has been developed from the project's Contract Progress Schedule of Record, and illustrates the impact of a delay to the Critical Path, Contract Milestones and/or Contract Completion Date as required in Subsection 8.10 - Determination and Extension of Contract Time for Completion. TEAs shall also be used to determine the schedule impact of proposed Extra Work Orders (EWO) as also required in Subsection 8.10.

TEAs shall be prepared and submitted in accordance with the requirements of Subsections 722.61 - Schedule Content and Preparation Requirements and 722.62 - Submittal Requirements and shall be based on the Contract Progress Schedule of Record applicable at the start of the delay or impact from an EWO. A TEA fragnet must start with a specific new activity describing the work contained in either a Notice of Delay previously submitted to the Department per Subsection 722.64.A - Notice of Delay or an EWO.

SECTION 722 (Continued)

TEAs shall be submitted:

1. as part of any Extra Work Order that may impact Contract Time,
2. with a request for a Time Extension,
3. within fourteen (14) Calendar Days after a request for a TEA by the Engineer for any other reason.

A TEA shall be submitted to the Engineer before any Time Extension is granted to the Contractor. Time Extensions will not be granted unless the TEA accurately reflects an evaluation of all past delays and the actual events that occurred that impacted the Critical Path. The TEA must also demonstrate a plan for the efficient completion of all of the remaining work through an optimized CPM Schedule. The analysis shall include all delays, including Contractor-caused delays, and shall be subdivided into timeframes and causes of delays.

TEAs shall incorporate any proposed activities, logic ties, resource considerations, and activity costs required to most efficiently demonstrate the schedule impacts in addition to detailing all impacts to existing activities, logic ties, the Critical Path, Contract Milestones and the Contract Completion Date. In addition, TEAs shall accurately reflect any changes made to activities, logic ties, restraints and activity costs, necessitated by an Extra Work Order or other schedule impact, for the completion of the remaining work. The Contractor shall provide TEAs that demonstrate that all delays have been mitigated to the fullest extent possible without requiring an Equitable Adjustment to the original bid basis.

All TEAs shall clearly indicate any overtime hours, additional shifts and the resource that are proposed to be incorporated in the schedule. The Engineer shall have final discretion over the use of overtime hours and additional shifts. The Engineer shall have the right to require that overtime hours and/or additional shifts be used to minimize the duration of Time Extensions if it is determined to be in the best interest of the Department to do so.

When accepted, the changes included in a TEA shall be incorporated into the next Contract Progress Schedule per the requirements of Subsection 722.63.C - Contract Progress Schedules / Monthly Updates.

During the review of any TEA, all Contract Progress Schedules shall continue to be submitted as required.

The Engineer may request that the Contractor prepare a Proposal Schedule or a Recovery Schedule to further mitigate any delays that are shown in the accepted TEA/Contract Progress Schedule.

C. Recovery Schedules

The Contractor shall promptly report to the Engineer all schedule delays during the prosecution of the Work. Except as otherwise designated by a Contract Modification, no Contract Progress Schedule that extends performance beyond the Contract Time and/or beyond any Contract Milestone shall be approved by the Engineer. The Contractor shall submit a Recovery Schedule within fourteen (14) Calendar Days of a Contract Progress Schedule submission that shows failure to meet the Contract Dates. This requirement is critical to the Department's ability to make informed decisions regarding Contract Time and costs.

SECTION 722 (Continued)

During the prosecution of the Work, should the Contractor's progress on a critical operation clearly not meet anticipated production, without cause by fault of the Department, or should a critical activity or series of activities not be staffed in accordance with the Contractor's approved Baseline Schedule resource planning, the Contractor shall be obligated to recover such delay. Recovery Schedules shall be prepared and submitted in accordance with Subsections 722.61 - Schedule Content and Preparation Requirements and 722.62 - Submittal Requirements within fourteen (14) Calendar Days of any of the cases listed above.

Recovery Schedules shall clearly indicate any proposed overtime hours, additional shifts, and the resources that are proposed to be incorporated in to the schedule. The Engineer shall have final discretion over the use of overtime hours and additional shifts and shall have the right to require that overtime hours and/or additional shifts be used to minimize the duration of Time Extensions, without additional compensation for any Contractor delays, if it is determined to be in the best interest of the Department to do so.

During the review of any Recovery Schedule, all Contract Progress Schedules shall continue to be required every month.

The Engineer may request that the Contractor prepare a Recovery Schedule to further mitigate any delays that are shown in an accepted TEA/Contract Progress Schedule.

Changes represented in accepted Recovery Schedules shall be incorporated into the next Contract Progress Schedule.

D. Proposal Schedules

A Proposal Schedule is an alternative schedule used to evaluate proposed changes to the Contract scope or significant alternatives to previously approved approaches to complete the Work, which may include changes to activity durations, logic and sequence. For Types A and B Schedules, the Proposal Schedule shall be cost and resource-loaded.

A Proposal Schedule may be requested by the Department at any time or may be offered by the Contractor. The Engineer may request that the Contractor prepare a Proposal Schedule to further mitigate any delays that are shown in an accepted TEA/Contract Progress Schedule.

The Contractor shall submit the Proposal Schedule within thirty (30) Calendar Days of a request from the Department.

The Proposal Schedule shall not be considered a Schedule of Record until the logic, durations, narrative and basis of the Proposal Schedule have been accepted by the Engineer. If the Proposal Schedule took the form of a fragnet, it must be incorporated into the Contract Progress Schedule of Record showing the current progress of all other activities and the impacts/results of the changes made by the Proposal Schedule before the Proposal Schedule is accepted by the Department.

Proposal Schedules shall clearly indicate any proposed overtime hours, additional shifts, and the resources that are proposed to be incorporated in the schedule. The Engineer shall have final discretion over the use of overtime hours and additional shifts.

Changes represented in accepted Proposal Schedules shall be incorporated into the next Contract Progress Schedule. During the review of any Proposal Schedule, all Contract Progress Schedules shall continue to be required every month.

SECTION 722 (Continued)**E. Disputes (Types A, B, C and D)**

All schedules shall be submitted, reviewed, dispositioned and accepted in the timely manner specified herein so as to provide the greatest possible benefit to the execution of this Contract.

Any dispute concerning the acceptance of a schedule or any other question of fact arising under this subsection shall be determined by the Engineer. Pending resolution of any dispute, the last schedule accepted by the Engineer will remain the Contract Schedule of Record.

COMPENSATION**722.80 Method of Measurement and Basis of Payment** (Types A, B, C and D)

The Special Provisions will specify the fixed-price amount to be paid to the Contractor for the Project Schedule requirements contained herein. Each bidder shall include this lump-sum, fixed-price bid item amount in his/her bid. Failure to do so may be grounds for the rejection of the bid.

All required schedule-related work, including, but not limited to computers, computer software, the planning and coordination with utilities, training, schedule preparation and schedule submittals will be paid for under the fixed price amount.

This fixed price amount is for payment purposes only and is separate from what the Department considers to be the Contractor's General Condition costs. If the Contractor deems it necessary to include additional costs to provide all of the requirements of this section, these additional costs shall be included in the Contractor's overall bid price.

Twenty percent (20%) of this pay item will be paid upon the Engineer's acceptance of the Contractor's Baseline Schedule, prepared and submitted in accordance with Subsection 722.63.A.

The remaining eighty percent (80%) of this pay item will be paid in equal monthly installments distributed across the Contract Duration from Notice to Proceed (NTP) to Contractor Field Completion (CFC), less the 2 months required for the submittal and review of the Baseline Schedule in accordance with the following formula:

$$\text{Monthly Payment} = \frac{\text{Remaining Fixed Price amount (80\% of Item 100.)}}{\text{Contract Duration in whole months} - 2 \text{ months}}$$

The timely and accurate submission of the Baseline Schedule is critical to the Contract and the Department's ability to make informed decisions. Only payments under Item 740 - Engineer's Field Office and Item 748 - Mobilization will be made until the Baseline Schedule is accepted by the Engineer.

SECTION 722 (Continued)

No payment for any other pay item will be processed beyond seventy-five (75) Calendar Days from Notice to Proceed (NTP) until the Baseline Schedule is accepted by the Engineer. Until the Engineer's acceptance of the Baseline Schedule, the combined total of all payments made to the Contractor will be limited to an amount no greater than the total price for Item 748 - Mobilization or 3% of the contract price, whichever is less.

All Contract Progress Schedule Updates submitted later than ten (10) Calendar Days after the CQE (Contract Quantity Estimate) completion date, or greater than forty (40) Calendar Days from the Data Date of the previous submission, will be deemed to be no longer useful and will not qualify for payment. Late submittal of missed Contract Progress Monthly Updates will not result in recovery of the previously forfeited portion of the Schedule of Operations Fixed Price Payment Item.

Failure to submit schedules as and when required may result in the forfeiture of that portion of the Schedule of Operations Fixed Price Payment and/or the withholding of the full or partial CQE payments by the Engineer.

Failure to submit schedules that are acceptable to the Engineer may result in the forfeiture of that portion of the Schedule of Operations Fixed Price Payment and/or the withholding of the full or partial CQE payments by the Engineer.

The Schedule of Operations pay item will be adjusted to pay for only the actual quantity of schedules that have been submitted in accordance with this section.

The Contractor's failure or refusal to comply with the requirements of this Section shall be reasonable evidence that the Contractor is not prosecuting the Work with due diligence and may result in the withholding of full or partial payments by the Engineer.

Should there be a Time Extension granted to the Contractor, the Engineer may provide an Equitable Adjustment for additional Contract Progress Schedule Updates at intervals directed by the Engineer. Item 100. will be the basis for this Equitable Adjustment.

722.82 Payment Items

100. SCHEDULE OF OPERATIONS - FIXED PRICE \$ _____ LUMP SUM

BIDDERS LIST

Pursuant to the provisions of 49 CFR Part 26.11 all official bidders will be required to report the names, addresses and telephone numbers of all firms that submitted bids or quotes in connection with this project. Failure to comply with a written request for this information within 15 business days may result in a recommendation to the Prequalification Committee that prequalification status be suspended until the information is received.

The Department will survey all firms that have submitted bids or quotes during the previous year prior to setting the annual goal and shall request that each firm report its age and gross receipts for the year.

BUY AMERICA PROVISIONS (23 CFR 635.410)

(Supplementing Subsection 6.01 Source of Supply and Quality)

The Buy America Federal Regulation (23 CFR 635.410) requires that all manufacturing processes for steel and iron to be permanently incorporated in Federal-Aid Highway Construction Projects must occur in the United States. Foreign steel and iron can be used if the cost of the materials does not exceed 0.1% of the total Contract cost or \$2,500, whichever is greater. The action of applying a coating to a covered material (i.e., steel and iron) is deemed a manufacturing process subject to Buy America. Coating includes epoxy coating, galvanizing, painting and any other coating that protects or enhances the value of a material subject to requirements of Buy America.

CARGO PREFERENCE ACT

Work under this contract shall comply with the Cargo Preference Act of 1954 (CPA) and implementing regulations (46 CFR Part 381).

(b) Contractor and Subcontractor Clauses. Use of United States-flag vessels: The contractor agrees-

"(1) To utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material or commodities pursuant to this contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.

"(2) To furnish within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, 'on-board' commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (b) (1) of this section to both the Contracting Officer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590.

"(3) To insert the substance of the provisions of this clause in all subcontracts issued pursuant to this contract"

ARCHITECTURAL ACCESS BOARD TOLERANCES

The Contractor is hereby notified that they are ultimately responsible for constructing all project elements in strict compliance with the current AAB/ADA rules, regulations and standards.

All construction elements in this project associated with sidewalks, walkways, wheelchair ramps and curb cuts are controlled by 521CMR - Rules and Regulations of the Architectural Access Board (AAB).

The AAB Rules and Regulations specify maximum slopes and minimum dimensions required for construction acceptance. There is no tolerance allowed for slopes greater than the maximum slope nor for dimensions less than the minimum dimensions.

Contractors shall establish grade elevations at all wheel chair ramp locations, and shall set transition lengths according to the appropriate table in the Construction Standards (or to the details shown on the plans).

All wheelchair ramp joints and transition sections which define grade changes shall be formed, staked and checked prior to placing cement concrete. All grade changes are to be made at joints.

NOTICE TO OWNERS OF UTILITIES (Supplementing Subsection 7.13)

Written notice shall be given by the Contractor to all public service corporations or municipal and State officials owning or having charge of publicly or privately owned utilities of his intention to commence operations affecting such utilities at least one week in advance of the commencement of such operations. The Contractor shall, at the same time, file a copy of such notice with the Engineer.

The following are the names of owners of the principal utilities affected as well as other major contacts, but completeness of this list is not guaranteed:

Electric Company/ Pole Data*Concord:*

Concord Municipal Light Plant/Verizon
P.O. Box 1029
Contact: Tom Christensen

Concord, MA 01742
(978) 318-3112

Acton:

Eversource Electric
247 Station Drive, NWBED 180
Contact: Steven Owens

Westwood, MA 02090
(508) 441-5881

Gas Company*Concord & Acton:*

National Grid Gas
40 Sylvan Road, 3rd Floor, W3.244
Contact: Melissa Owens

Waltham, MA 02451
(781) 907-2845

Tennessee Gas Pipeline Company
8 Anngina Drive
Contact: David Wood

Enfield, CT 06082
(860) 763-6005

Telephone Company*Concord & Acton:*

Verizon
385 Myles Standish Blvd.
Contact: Karen Mealey

Taunton, MA 02780
(774) 409-3160

Water*Concord:*

Concord Water and Sewer Division
135 Keyes Road
Contact: Alan Cathcart

Concord, MA 01742
(978) 318-3250

Acton:

Acton Water District
P.O. Box 953
Contact: Chris Allen
Contact: Alan Cathcart

Acton, MA 01720
(978) 263-9107
(978) 318-3250

NOTICE TO OWNERS OF UTILITIES (Continued)

Sewer

Concord:

Concord Water and Sewer Division
135 Keyes Road
Contact: Alan Cathcart

Concord, MA 01742
(978) 318-3250

Acton:

Acton Health Dept.
472 Main Street
Contact: Doug Halley

Acton, MA 01720
(978) 264-9634

Railroad

Concord & Acton:

MBTA
100 Sumer Street – Suite 1200
Contact: Christine Bresnahan

Boston, MA 02110
(617) 222-3361

Cable

Concord & Acton:

Comcast Cable Corporation
676 Island Pond Road
Contact: Wendy Brown

Manchester, NH 03109
(603) 541-1082

Crown Castle
80 Central Street
Contact: Mark Bonanno

Boxborough, MA 01719
(508) 616-7818

MCI-Verizon Business
P.O. Box 600
Contact: Stephen Parretti

Charlton, MA 01507
(508) 248-1305

Acton:

AT&T/Teleport Communications
America, c/o Siena Engineering
50 Mall Road – Suite 203
Contact: Hayleigh Walker

Burlington, MA 01803
(781) 221-8400 x 7023

Eversource Fiber
247 Station Drive
Contact: Scott Sullivan

Westwood, MA 02090
(413) 624-5500

Fire Alarm

Acton:

Acton Fire Alarm
371 Main Street
Contact: Ken Ineson

Acton, MA 01720
(978) 264-9645

NOTICE TO OWNERS OF UTILITIES (Continued)

Department of Public Works

Concord:

Concord Engineering Division

133 Keyes Road

Contact: Bill Renault

Concord, MA 01742

(978) 318-3210

Acton:

Acton Town Engineer

472 Main Street

Contact: Corey York

Acton, MA 01720

(978) 929-6630

Other

Raytheon Company

880 Technology Park Drive, MS-T4051

Contact: Douglas Flynn

Billerica, MA 01821

(978) 436-8554

Concord Light Broadband

P.O. Box 1029

Contact: Mark Howell

Concord, MA 01742

(978) 318-3170

The following website lists the names and addresses of the utilities presumed to be affected, but the completeness of the list is not guaranteed: <http://www.massdot.state.ma.us/>

Select Quick Links

Select Doing Business with the Highway Division

Select Design/engineering

Select Utility Contacts

Select District

Select the City/Town, then locate the utility

Town officials are shown at website <http://www.mass.gov/dor/>. From the Main Menu Selection Box select “Local Officials”, then in the right margin under “Online Services” select “Local Officials Directory”. Enter the city/town on the left of the webpage and locate the official to contact.

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION FILE NUMBER SIGN

This project is subject to Massachusetts General Laws, Chapter 131, Section 40 as amended. Signs shall be in accordance with the latest MassDOT Construction Standards. All costs for the manufacture, erection, maintenance, moving, and removal of the signs shall be absorbed by the contractor with no additional compensation other than the contract unit prices.

For this project the Massachusetts Department of Environmental Protection File Number is **XXX-XX**.

NATIONAL GRID EMERGENCY TELEPHONE NUMBERS

GAS:

Emergency: 1-800-233-5325
New Service: 1- 877-696-4743
Customer Support: 1-800-732-3400

ELECTRIC:

Outage/ Emergency: 1-800-465-1212
New Service: 1-800-375-4730
Customer Support: 1-800-322-3223

EVERSOURCE EMERGENCY TELEPHONE NUMBERS

GAS:

Outage/ Emergency: 800-592-2000
New Service: 866-678-2744
Customer Support: 800-592-2000

ELECTRIC:

Outage/ Emergency: 800-592-2000 or 844-726-7562
New Service: 1-888-633-3797 (1-888-need pwr)
Customer Support: 1-800-340-9822

**GENERAL REQUIREMENTS FOR DEMOLITION AND
WORK INVOLVING PAINTED STEEL**

(01/14/2016)

Demolition and work involving painted steel shall conform to the requirements of Section 961 of the Supplemental Specifications dated July 1, 2015.

Work Involving Painted Steel.

Hazardous materials shall be removed in the immediate area of any intended welding, heating, saw cutting or burning of steel. Hazardous material removal is required to allow the demolition of structural steel, railings, drainage systems, utility supports, steel lamp posts, etc.

The contractor shall assume that the coatings on the steel contain lead (Pb), unless otherwise determined by testing. The contractor shall certify in writing to the Engineer the results of all testing, and shall also certify that any lead (Pb) coated steel removed from the project was not reused or buried, but was sent to a scrap metal recycling facility.

Implement and maintain programs and procedures, which comply with the requirements of this specification and all applicable standards and regulations. Comply with all applicable regulations even if the regulation is not specifically referenced herein. If a state or local regulation is more restrictive than the regulation of this specification, follow the more restrictive requirements.

This requirement is intended only for the demolition and preparation prior to repair and does not include provisions for recoating of steel.

Environmental

All applicable portions of Sections 961.65 “Worker Protection” and 961.66 “Environmental Protection and Monitoring” shall be followed when performing this work.

During chemical stripping a hand washing facility may be used in lieu of a decontamination/changing facility.

Hazardous material shall be collected during the disassembly and disposed of as outlined in Section 961.68 “Handling of Hazardous Waste and Reporting Release Programs”.

The applicable submittals shall be according to Section 961.69 “Submittals”.

GENERAL REQUIREMENTS FOR DEMOLITION AND WORK INVOLVING PAINTED STEEL (Continued)**Cleaning/Removal****Cutting Or Burning Of Steel**

All surfaces to be welded, heated, saw cut or burned shall be cleaned so as to remove all contaminants and/or hazardous materials, which could be discharged to the environment as a function of the subsequent operations.

Lead paint shall be removed in its entirety in an area prescribed by a 6 inch (15 cm) minimum offset from the required work. The paint removal operation may be dry abrasive blasting, wet abrasive blasting or chemical stripping.

Proper level of containment shall be used when performing this work in accordance with Section 961.67 "Containment". Full containment is not required during chemical stripping operation however; the Contractor shall install proper shielding and/or tarpaulins under the chemical stripping operations in order to catch all debris generated during this procedure. A cleaned area must be inspected and approved before the demolition operations are started.

During cleaning operations the Contractor shall be required to furnish and erect temporary floodlights illuminating the steel surface at a minimum of 30-foot candles. This lighting shall be used in areas where there is insufficient lighting for proper cleaning operations and inspection. The Contractor shall supply electrical power.

The Contractor shall provide support for interim and final inspection of the bridge during cleaning operations. This support shall include the necessary traffic controls and safe access to the work.

Mechanical Disassembly Of Steel

All surfaces to be mechanically disassembled by shear cutting or removing bolts or rivets shall not require deleading. When shear cutting or removing bolts or rivets, the Contractor shall not use any method that will cause dust and/or particles to be emitted and/or dispersed into the environment to an extent that would expose the workers above the Action Levels of $30\mu\text{g}/\text{m}^3$.

For purposes of limiting the lead (Pb) dust, the Contractor will be required to dampen the lead paint work areas.

The contractor shall install a proper shielding and/or tarpaulins under all lead-paint-coated surfaces to be shear cut or bolts or rivets ordered removed in order to catch any loose lead paint chips, dust or particles.

EMERALD ASH BORER ADVISORY

To the extent possible, all trees and brush shall be disposed on site, typically chipped and spread in place. When trees or brush must be removed, such as in urban, or otherwise populated areas, Contractor shall identify proposed location for disposal, and provide written notification to the Engineer for approval. Disposal shall be in city or town of project, or at minimum, within county, of construction operations.

NEW INTRODUCTIONS OF INVASIVE PLANTS INTO OR AROUND THE SITE

(Supplementing Subsections 7.01(D) Plant Pest Control and 7.13 Protection and Restoration of Property)

The Contractor shall ensure that no invasive plant species, as defined and listed by the Massachusetts Invasive Plant Advisory Group, are introduced or moved around the site by construction activities either by improperly cleaned construction equipment or importation of infected materials such as borrow, compost, nursery stock, seed, or hay bales. Corrective measures, if necessary, shall be made by the Contractor as directed by the Engineer. The Contractor shall be solely responsible for all costs associated with ensuring that invasive species are not introduced or moved around the site by construction activities and for all corrective measures required for as long as necessary to eliminate the introduced invasive plant species and prevent re-establishment of same. Item 102.33 includes compensation for site assessment to determine pre-construction presence of invasive plants. Item 102.3 includes compensation for control of invasive plants.

PAINTING - STRUCTURAL CERTIFICATION

All Contractors or Subcontractors performing lead based paint removal, containment and collection, surface preparation, or coating of structural steel must be pre-qualified by MassDOT in the Painting - Structural category.

NOTIFICATION OF FUNDING SOURCES FOR WORK TO BE PAID BY OTHERS

This contract has an agreement with the Towns of Acton and Concord; whereas when the construction costs for the contract scope exceed the total participating contract bid price by more than ten percent (10%), the Towns shall be responsible for the amount over 110% of the total participating contract bid price.

ITEM 102.3 CONTROL OF INVASIVE PLANTS EXISTING ON SITE HOUR

Work under this item consists of controlling invasive plants within the project limits. An Invasive Plant Management Strategy (IPMS) for their control shall be submitted to the Engineer for review and approval and the IPMS shall be implemented on site. The IPMS shall be measured and paid for under Item 102.33, Invasive Plant Management Strategy.

Work under this item shall be coordinated with work and schedule for Clearing and Grubbing, Selective Clearing, Mowing, Tree Removal and Planting items.

Payment is per hour on site and shall be compensation for a minimum crew of 2 licensed applicators, 2 back-pack sprayers and mist-blowers, a properly equipped spray truck with spray hoses, and a tank with sufficient capacity for a full day of work.

The overall intent is to improve the habitat value of the site, protect proposed landscape restoration, improve future maintenance operations, and attempt to prevent future spread both on-site and to adjacent sites.

Measures to prevent the introduction of invasive plant species to the site and to correct their introduction as a result of construction-related activities shall be covered under the Standard Specifications, Division I - Sections 7.01(D) Plant Pest Control and 7.13 Protection and Restoration of Property as amended in these Special Provisions.

Plant species targeted for management under this item shall be as determined in the field per the site walk and as specified in the IPMS. They shall include but are not limited to Bittersweet, Japanese Knotweed, Honeysuckle, Burning Bush, Rosa Multi-flora, Glossy Buckthorn and Norway Maple.

The definition of invasive plant species shall be as described by Massachusetts Invasive Plant Advisory Group (MIPAG): “non-native species that have spread into native or minimally managed plant systems in Massachusetts, causing economic or environmental harm by developing self-sustaining populations and becoming dominant and/or disruptive to those systems.”

Control of invasive plants shall begin immediately with the initiation of construction and continue for a minimum of two (2) growing seasons. Work shall be done during the growing season from May – October, with a preference for herbicide treatment towards the end of the growing season, unless otherwise specified in the IPMS.

The general expectation of treatment results is that there is no re-growth of targeted plant species at end of the first season unless otherwise addressed in the Invasive Plant Management Strategy.

Areas identified for vegetation control measures shall be as shown on the plans and as determined in the field by the Engineer and a MassDOT Landscape Architect. Contact at MassDOT Landscape Design Section is Stephanie Smoot at (857) 368 -9175.

ITEM 102.3 (Continued)**SUBMITTALS**

No work shall begin without approval of the submittals.

Within 15 business days prior to the site walk, the Contractor shall submit all qualifications to the Engineer.

Submittals include the following items.

Qualifications

Contractor shall submit company qualifications to MassDOT Landscape Design for review and approval.

1. Company must provide proof of qualifications by providing the following:
 - a. Narrative describing company, its expertise and experience with invasive plant control.
 - b. Demonstrate experience with herbicide treatment as part of restorations and in sensitive areas
 - c. Describe company's technical qualifications and past performance.
2. Company must meet licensing requirements:
 - a. All crew applicators must have a Massachusetts Commercial Applicator License (CORE).
 - b. At least one or more applicator must have ROW certification if required for specific project.
 - c. Company must provide name(s) of applicator(s) and Applicator License/Certification number for all contractor crew leaders working on the project.
 - d. Company must provide documentation of any warnings, penalties or fines received in the last three (3) years.
3. Company must provide proof of experience with invasive plant control and include following:
 - a. At least five (5) references from prior invasive plant control work completed in last five (5) years. Provide contact information including address, phone number and email.
 - b. Provide a summary of each of these projects including nature of the problem, specific invasive vegetation treated, dates and period of treatment, methodologies used, and summary of success or not in terms of meeting performance objectives. Include summary of equipment used.
 - c. Photo documentation of these projects.
 - d. GPS coordinates of project locations, if available.
4. Crew leader must have expertise with invasive plant control and provide the following:
 - a. Have held Core license for at least five (5) years.
 - b. Resume listing five (5) or more years of experience applying pesticides with the company or with another company specializing in vegetation management.

ITEM 102.3 (Continued)

The following companies are pre-approved by MassDOT Landscape Design Section:

Groundscapes Express, Inc.
P.O. Box 737
Wrentham, MA 02093
Contact: John Engwer
Phone: 508-384-7140

Native Habitat Restoration
P.O. Box 334
Stockbridge, MA 01262
Contact: Jess M. Toro : 413-358-7400
Sari Hoy: 413-394-0277

New England Environmental, Inc.
15 Research Drive
Amherst, MA 01002
Contact: Scott Fisher
Phone: 413-256-0202

Vegetation Control Service, Inc.
2342 Main St.
Athol, MA 01331
Contact: Andrew Powers
Phone: 800-323-7706

Chris Polatin
Polatin Ecological Services, LLC
Old Blake Farm
334 Mountain Road
Gill, MA 01351
Phone: 413-367-5292

Ted Elliman
New England Wild Flower Society
180 Hemenway Road
Framingham, MA 01701
508-877-7630 x 3203

Invasive Plant Management Strategy (IPMS)

At least thirty (30) days prior to proposed treatment the IPMS shall be submitted for approval by the Engineer and MassDOT Landscape Architect. All chemicals, methods and work shall be consistent with the IPMS. The IPMS shall be as described under Item 102.33.

Follow-Up Treatment

Depending on treatment results after the first year, the IPMS may be amended for the second year to address additional concerns or adjust to conditions. Treatment shall be adjusted accordingly.

Herbicide Use Report

Within two (2) weeks after each application, the Contractor shall provide to the Engineer a completed and signed MassDOT Herbicide Use Report (Document A00810). Where applicable, the Contractor shall provide the name/s of the associated water body/bodies affected by potential discharge, per the requirements of Sections 7.1 and 7.2 of the USEPA Pesticide General Permit for the Discharges from the Application of Pesticides.

ITEM 102.3 (Continued)

Photo Documentation

Digital photos with date and time stamp shall be provided with IPMS and follow-up reporting. Photos shall show existing conditions and post-treatment conditions.

MATERIALS

All proposed herbicides shall be as approved in the IPMS. Herbicides shall be labeled for the method of treatment and shall meet all federal, state and local regulation requirements. Application rates will depend on herbicide proposed and shall be per the manufacturer's label for specific application.

CONSTRUCTION METHODS

All methods used shall be as approved in the IPMS.

Prior to the start of any work, Contractor shall walk the site with the Engineer, Environmental Monitor and the MassDOT Landscape Architect. The purpose of the site inspection is to identify limits of work, mark locations of areas designated for treatment, and mark individual plants targeted for treatment or removal according to the IPMS. Contractor shall be responsible for marking delineated areas and plants to be preserved, removed, or otherwise treated. Fencing or other materials needed for marking and delineating protected areas shall be incidental to this item.

Herbicide Applications

All herbicide application shall conform to Massachusetts Pesticide Laws and Regulations per the Massachusetts Department of Agricultural Resources (MDAR) Pesticide Bureau.

Mixing, applying and/or disposing of herbicides shall always be in accordance with instructions on their labels and all applicable federal, state, and local regulations. Mixing shall not occur within sensitive areas, wetlands, or buffer zones.

Contractor shall not spray 2 hours prior to precipitation and during rain. The Contractor shall be responsible for monitoring weather conditions and adjusting the work schedule as appropriate for the herbicide and application method to be used.

Targeted vegetation shall be identified and marked prior to treatment. Plants treated by foliar spray, injection or glove application or other methods that leave standing vegetation, as opposed to cut-stump application, shall remain clearly marked for identification through the contract period.

Desirable vegetation shall be protected from both spray and other physical damage.

ITEM 102.3 (Continued)

Contractor is responsible for any damage to vegetation not designated for removal or treatment. Vegetation damaged shall be restored. Cost of replacement plants and/or restoration shall be borne by the Contractor.

Contractor shall ensure that the public does not enter a work area while herbicide application or spraying is underway.

Disposal of Invasive Plant Material

All material to be cleared shall become the property of the Contractor. The satisfactory disposal of all cleared plant material (seeds, roots, woody vegetation, associated soils, etc.) shall be the Contractor's responsibility.

The Contractor shall take measures to prevent viable plant material from leading to further infestations (seeds, roots, woody material, etc.) while stockpiled, in transit, or at final disposal locations. All precautions shall be taken to avoid contamination of natural landscapes with invasive plants or invasive plant material.

Chipping, shredding, or on-site burning of plant material shall not be permitted unless written approval is given as part of the Invasive Plant Management Strategy.

For plant material taken to an incinerating facility per the IPMS, a receipt from that facility shall be submitted to the Engineer as proof of disposal.

In some instances, it may be preferable to dispose of plants on site with on-going monitoring for re-sprouting. This may be used only if method and disposal locations have been approved in the IPMS. Site work such as grading and seeding to stabilize and restore disposal area shall be incidental to this item.

Contractor shall be responsible for treating areas of re-growth due to improper disposal.

MONITORING

After initial herbicide treatment, all treated plants and areas shall be monitored through visual observation and re-treated as necessary and appropriate throughout the season and for the duration of the contract per the management proposal and schedule for control submitted by Contractor. Monitoring shall be incidental paid for under Item 102.33, Invasive Plant Management Strategy.

METHOD OF MEASUREMENT

Control of invasive plants existing on site will be measured for payment by the hour of crew time spent on the project doing actual work. A crew shall be defined as a minimum of two licensed applicators each equipped with (at minimum) back-pack sprayer and mist blower. The crew shall also have a properly equipped spray truck with hoses and a tank with sufficient capacity for a full day of work.

ITEM 102.3 (Continued)

BASIS OF PAYMENT

Control of invasive plants existing on site will be paid at the Contract unit price per hour, which price shall include all labor, materials, equipment, and incidental costs required to complete the work.

Payment will be based upon time spent on the project doing actual work and shall not include travel time to and from the Contractor's place of business and shall also not include time for investigative field trips.

The Invasive Plant Management Strategy will be paid for under Item 102.33.

ITEM 102.33 **INVASIVE PLANT MANAGEMENT STRATEGY** **HOUR**

This item consists of providing an Invasive Plant Management Strategy (IPMS) for the control of invasive plants on the project site and shall be coordinated with Item 102.3 Control of Invasive Plants on Site. The IPMS shall be submitted to the Engineer for review and approval and the IPMS shall be implemented on site.

Invasive plant control treatment on site shall be as described under Item 102.3 Invasive Plant Control on Site and shall be compensated per that Item.

Work under this item shall be coordinated with work and schedule for Clearing and Grubbing, Selective Clearing, Mowing, Tree Removal and Planting items.

SUBMITTALS

Task Summary: for measurement of payment, the contractor shall submit the total sum and a breakdown of hours for the following tasks performed, which shall include at least: Site Walk/s, IPMS Written Reports, Site Monitoring if required, and Final Report if required.

ITEM 102.33 (Continued)**Invasive Plant Management Strategy (IPMS)**

Prior to the start of any invasive plant control treatment, submit in writing an IPMS proposal and Schedule of Control for approval by the Engineer, Environmental Monitor and MassDOT Landscape Architect at least thirty (30) days prior to proposed treatment. All chemicals and methods proposed shall be consistent with applicable Massachusetts Wetlands Protection Act Order of Conditions.

The IPMS shall include the following:

1. Description of treatment areas including identification of targeted invasive plant species, locations, approximate size of areas and digital photos with time/date stamp. Delineate treatment areas with polygons outlining their perimeter or locations of individual plants. A free-hand sketch drawn on construction plans or an aerial photo can be used to show locations.
2. Note coordination as required with items for clearing, clearing and grubbing, tree removal, mowing, planting, and wetland mitigation.
3. Proposed methods of treatment for each species or areas including manual removal, cutting, or herbicide treatment and proposed application rate.
4. If herbicides are proposed, submit product label including application methods and rates (entire MSDS information need not be submitted if available online).
5. Proposed time of treatment based on target plant species and construction schedule.
6. Method for disposing of invasive plant material including stems, trunks, branches, roots, associated soils, etc.
7. General monitoring schedule.
8. Preliminary re-treatment schedule. Re-treatment shall be based on assessment of initial results and time of year.
9. Proposed performance metrics, or measure of treatment success, which shall be agreed upon by MassDOT.
10. Expected end date of contract and last treatment.

Note: The IPMS is critical for identifying pre-construction conditions as well as strategies for minimizing import or spread of invasive plants. Failure to provide approved IPMS may jeopardize this item, in which case, the contractor will be responsible for control of invasive plants found on site at no cost to the contract.

ITEM 102.33 (Continued)**Follow-Up Treatment Schedule**

Depending on treatment results after the first year, the IPMS may be amended for the following year/s to address additional concerns or adjust to conditions. A follow-up treatment schedule shall follow the same format as outlined above and submitted to the Engineer and MassDOT Landscape Architect for approval at least thirty (30) days prior to proposed treatment.

Reporting

Within two (2) weeks after each application, the Contractor shall provide to the Engineer a completed and signed MassDOT Herbicide Use Report (Document A00810). Where applicable, the Contractor shall provide the name/s of the associated water body/bodies affected by potential discharge, per the requirements of Sections 7.1 and 7.2 of the USEPA Pesticide General Permit for the Discharges from the Application of Pesticides.

Final Report

A final report documenting status of invasive control at the end of the project may be required for regulatory purposes or for instances where control will be continued by other means. Report shall include photo documentation, notation on a plan or aerial image of area treated, summary of treatment performed, and control achieved.

Photo Documentation

Digital photos with date and time stamp shall be provided with IPMS and follow-up reporting.

METHOD OF MEASUREMENT

Invasive plant management strategy will be measured for payment by the hour. The basis for measurement shall be per the completion of tasks as approved under the Task Summary submittal.

BASIS OF PAYMENT

Invasive plant management strategy 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.

Payment shall not include travel time to and from the Contractor's place of business.

ITEM 102.51
ITEM 102.52

INDIVIDUAL TREE PROTECTION
TEMPORARY TREE PROTECTION FENCE

EACH
FOOT

The work under these items shall conform to the relevant provisions of Sections 101, 644 and 771 and the following:

The purpose of these items is to prevent damage to branches, stems and root systems of existing individual trees as well as shrubs and other quality vegetation to remain, and to ensure their survival. 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 or where directed, the Contractor shall take the appropriate protective measures specified herein.

Individual Tree Protection, Item 102.51, shall be used when construction activities are likely to occur within the canopy of individual trees or where there may be any risk of damage to trees.

Temporary Tree Protection Fence, Item 102.52, shall be used to protect areas of existing trees or other areas of quality vegetation that is to remain.

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.

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.

Prior to any construction activities, the Contractor and Arborist shall walk the site with the Engineer and Town Tree Warden to identify which trees will require protection and to determine approved measures. The Arborist shall make recommendations as to appropriate methods to protect the trees. The Engineer will have final decision as to trees 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.

ITEM 102.51 and 102.52 (Continued)**Submittals**

Incidental to this item, the Contractor shall provide to the Engineer one (1) copy 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 lumber 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 cladding, at least 8 feet in length, clad together with wire. Alternative materials shall be at the approval of the Engineer. Alternative materials shall provide adequate protection from anticipated construction activities and shall not injure or scar trunk. Trunk protection shall include burlap to separate trunk cladding from bark.

Temporary Tree Protection Fence shall be brightly colored polypropylene barricade or wooden snow fencing for tree protection or safety fencing as shown on the Contract drawings or as directed by the Engineer. Fencing shall be a minimum of 4 feet high and supported by steel or hardwood stakes spaced at a maximum of 8 feet on center or by other means acceptable to the Engineer. Fencing shall be materials and fastenings sufficient to provide sturdy and highly visible separation of the construction activities from the trees and existing plantings to be preserved

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.

ITEM 102.51 and 102.52 (Continued)

For individual tree protection, the Contractor shall set posts and fencing at the limits of the tree canopy. 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 cladding. Cladding for tree trunks shall extend from the base of the tree to at least 8 feet from the base.

To the extent possible, temporary landscaped fencing shall be installed at the limit of tree canopy and shall be staked and maintained vertical for the length of the contract.

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 mechanical equipment that might damage the existing root systems.

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 off site by the Contractor at no additional cost.

ITEM 102.51 and 102.52 (Continued)**Tree Damage**

The Contractor shall be held responsible for the health and survival of the existing trees in the immediate vicinity of the 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.

COMPENSATION

Where the plans show specific, individual trees to remain and where grading or other disturbance is shown within the drip line of these trees or where the Engineer determines that an individual tree must be protected, these trees shall be protected and paid for under Item 102.51 Individual Tree Protection per each tree protected.

Temporary tree protection fence will be measured for payment by the foot of fence installed, complete in place.

Payment under these items 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.

Compensation for Individual Tree Protection will be paid for at the contract unit price per each under Item 102.51. This item 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, and the subsequent removal and satisfactory disposal of the protective materials upon completion of the contract.

Where construction disturbance, such as grading activities, will occur within the limits of the canopy of groups of trees, these trees shall be protected and paid for under Item 102.52, Temporary Tree Protection Fence.

Temporary tree protection fence will be paid for at the Contract unit price per foot. This item 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, and the subsequent removal and satisfactory disposal of the protective materials upon completion of the contract.

Cost of wood chips, as required, shall be incidental to these items.

ITEM 114.1**DEMOLITION OF SUPERSTRUCTURE OF
BRIDGE NO. C-19-037****LUMP SUM**

The work to be done under this item shall conform to the relevant provisions of Section 112 Demolition of Buildings, Structures and Bridges of the Standard Specifications for Highways and Bridges and the following:

The work shall consist of the removal and satisfactory disposal of the existing steel girder bridge including structural steel girders, structural steel diaphragms, and bearings. Removal of the existing railroad track steel rails and existing wood timber railroad ties are paid for separately under Item 129.5 – Track Excavation and Item 184.1 – Disposal of Treated Wood Products, respectively.

The Contractor shall protect Nashoba Brook from falling debris during demolition activities and shall provide shielding, tarps, etc. as necessary to perform the work. Any such shielding shall be considered incidental to this Item and no separate payment is included for this protection. All materials removed under this demolition Item shall become the property of the Contractor and shall be recycled, reused, or disposed of in accordance with all applicable Local, State, and Federal requirements.

The Contractor shall submit its proposed method of demolition including equipment, tools, devices, protection methods, etc. to the Engineer for approval. The demolition procedure and any necessary calculations and drawings shall bear the stamp of a Professional Engineer Registered in the Commonwealth of Massachusetts certifying that all existing structural members are suitably braced and supported throughout the demolition process. Work shall not commence until the Engineer has given written approval of the method of demolition.

The Contractor shall also submit the crane capacity, location, radii of movement, etc. to the Engineer for approval. The submittal will specify that the requirements for equipment and all procedures utilized will be in conformance with the intent of Subsection 960.61, Steel Erection, of the Supplemental Specifications. The submittal shall include drawings and calculations of all loads and selection of crane and lifting hardware and shall be stamped by a Professional Engineer Registered in the Commonwealth of Massachusetts.

MassDOT does not guarantee or represent that the bridge materials will actually coincide with any descriptions contained herein or represented on the Plans. The Contractor must satisfy them self by their own investigation and research regarding all conditions and materials affecting the work to be done. No additional compensation, other than the Lump Sum Price Bid for this Item, shall be made if the materials or work proves to be different from that inferred or described herein, or shown on any Plans. Plans of the existing structure do not exist.

ITEM 114.1 (Continued)**COMPENSATION**

Demolition of Superstructure of Bridge No. C-19-037 will be paid for at the Contract unit price per lump sum, which price shall include all labor, materials, equipment, and incidental costs required to complete the work.

The contractor will make their own investigation of the structure to be demolished including the materials that are part of, or may be stored in the structure. No increase will be made to the bid price due to the nature of the materials involved in the demolition. All costs for permits, dump fees, taxes, special handling of hazardous materials, etcetera, shall be included in the bid price of the demolition item.

ITEM 129.5**TRACK EXCAVATION****FOOT**

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

The work shall consist of the dismantling and removal of the existing railroad track steel rails, switch components, joint bars, plates, bolts, anchors, spikes, relay equipment, and wood ties as shown on the plans. The track steel rails, switch components, joint bars, plates, bolts, anchors, spikes, relay equipment, and wood ties shall be sorted and stacked at an accessible location adjacent to the roadway or location convenient for loading and transport.

All steel rails, switch components, joint bars, plates, bolts, anchors, and spikes, (hereafter referred to as "OTM" – Other Track Material) shall remain the property of MassDOT Rail Division and shall be removed from the track in the following manner:

Rails to be removed must be disconnected from adjacent rail segments at the joint bars and removed as whole (33') segments. Care shall be taken not to damage the rails and no cutting of the solid rail is allowed. Switch components are to be kept together and each switch shipped as a unit. Bolts at the joints shall be carefully torch cut and the joint bars knocked off with a sledge hammer. Extreme care shall be taken not to damage the joint bars. All anchors shall be knocked off and all spikes shall be pulled. All scrap OTM such as bolt scraps, anchors and spikes shall be accounted for, picked up and placed in a scrap bin for transport. The individual rails shall be lifted from the ties, sorted by size, and prepared for transport. All joint bars and tie plates shall be accounted for, picked up and palletized. 25 pairs of joint bars to a pallet and 160 tie plates to a pallet and each pallet clearly marked and shrink wrapped. Any damaged joint bars and tie plates will be placed in the scrap bin. Care shall be taken not to damage the rails.

The disposal of creosote wood ties shall be in accordance with and paid for under Item 184.1 Disposal of Treated Wood Products.

The removal and disposal of all other materials related to the railroad facilities shall be in accordance with and paid for under Item 120.1 Unclassified Excavation.

ITEM 129.5 (Continued)**Submittals**

The Contractor shall submit or review and approval the methods and equipment proposed for removal of the track steel rails and switch components.

COMPENSATION

Track excavation will be measured for payment by the foot along the centerline of the track bed and shall include both rails and all associated hardware.

Track excavation will be paid for at the Contract unit bid price per foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

<u>ITEM 129.7</u>	<u>HANDLING AND TRANSPORTATION OF RAIL COMPONENTS</u>	<u>FOOT</u>
<u>ITEM 129.71</u>	<u>HANDLING AND TRANSPORTATION OF OTHER</u>	<u>TON</u>
	<u>TRACK MATERIALS</u>	

The work under this item shall conform to the relevant provisions of Sections 112 of the Standard Specifications and the following:

The work shall consist of the loading, transporting, unloading and stockpiling of the existing steel railroad track materials excavated and stacked under Item 129.5 Track Excavation. The Contractor shall contact Ms. Chalita Belfield, MassDOT Rail Division at 857-368-8957 to coordinate the delivery of the rail, switches, and associated steel components (joint bars, bolts, spikes, plates, and anchors). The rail will be delivered to two storage locations – Mansfield, MA and Walpole, MA while the switches and all the associated steel components (joint bars, bolts, spikes, plates, and anchors hereafter referred to as “OTM” – Other Track Material) will be delivered to Walpole, MA.

All steel rails, switches, and OTM (joint bars, bolts, anchors, plates and spikes), shall **remain the property of MassDOT Rail Division and once removed from the track and stacked, shall be sorted and prepped for transport in the following manner:**

Care should be taken not to damage the rail. Rails of the same size shall be loaded and transported together whenever possible. There are four known sizes of rail in this project – 132lb, 115lb, 107lb, and 85lb. **As it is not known what quantity of each rail size presently exists on site, for bidding purposes, bidders should assume that all rail will be transported to Mansfield, MA.**

Care should be taken not to damage any switches. All switch components for each switch removed shall be accounted for and kept together. Each switch is to be shipped as a unit.

Care should be taken not to damage the joint bars. All joint bars and tie plates shall be accounted for, picked up and palletized. 25 pairs of joint bars to a pallet and 160 tie plates to a pallet and each pallet clearly marked and shrink wrapped in preparation for transport.

ITEM 129.7 and 129.71 (Continued)

All remaining OTM such as bolt scraps, anchors and spikes shall be picked up and placed in a scrap bins or dumpsters in preparation for transport. Any damaged joint bars and tie plates will be placed in the scrap bin.

All Rail shall be transported to, unloaded at, and neatly stacked at either of the two following locations (the decision as to which location each truckload of rail will go to shall be made by the MassDOT Rail Division Representative):

The Town of Mansfield, MA – Mansfield Yard - 514 No. Main Street, Mansfield, MA 02048.

The Town of Walpole, MA – Walpole Yard - 275 West Street, Walpole, MA 02081.

Rails are to be unloaded and neatly stacked together and upright on used railroad ties, or 4" x4" dunnage spaced at the mid and quarter points of the rail at a location within the yard as directed by MassDOT Rail Division personnel. Like size rails shall be grouped and stacked together. For inventory purposes, the stockpile of rail for Project 2C shall be kept separate from the other existing stockpiles of rail and spray painted a distinct color (not to be orange) on one end.

All switches and OTM shall be transported to, unloaded at, and neatly stacked as designated by the MassDOT Rail Division Representative at the following location:

The Town of Walpole, MA – Walpole Yard - 275 West Street, Walpole, MA 02081.

All scrap OTM, palletized joint bars, palletized tie plates, and rail less than 107 lbs. will be delivered to this location. Scrap OTM and rail shall be loaded into the scrap dumpster on site.

COMPENSATION

Handling and transportation of rail components will be measured for payment by the foot of rail loaded, transported, unloaded and neatly stacked at the designated MassDOT yard.

Handling and transportation of rail components will be paid for at the Contract unit price per foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

Handling and transportation of other track materials will be measured for payment by the ton of OTM loaded, transported and unloaded, neatly stacked at the designated MassDOT yard.

Handling and transportation of other track materials will be paid for at the Contract unit price per ton, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

Railroad Ties or Timbers are not classified as OTM.

ITEM 180.01 ENVIRONMENTAL HEALTH AND SAFETY PROGRAM LUMP SUM

The work shall consist of ensuring the health and safety of the Contractor's employees and subcontracting personnel, the Engineer, their representatives, the environment, and public welfare from any on-site chemical contamination present in air, soil, water and sediment.

The Contractor shall prepare and implement a site-specific Environmental Health and Safety Plan (EHASP) which has been approved and stamped by a Certified Industrial Hygienist (CIH) and includes the preparer's name and work experience. The EHASP shall include appropriate components required by OSHA Standard 29 CFR 1910.120(b) and the Massachusetts Contingency plan (MCP) 310 CMR 40.0018 and must comply with all applicable state and federal laws, regulations, standards and guidelines, and provide a degree of protection and training appropriate for implementation on the project. The EHASP shall be a dynamic document with provision 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. The EHASP shall be developed and implemented independently from the standard construction HASP required to work on all MassDOT construction projects.

Health and safety procedures provided by the Contractor shall comply with all the appropriate regulations that address employee working conditions, including but not limited to standards established by OSHA and National Institute for Occupational Safety and Health (NIOSH). Equipment used for the purpose of health and safety shall be approved by and meet pertinent standards and specifications of the appropriate regulatory agencies.

A copy of the most up-to-date version of the EHASP shall be maintained on-site at all times by the Contractor. The on-site copy shall contain the signature of the Engineer and each on-site employee of the MassDOT, Contractor, and Subcontractors involved with on-site activities. The employee's signature on the EHASP shall be deemed prima facie evidence that the employee has read and understands the plan. Updated copies of signature sheets shall be submitted to the Engineer.

The EHASP shall specify a Contractor Site Safety and Health Officer responsible for implementation of the EHASP and to oversee all construction activities, including handling, storage, sampling and transport, which require contact with or exposure to potentially hazardous materials.

The level of protection, required to ensure the health and safety of on-site personnel will be stipulated in the EHASP. The Site Safety and Health Officer shall implement the EHASP based on changing site and weather conditions, type of operation or activity, chemical compounds identified on-site, concentration of the chemicals, air monitoring data, physical state of the hazardous materials, potential duration of exposure to hazardous materials, dexterity required to perform work, decontamination procedures, necessary personnel and type of equipment to be utilized.

ITEM 180.01 (Continued)

During implementation of the EHASP, a daily log shall be kept by the Site Safety and Health Officer and a copy shall be provided weekly to the Engineer. This log shall be used to record a description of the weather conditions, levels of personal protection being employed, screening data and any other information relevant to on-site environmental safety conditions. The Site Safety and Health Officer shall sign and date the daily log.

Method of Measurement and Basis of Payment

Preparation and implementation of the Environmental Health and Safety Program, including the monitoring, protection and storage of all contaminated materials, as well as subsequent modifications to the EHASP, will be measured and paid for at the Lump Sum Bid Price.

Payment of 50% of the Environmental Health and Safety Program contract price will be made upon the initial acceptance of the EHASP by the Engineer. Payment of the remaining 50% of the Environmental Health and Safety Program contract price will be made upon completion of the work. The bid price shall include preparation and implementation of the EHASP as well as the cost for its enforcement by the Site Safety and Health Officer along with any necessary revisions and updates. The work of implementing the Environmental Health and Safety Program includes work involving, but not limited to, the monitoring, protection, and storage of all contaminated materials.

ITEM 180.02 **PERSONAL PROTECTION LEVEL C UPGRADE** **HOUR**

The work shall consist of providing appropriate personal protective equipment (PPE) for all personnel in an area either containing or suspected of containing a hazardous environment.

Contingencies for upgrading the level of protection for on-site workers will be identified in the EHASP and the Contractor shall have the capability to implement the personal protection upgrade in a timely manner. The protective equipment and its use shall be in compliance with the EHASP and all appropriate regulations and/or standards for employee working conditions.

Personal Protection Level C Upgrade will be measured and paid only upon upgrade to Level C and will be at the contract unit price, per hour, per worker, required in Level C personal protection. No payment will be made to the Contractor to provide Level D PPE.

ITEM 180.03**LICENSED SITE PROFESSIONAL SERVICES****HOUR**

Within limited areas of the project site, soils, sediments and/or groundwater may be contaminated. A Licensed Site Professional (LSP) shall be required to provide the services necessary to comply with the requirements of the MCP. These services may include sampling, analysis and characterization of potentially contaminated media, preparation of Immediate Response Action (IRA) Plans, Utility-Related Abatement Measure (URAM) and Release Abatement Measure (RAM) Plans, Imminent Hazard Evaluations, status reports, transmittal forms, release notification forms, risk assessments, completion statements, and related documents required pursuant to the Massachusetts Contingency Plan (MCP). LSP hours related to the characterization and disposal of contaminated soil and/or sediment are incidental to the disposal items. An estimate of LSP services to be provided shall be submitted to the Engineer for approval before any LSP activity begins.

The name and qualifications of the LSP and all environmental technicians to be assigned to the project shall be submitted to the Engineer for approval at least four weeks prior to initial site activities. The LSP shall have a current, valid license issued by the Massachusetts Board of Registration of Hazardous Waste Site Cleanup Professionals. The LSP shall have significant experience in the oversight of MCP activities at active construction sites. Qualification packages for the LSP and each technician shall include a resume, all recent work assignments with responsibilities identified (previous 5 years), and applicable training and certifications. A list of all Notices of Noncompliance, Notice of Audit Findings and Enforcement Orders issued by the DEP shall be submitted for all work assignments listed for the LSP and environmental technicians.

The LSP shall evaluate soil and/or sediment with discoloration, odor, and presence of petroleum liquid or sheening on the groundwater surface, or any abnormal gas or materials in the ground which are known or suspected to be oil or hazardous materials. Excavated soil and sediment which is suspected of petroleum contamination shall be field screened using the jar headspace procedures according to established DEP Guidance. All field screening equipment must be pre-approved by the Engineer. The LSP shall ensure proper on site calibration of all field screening instrumentation.

The Engineer shall be contacted immediately when observations or any field screening results verify contamination requiring further analysis, and/or enhanced management of suspect soil and/or sediment. Any enhanced management of contaminated soil to ensure proper stockpiling and storage is incidental to the LSP Services item. The LSP shall adequately characterize subsurface conditions prior to backfill in areas where contaminated material has been excavated. The Engineer shall approve the locations of the testing sites prior to the sampling.

ITEM 180.03 (Continued)

Contaminated soil, sediment and/or groundwater shall be handled in accordance with all applicable state and federal statutes, regulations and policies. The LSP shall adequately characterize contaminated media for comparison to the requirements of the MCP. The Contractor and the LSP shall be aware of the reporting requirements for releases of oil and/or other hazardous material (OHM) as set forth in federal and state laws and regulations, and shall both be held responsible for performing the work in accordance with all applicable Federal and State laws and regulations. The LSP shall maintain written records in a clear and concise format which tracks the excavation, stockpiling, analysis and reuse/disposal of all suspect contaminated soils, sediments and groundwater. These records shall be up-to-date and available to the Engineer on a bi-weekly basis. The LSP shall review and summarize the laboratory data from any analyses performed on contaminated media. A report shall be delivered to the Engineer outlining the material sampling methods, laboratory analysis results and proposed course of action. The laboratory report together with Chain of Custody forms for all analytical results shall be submitted to the Engineer within 14 days after completion of such analyses.

The LSP and Contractor shall be held responsible for the submission of all MCP-related documents to the Engineer at least 14 days in advance of any timeframe specified in the MCP and for the timely submission of data and tracking information as noted within this Item. All documents prepared under this Item must be reviewed and signed by the approved LSP. The Contractor and LSP shall be responsible for all fines, penalties and enforcement requirements imposed by applicable regulatory agencies for failure to meet regulatory and contract timeframes. No compensation will be provided for such fines, penalties and enforcement actions.

The Contractor and the LSP shall be aware of the reporting requirements for releases of oil and/or other hazardous material (OHM) as set forth in federal and state laws and regulations, and shall both be held responsible for performing the work in accordance with all applicable Federal and State laws and regulations.

If the Contractor causes a release of OHM, the Contractor shall be responsible for assessing and remediating the release in accordance with all pertinent State and Federal regulations, including securing the services of a LSP, at his own expense.

The LSP shall coordinate all activities involving both MassDOT and the DEP through the Engineer. Any notification of release shall be approved by the Department before submittal to the DEP, except if an imminent hazard condition exists as defined in 309 CMR 4.03(4)(b).

ITEM 180.03 (Continued)**Laboratory Testing in Support of LSP Services**

Laboratory testing provides for analytical testing in support of LSP services related to maintaining MCP compliance, such as delineating the extent and type of contamination present. Sampling and testing for disposal purposes are not included.

In order to maintain compliance with the MCP or other regulatory requirements, the LSP shall request approval from the Engineer to obtain samples from various locations and depths within the project area and to perform laboratory analyses on those samples. The samples shall be delivered to a DEP-certified laboratory using proper chain-of-custody documentation for analyses which, depending upon site conditions and suspected and/or identified contaminants of concern, may include, but are not limited to, metals, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polycyclic aromatic hydrocarbons (PAHs), extractable petroleum hydrocarbons (EPHs) and volatile petroleum hydrocarbons (VPHs). Subsequent testing, depending upon initial results, may be required for Toxicity Characteristic Leaching Procedure (TCLP) analyses (EPA Method 1311) for metals.

Method of Measurement and Basis of Payment

LSP Services for work under this item will be measured per person, per hour of service provided by LSP, Environmental Technicians and other approved personnel. Travel time shall not be included in the billable hours. LSP hours related to soil/sediment disposal (disposal characterization, landfill acceptance, disposal package preparation, etc.) shall be incidental to disposal items.

The quantity and type of laboratory tests must be approved by the Engineer beforehand. The contractor will be reimbursed upon satisfactory written evidence of payment. The contractor may be required to obtain cost estimates from three DEP certified laboratories for the Engineer to choose the service provider. Laboratory testing related to soil/sediment disposal (disposal characterization, landfill acceptance, disposal package preparation, etc.) shall be incidental to disposal items.

LSP Services will be paid at the Contractor bid price for each hour, or fraction thereof, spent to perform the work as described above. The bid price shall be a blended rate that includes the cost of the LSP, environmental technicians and other personnel, the performance of all work tasks and field screening, including required equipment, materials and instrumentation, and production of all documentation described above. All requests for payment must be accompanied by the following information: the names of the personnel associated with the work charged under LSP Services, dates and hours worked, work conducted, including, where appropriate, locations as identified on the construction plans, and a copy of the field diary for the dates submitted.

Laboratory Testing will be reimbursed upon receipt of paid invoices for testing approved by the Engineer.

<u>ITEM 181.11</u>	<u>DISPOSAL OF UNREGULATED SOIL</u>	<u>TON</u>
<u>ITEM 181.12</u>	<u>DISPOSAL OF REGULATED SOIL - IN-STATE FACILITY</u>	<u>TON</u>
<u>ITEM 181.13</u>	<u>DISPOSAL OF REGULATED SOIL - OUT-OF-STATE FACILITY</u>	<u>TON</u>
<u>ITEM 181.14</u>	<u>DISPOSAL OF HAZARDOUS WASTE</u>	<u>TON</u>

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 purposes of this specification. 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 disposal facility (ies) 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 shall 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 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 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:

ITEMS 181.11 through 181.14 (Continued)

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 (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 location for unregulated soils for approval. If such a disposal location 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 location that they have 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.

ITEMS 181.11 through 181.14 (Continued)

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/permitted 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 30.000, Toxic Substances Control Act (TSCA) regulations, or the equivalent 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 Item 180.03 – LSP Services. 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.

ITEMS 181.11 through 181.14 (Continued)

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.

WASTE TRACKING:

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 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 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.

ITEMS 181.11 through 181.14 (Continued)**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 DEP, the U.S. Environmental Protection Agency (EPA), 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 shall apply. 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 program. 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.

ITEMS 181.11 through 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.

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.

Disposal and Recycling Facilities:

1. Provide the name, address, applicable licenses and approved waste profile for disposal and/or 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.

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.

III. Material Tracking and Analytical Documentation for Reuse/Disposal.

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.

ITEMS 181.11 through 181.14 (Continued)

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.

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.

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 off-site using the same categories identified for demolition debris above.

Method of Measurement and Basis of Payment

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. The work of the LSP for disposal under all of these items shall be incidental to the work with no additional compensation.

ITEM 181.11 Measurement for Disposal of Unregulated Soil shall be under the Contract Unit Price by the weight, in tons, 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 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.

ITEMS 181.11 through 181.14 (Continued)

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 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 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 183.1 **TREATMENT OF CONTAMINATED GROUNDWATER** **GALLON**

This Item addresses the treatment and disposal of contaminated groundwater encountered during excavation operations. The work generally consists of furnishing the materials, equipment, labor, services, testing/sampling, waste characterization, transportation, disposal, permits and agreements necessary to perform the work required for the collection, treatment and disposal of contaminated groundwater.

The Contractor is advised that contaminated groundwater may be encountered during dewatering activities. The levels and nature of contamination may vary depending on location and/or depth. No data has been provided in this specification indicating the types of contaminants that may be found in groundwater encountered during this work. It will be the responsibility of the Contractor to ensure that water removed during dewatering operations is treated and disposed of in accordance with all applicable laws and regulations and in accordance with this specification.

The Contractor shall monitor the quantity of groundwater collected for treatment using an in-line totalizer flowmeter or an alternate method approved by MassDOT. The Contractor shall, at all times, minimize the quantity of groundwater removed from the excavations. All groundwater determined to be contaminated will be managed in accordance with all applicable local, state and federal regulations.

It is not the intent herein for the Department to design for or specify to the Contractor which particular treatment is to be used, if necessary. Rather, it is the Department's intent to provide guidance to the Contractor for informational and bidding purposes only. It is, therefore, the Contractor's responsibility to use a treatment method to allow him/her to meet any and all laws, regulations, policies, guidelines and permit requirements. Treatment of contaminated groundwater for dewatering operations is generally performed using a mobile treatment trailer equipped with one or more granular-activated carbon (GAC) canisters, although other techniques are also used.

ITEM 183.1 (Continued)

It is likely that treatment of the contaminated groundwater using granular-activated carbon will be required to complete the work under this Contract. The Methods described under Item 183.1 provides for the identification, testing, management and treatment or disposal of contaminated groundwater and shall be implemented, at a minimum and as necessary by the Contractor via Methods under Item 183.1.

The overall handling and management of contaminated groundwater is regulated under the provisions of 310 CMR 40.0000, 314 CMR 3.00 and 5.00, NPDES and other applicable laws. The unpermitted discharge of contaminated dewatering effluent into the environment (storm drain, surface water body, onto the ground) is a violation of federal and state laws and regulations. Should dewatering of contaminated groundwater be necessary, approvals must be sought from the appropriate federal, state, or local regulatory jurisdiction. The USEPA will not specify a treatment system or method, but normally requires that the treated discharge meet Massachusetts Drinking Water Standards.

The discharge standards are normally met by treating the dewatered groundwater through granular-activated carbon canisters, or similar techniques. Longer term discharges to surface waters or storm drains, and any discharges to the ground, require approval and/or issuance of a permit from the DEP Division of Water Pollution Control. The Contractor shall be responsible for applying for, paying all fees for and obtaining all permits required for treatment and/or disposal of contaminated groundwater. Additional requirements may be mandated by local/regional sewer authorities for discharge to sanitary sewer or Publicly Owner Treatment Works (POTW). Copies of permit applications and correspondence from federal and state agencies and sewer authorities shall be supplied to the Engineer prior to dewatering activities.

EPA regulations published in the Federal Register on September 9, 2005 (70 FR 53663) require a National Pollutant Discharge Elimination System (NPDES) Remediation & Miscellaneous Contaminated Sites General Permit (RGP) for all contaminated construction site dewatering activities in Massachusetts (MAG910000) that will involve the discharge of water to classes of receiving waters designated in the Massachusetts Water Quality Standards (314 CMR 4.00). The application requires that operators of proposed new discharges seeking coverage under this general permit submit a Notice of Intent (NOI) to EPA New England post-marked at least 14 days prior to commencement of discharge. The Contractor is solely responsible for applying for and obtaining coverage under the NPDES Remediation General Permit from EPA and, if applicable, DEP, including the costs associated with sampling and analysis of groundwater and any application fees. The Contractor is required to submit a completed copy of the NOI to the Engineer and the Director of Environmental Programs, Construction Division, 10 Park Plaza, Boston, prior to commencement of discharge.

Upon permanent cessation of the discharges authorized by the RGP, the Contractor shall be responsible for submitting a Notice of Termination (NOT) to EPA New England within 30 days of the permanent cessation. The Contractor is required to submit to MassDOT a completed copy of the NOT within 14 days of the permanent cessation of the discharges authorized by the RGP. All costs and fees associated with the submission of the NOT will be the responsibility of the Contractor.

ITEM 183.1 (Continued)

The Contractor shall be responsible for adhering to regulations, specifications, and recognized standard practices related to contaminated groundwater handling during dewatering activities. MassDOT shall not be responsible at any time for the Contractor's violation of pertinent local, 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 (DEP), the U.S. Environmental Protection Agency (EPA), Federal Department of Transportation (DOT), Massachusetts Water Resources Authority (MWRA), the Commonwealth of Massachusetts and other applicable local, state and federal agencies governing this work.

The Contractor shall be responsible for determining compliance with the requirements of any permit and for any sampling, testing, and disposal required in connection with said permits. MassDOT and the City/Town reserve the right to collect additional samples of dewatered groundwater to determine the Contractor's compliance with the Permit's requirements. All laboratory testing is to be performed by a DEP certified laboratory for all parameters being tested. Copies of all field and laboratory testing results, reports, etc. required by the permits must be supplied to the Engineer. MassDOT, DEP, and the permit-granting agency, where applicable, reserve the right to collect additional samples of discharged groundwater to verify compliance with permit requirements.

For the purpose of these specifications and to establish a basis for the bid, it is anticipated that granular-activated carbon will be the treatment medium for dewatered contaminated groundwater. The bidder shall factor into the payment item all costs associated with the testing and analyses that may be required by the permitting agency. In addition, any laboratory testing of groundwater is to be performed by a DEP certified laboratory for the parameters being tested. Copies of all field and laboratory testing results will be supplied to the Engineer. Bid price shall also include full compensation for labor, materials, maintenance, mobilization, rental and other related costs. Item 183.2 will be used for disposal of used granular-activated carbon canisters.

SUBMITTALS:

Prior to initiating work, the Contractor shall submit an excavation dewatering plan to the MassDOT that includes a detailed description of the approach to dewatering, a description of methodology for sealing the excavation to minimize infiltration of groundwater, if deemed applicable to the work, anticipated treatment, discharge points, sampling frequency, required permits, transporters and waste facilities complete with license numbers, permit numbers, contact person, and address and telephone number that the Contractor plans to utilize for waste disposal. The plan shall be submitted for the record.

ITEM 183.1 (Continued)

The Contractor shall submit to MassDOT for review, the proposed methods for dewatering and groundwater treatment and disposal for the various portions of the work to be done. The review shall be for methods only. The Contractor shall remain responsible for the maintenance, performance, structural integrity and safety of the systems installed for this work as well as regulatory compliance of the applicable local, state and federal discharge standards. The contractor shall provide all groundwater sampling and analyses, results and reports required by all applicable local, state and federal agencies. The Contractor shall submit to MassDOT for review all plans and documents that must be submitted to the EPA and DEP, including NOI, NOT, treatment system analytical reports and correspondence. Copies of all permits and approvals and lab analyses and test results associated with groundwater treatment and disposal must be submitted to MassDOT within 3 days of receipt by the Contractor.

ESTABLISHMENT OF TREATMENT PROCEDURE:

Since concentrations of contaminants in groundwater cannot be easily assessed in the field, all groundwater extracted from the ground will be considered contaminated and will be initially pumped and stored into open settling tank(s) or a fractionation tank until it can be sampled and analyzed, unless otherwise directed by MassDOT. The Contractor will perform initial sampling and analyses of the groundwater to determine the need for a permit to dispose of contaminated groundwater. Based on the results of the initial sample analysis, which must be provided to the Engineer within twenty-four (24) hours of the time the samples are received by the laboratory, the Contractor will determine the necessity for treatment(s) and disposal procedures. Sampling must also be performed to meet applicable discharge criteria as set by the appropriate regulatory agencies for the permit obtained for disposal. All discharges must meet regulatory standards set forth in the permits required for discharge. For the purposes of the bidding process, it is anticipated that the treatment system will consist of sedimentation tanks, an oil water separator and liquid-phase granular activated carbon as the primary on-site treatment medium for dewatered contaminated groundwater. MassDOT may require additional treatment processes if such is determined necessary during the groundwater testing procedure. The Contractor shall integrate the additional treatment process into the treatment system, if necessary.

The Contractor shall provide all labor, equipment and appurtenances required to treat the groundwater, subject to the approval of MassDOT. Groundwater stored and tested but not requiring treatment or off-site disposal shall be discharged to a location subject to the approval of MassDOT without payment to the Contractor.

TREATMENT UNITS:

The Contractor shall furnish all labor and materials, and shall install and operate temporary groundwater treatment and disposal system(s) as necessary to treat contaminated groundwater pumped from excavations during construction activities under the Contract. Such systems shall be capable of treating groundwater to meet applicable discharge criteria as set by the appropriate regulatory agencies.

ITEM 183.1 (Continued)

The Contractor or their Environmental Consultant shall operate, maintain and modify the selected treatment system, and conduct the necessary monitoring and reporting of influent, midpoint and effluent results, as required by the discharge permit for the disposal option selected.

METHOD OF MEASUREMENT:

Provide a treatment system that meets permit discharge requirements, mobilize it to the site, provide copies of laboratory analytical data indicating that the system is performing appropriately to meet permit requirements, and demobilize it from the site. This includes management and disposal of wastes generated during treatment prior to discharging such as activated carbon, etc. Work under Item 183.1 is based upon the number of gallons disposed or contaminated groundwater pumped through the granular-activated carbon (Item 183.2) as the medium for the treatment of contaminated groundwater that is found in pipe trenches, manhole excavations, catch basin excavations, that need to be dewatered.

BASIS OF PAYMENT:

Item 183.1 will be paid at the Contract unit price Gallon of groundwater pumped, stored, treated as needed and tested as required by discharge permits and regulatory requirements, which price shall be full compensation for all necessary labor and materials, mobilization, maintenance, demobilization of the appropriate unit(s), freight, rental costs, field and laboratory testing costs and permits. Costs associated with the disposal of granular-activated carbon shall be covered under Item 183.2.

ITEM 183.2 DISPOSAL OF GRANULAR ACTIVATED CARBON POUND

Work under Item 183.2 is based upon the disposal of used granular-activated carbon as the treatment medium for contaminated groundwater (Item 183.1) that is found during excavations in which contaminated groundwater is encountered.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Item 183.2 will be measured and paid at the Contract unit price per Pound of carbon that is properly disposed and replaced, as necessary, to meet treated water discharge requirements during dewatering operations at the site. Payment for Disposal of Granular Activated Carbon shall include compensation for all labor, equipment, materials, permits, characterization, sampling and on-site or laboratory analysis as needed or required by permits, for replacement and disposal of liquid-phase activated carbon for the on-site contaminated groundwater pumping, collection, treatment and treated water discharge system during the time period required to complete the work. No payments shall be made for replacing carbon which is spent due to the Contractor's failure to remove floating petroleum product or excess sediments prior to the groundwater entering the carbon treatment units. All other costs associated with treatment of contaminated groundwater will be covered under Item 183.1- Treatment of Contaminated Groundwater.

ITEM 184.1 DISPOSAL OF TREATED WOOD PRODUCTS TON
(Rev 08/09/2016)

Work under this item shall include the transportation and disposal of all treated existing wood product as directed by the Engineer.

The timber components of the existing structure are suspected to be treated with creosote, pentachlorophenol and/or CCA. This item shall include all costs for sampling, laboratory testing, loading, transportation and disposal of the treated wood. The Contractor is required to submit disposal manifests to the Engineer prior to the completion of the project. All aspects of this Item are to be completed in accordance with state and federal regulations.

Measurement and payment shall be by the weight, in tons, of treated timber transported and accepted at a licensed facility. The work shall be considered full compensation for all labor, tools, equipment, materials, testing, loading, transportation, approvals, and permits necessary for the completion of the work.

ITEM 236.01**PRECAST CONCRETE CULVERT – 48” X 48”****LUMP SUM**

The work under this item shall conform to the special provisions for Item 995.011 Culvert Structure, Culvert No. C-19-040 (BUK), and the following.

Work under this Item shall include all materials, equipment and labor needed to construct the 48” high by 48” wide precast concrete culvert with a natural substrate bottom that passes under the shared use path and MSE wall in Acton at Sta 21+99. The work shall also include the concrete headwalls at each end of the culvert.

NATURAL SUBSTRATE BOTTOM

The natural substrate construction material is to be placed within the culvert and the immediate upstream and downstream area as depicted on the plans. The intent of this item is to replicate within the culvert area an environment that is similar to the existing environment adjacent to the work area.

The Contractor shall excavate to install the new structures. Any material can be stockpiled and reused for the natural substrate bottom, provided the material is characteristic of the existing material upstream and downstream of the work area, or meets the criteria below. The elevations and conditions of the existing ground shall be maintained to the maximum extent practicable.

If the excavated material is not suitable or there is not enough material, the natural substrate material shall be comprised of a natural stone mix – gravel/cobble; ≤ 6” cobbles.

The natural substrate stone shall be native cobbles and gravel similar in shape and size of the stone adjacent to the work area. Large angular stones shall not be used. Crushed Stone will not be accepted.

COMPENSATION

Precast Concrete Culvert – 48” X 48” 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 design, drawings, excavation, culvert, concrete headwalls, gravel backfill, compaction, membrane waterproofing, dewatering or shoring required for the construction of the culvert.

Unsuitable material encountered at the bottom of the culvert excavation will be removed and paid for under Item 141., Class A Trench Excavation.

Crushed stone shall be used in backfilling area where unsuitable material has been removed and will be paid under Item 156., Crushed Stone.

ITEM 290.3

INFILTRATION TRENCH

FOOT

The work under this item shall conform to the relevant provisions of Section 260 of the Standard Specifications and the following:

The work shall consist of the construction of a stone filled trench adjacent to the path infiltrate surface runoff from the path. The trench will be lined with a geotextile fabric commonly used in subdrain installations. There shall be a layer of stone between the geotextile fabric and finished surface. See detail on the plans for detail.

All stone shall be double washed to remove fines.

COMPENSATION

Infiltration trench will be measured for payment by the foot of trench constructed, complete in place.

Infiltration trench will be paid for at the Contract unit price per foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for excavation, filter fabric and stone, but all costs in connection therewith shall be included in the Contract unit price bid.

ITEM 295.01
ITEM 295.02**BIORETENTION BASIN (STA. 23+00 RT)**
BIORETENTION BASIN (STA. 32+00 RT)**LUMP SUM**
LUMP SUM

The work under this item shall conform to the relevant provisions of Section 120, Section 144, Section 150, Section 751, the contract plans and the following:

The work shall consist of creating a bioretention basin conforming to the requirements of the Massachusetts Department of Environmental Protection Massachusetts Stormwater Handbook, as shown on the plans.

Construction Specifications for Bioretention Area

The following Construction Sequence is to be used as a general guideline. The Contractor shall coordinate with the owner and engineers and submit a proposed construction sequence for review and approval prior to construction.

1. Contractor shall stake out the bioretention basin area boundaries in the field. The location of the staked-out area shall first be approved by the Engineer prior to excavation of the site.
2. Install and maintain erosion and sediment control measures as shown on the plans and provide temporary stormwater diversion from inlets to the outlet.
3. Remove trees within the boundaries of the approved staked-out excavation area. Excavate existing topsoil and stockpile for reuse.
4. Excavate and construct the bioretention area to the design elevation per the plans in cells of 500 to 1,000 square feet in coordination with the temporary stormwater diversion. The bottom of the excavation shall be level and not compacted or smeared.
5. The excavation shall first be inspected and approved by the Engineer prior to placement of the filter fabric and filter media soil. Scarify the bioretention area bottom as directed by the Engineer.
6. Place Filter Media Soil material in layers with a maximum thickness of 12 inches minimizing compaction of soil. Assume 10% settlement and rake to the final depth.
7. Place 2" of hardwood mulch on bottom of bioretention area, mixing 1" into filter media soil. Top 1" layer is to be placed after seeding and installation of plants.
8. Seed area with one pound of Wetland Seed Mix per 2000 sq. ft., which mix shall be Pure Live Seed and shall be a wetland mix comprised of native New England species from one of the following suppliers or an approved equal: New England Wetland Plants, Amherst, MA (#413) 549-4000; Allen Seed, Exeter, RI (#800-527-3898); or Ernst Conservation Seeds, Meadville PA (#800- 873-3321). The seed mix shall be raked into the filter media soil immediately after spreading it out.
9. Seed all disturbed slopes adjacent to the bioretention area with an erosion control seed mix conforming to M6.03.1 of the Standard Specifications. Imbed silt fence along toe of slope to prevent erosion control seed mix from entering the bioretention area.
10. Install plants at the location and number per the plan. Spread remaining top 1" mulch layer.

ITEM 295.01 & 295.02 (Continued)

11. Contractor shall water seeded bottom and sides of bioretention area for a period of 60 days after application of seed mix. Contractor will restabilize any areas where grass cover is disturbed within the 60-day period. Contractor shall conduct regular inspections of the stabilizing bioretention area at a rate of twice per month (minimum of four inspections) over the 60-day period following seed mix application.

Project Conditions:

Installation:

Installation of the bioretention area shall occur during one of the following periods. Coordinate installation periods with planting periods and initial maintenance periods to provide required maintenance from date of substantial completion.

Spring planting: April 1 to June 1.

Fall planting: August 15 to October 15.

Weather limitations:

Proceed with installation only when existing and forecasted weather conditions permit. Do not plant during inclement weather including but not limited to heavy rain, extended drought, high winds, frost, and similar conditions.

Planting soil:

The soil should be a uniform mix, free from stones, stumps, roots or other similar objects larger than 2 inches. No other materials or substances should be mixed or dumped within the bioretention area that may be harmful to plant growth or prove a hindrance to the planting maintenance or operations. The media soil shall be free of noxious weeds or invasive species. A textural analysis is required for conformance to the soil composition criteria listed in the specification below.

The soil shall also be tested for conformance to the following criteria:

pH range:	5.5-6.5
Organic content:	1.5% to 3%
Magnesium:	Minimum 32 ppm
Phosphorous (P205):	Not to exceed 69 ppm
Potassium (K20):	Minimum 78 ppm
Soluble salts:	Not to exceed 500 ppm

If the soil pH should fall out of the acceptable range, it may be amended with lime to raise the pH or with iron sulfate to lower the pH, as necessary. All testing should be performed by the same testing facility to maintain consistent results. The soil sample results along with a material sample must be submitted and approved by the engineer prior to delivery to the project site.

ITEM 295.01 & 295.02 (Continued)**Mulch layer specifications:**

Shredded, aged, unstained and untreated hardwood mulch is the preferred accepted mulch to prevent flotation during storm events. Pine mulch and wood chips will float and move to the perimeter of the bioretention area during a storm event and are typically not acceptable. Finely shredded, well-aged, organic dark pine mulch may be acceptable on a case by case basis. The Contractor must submit a mulch sample (2-gallon minimum) to the engineer for inspection prior to delivery of mulch to the site.

Compaction:

It is very important to minimize compaction of the base of the bioretention area and the required soil backfill. When possible, excavator backhoes should be used to remove original soil. Other wide track, marsh track or light equipment with turf type tires is acceptable. Equipment traffic or parking on the bioretention area should be limited at all times during and after construction of the area. Excessive compaction will result in reduced infiltration rates and potential design failure.

Tilling with a chisel plow, ripper, or subsoiler may be necessary if excessive compaction occurs. Substitute methods must be approved by the engineer. Rototillers typically do not till deep enough to reduce the effects of compaction from heavy equipment.

When backfilling the bioretention area, place soil in lifts less than 12". Except on the side slope, do not use heavy equipment to backfill within the bioretention area. Grade materials with light equipment such as a compact loader or a dozer/loader with marsh tracks.

Plant installation:

Root stock of the plant material should be kept moist during transport and during storage on the site. The diameter of the planting pit should be at least six inches larger than the diameter of the planting ball. Set and maintain the plant straight during the entire planting process. Thoroughly water ground bed cover after installation.

Grasses and legume seed should be tilled into the soil to a depth of at least 1 inch. Grass and legume plugs should be planted following the non-grass ground cover planting specifications.

The planting soil specifications provide enough organic material to adequately supply nutrients from natural cycling. The primary function of the bioretention area is to improve water quality. Adding fertilizers defeats, or at a minimum, impedes this goal.

The side slopes shall be stabilized with loam and seed using seed mix from Item 765.421.

Miscellaneous:

The bioretention area may not be constructed until all contributing drainage areas have been stabilized and shall remain offline and non-operational until all vegetation is stabilized.

ITEM 295.01 & 295.02 (Continued)Material Specifications:

The acceptable materials to be used in the bioretention area are outlined in the following table:

Bioretention Area Material Specifications		
Material	Specification	Notes
Filter Media Soil	Filter Media to contain: <ul style="list-style-type: none"> • 40% Sand • 20-30% topsoil (<5% clay) • 30-40% compost Organic content is to be 1.5% to 3%. Volume of material is to be 110% of plan volume to account for settling or compaction.	Sand should be gravelly sand using ASTM D422. Topsoil shall be a USDA soil type sandy loam, loamy sand or loam texture. Compost must be processed from yard waste per MassDEP Guidelines.
Mulch Layer	Fine shredded hardwood mulch. Well-aged (6 months minimum).	2-inch layer on the surface of the filter media soil, mixed 1 inches into the filter media soil.
Filter Fabric	Non-woven geotextile fabric with flow rate of > 110 gallons/minute/square foot.	For use on bottom of filter media soil.
Erosion Control Blanket	Woven, 100% biodegradable jute fiber, 7.7 lbs./1000 sq. ft.	To be used on bioretention area side slopes > 3:1.
Plant Material	All plant materials shall conform to the guidelines of the "American Standard for Nursery Stock", latest edition.	Plant species and quantities per the plans.
Grass Seed	Use seed mix from Item 765.6 for side slopes.	Application rate of 25 lbs./acre or per seed manufacture's requirements.

COMPENSATION

Bioretention basin will be paid for at the Contract lump sum price, which payment shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for excavation, special soil backfill, stone stabilization slope, plantings, seeding, standpipe, frame and grate, subdrain, stone trench, geotextile around stone trench, fittings and outlet pipe, but all costs in connection therewith shall be included in the Contract lump sum price bid

ITEM 385.1**MONITORING WELL DECOMMISSIONED
AND ABANDONED****EACH****DESCRIPTION**

The Contractor shall decommission and abandon the existing monitoring wells located on either side of Route 2 prior to construction of the overpass.

The work, to be performed by a registered well driller in Massachusetts, consists of furnishing all labor, materials and equipment required for the performance of all operations in connection with the following items:

1. Clear wells of all obstructions such as pipes, valves, pumps and any obstacles of debris that may have entered the well.
2. For monitoring wells, well abandonment shall be conducted in accordance with Mass DEP Policy WSC #91-310 Standard References for Monitoring Wells.
3. For hand driven well points remove the well point and grout to surface.
4. Provide final surface finish.

References

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in text by basic designation only. The list provided below is not intended to be all inclusive of each regulation prevailing over the work. The latest version of the document listed shall govern the work performed.

1. Massachusetts Department of Environmental Protection, 310 CMR 40.0000, Massachusetts Contingency Plan.
2. Massachusetts Department of Environmental Protection, Standard References for Monitoring Wells, Policy #WSC-91-310, Section 4.6 Decommissioning of Monitoring Wells.
3. Massachusetts Department of Environmental Protection, 310 CMR 46.00, Certification of Well Drillers and Filing of Well Completion Reports.
4. American Society for Testing Materials, Standard Specification for Portland Cement, C150-07.

Submittals

The well contractor shall complete well abandonment records of the decommissioning procedure. The decommissioning report shall include:

1. Method of well abandonment/decommissioning.
2. Depth sealed: The depth of all plugging materials should be recorded.
3. Quantity of sealing material: The quantity of sealing material used. Measurements of static levels and depths should be recorded.
4. Changes recorded: Any changes in the well made during the plugging, such as perforating casing, should be recorded in detail.

The driller shall complete a well abandonment completion report in accordance with 310 CMR 46.00 and Policy # WSC-91-310. This report must be filed with the MassDEP with a copy to the Acton/Concord Board of Health, and to the Engineer.

ITEM 385.1 (Continued)**MATERIALS****Neat Cement Grout**

Cement conforming to ASTM standard C150 and water, with not more than six gallons of water per 94 lbs. Type II cement, must be used for openings less than or equal to one and one-half (1-1/2) inch openings.

Cement-Bentonite Grout

20 parts of cement conforming to ASTM Standard C150 to 1 part bentonite. The ratio of cement to water shall be 94 lbs of cement to eight gallons of water. Type H cement must be used for openings larger than one and one-half (1-1/2) inches.

Regardless of the type used the grout:

1. Shall be sufficiently fluid so that it can be applied through a tremie pipe from the bottom of the well upward.
2. Shall remain as a homogeneous fluid when applied to the subsurface rather than desegregating by gravity into a two-phase substance.
3. Shall be resistant to chemical or physical deterioration.
4. Shall not leach chemicals, either organic or inorganic, that will adversely affect the quality of the groundwater where it is applied.

Concrete

1. Portland Cement: ASTM Specification C150, Type 1, Type II, and Type III, of American manufacture.
2. These different types of cements shall not be used interchangeably in the same element or portion of the work.
3. Fine Aggregate: shall be graded natural sands - conforming to ASTM C150.
4. Coarse Aggregate: shall be hard, durable, uncoated crushed stone or gravel conforming to ASTM C 33.

CONSTRUCTION METHODS**Preparation of Site**

Remove all materials from the well.

Well Casing Removal

If the monitoring well construction is a generally shallow (less than 25 feet) water table wells, in accordance with Mass DEP's Standard References for Monitoring Wells (MADEP Policy #WSC-91-310) two options are available: removal of casing or plug the well in place.

1. If the casing is pulled and the hole collapses, the material in the hole must be compacted to avoid subsidence at the surface and the remainder of the annulus plugged with cement-bentonite grout.
2. If the casing is not pulled or the hole does not collapse upon removal of the casing, the well shall be plugged with cement-bentonite grout.
3. If the casing cannot be pulled, the top three feet of the casing shall be cut and the well annulus shall be plugged using neat cement grout.

ITEM 385.1 (Continued)

Well Plugging

Neat cement (or cement-bentonite grout) shall be inserted into the well casing or open portion of the borehole as specified above.

To assure that a well is properly plugged and that there has been no bridging of the material, verifying calculations and measurements shall be made by the well contractor to determine whether the volume of material placed in the well equals or exceeds the volume of the hole that has been plugged.

The plugging materials shall be introduced at the bottom of the well (or borehole) and placed progressively upward to a level approximately four feet below grade and should be terminated approximately 4 feet below grade with a 1 foot thick concrete plug atop the grout. The remaining 3 foot portion of the borehole should be filled to grade with materials compatible with the abutting land surface and properly compacted to minimize subsidence. Sealing materials shall never be poured from the land surface into the well, borehole, or annular space being sealed. The grout pipe (or tremie pipe) method, either with or without a grout pump, will achieve all the objectives of the well plugging program.

COMPENSATION

Monitoring well decommissioned and abandoned will be measured for payment by the Each, complete in place.

Monitoring well decommissioned and abandoned will be paid for at the Contract unit price per Each, which price shall include all labor equipment, materials and incidental costs required to complete the work.

ITEM 415.**PAVEMENT MICROMILLING****SQUARE YARD**

All references to Section 130 Pavement Milling within Section 450 Hot Mix Asphalt Pavement shall be replaced by Item 415 Pavement Micromilling.

DESCRIPTION

415.20 General.

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.

CONSTRUCTION PROCEDURES

415.60 General.

All construction procedures under Pavement Micromilling shall also conform to any of the following relevant provisions of Pavement Milling:

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 (3 meters) 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 (10 meter) ski minimum, 30 foot (10 meter) 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 (2 meter) 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.

ITEM 415. (Continued)

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.

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 (10 meter) 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 $\pm 3/4"$ ($\pm 20\text{mm}$) 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 an 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.

ITEM 415. (Continued)**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 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)

The milled surface of each travel lane shall be divided into longitudinal Sublots of 500 feet (150 meters). The Contractor shall perform a minimum of one random QC measurement within each Sublot with a 10-foot (3 meter) 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 (3 meter) 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” (1.6 mm). Any point in the surface not meeting these requirements shall be corrected as directed by the Engineer at the Contractor’s expense.

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.

Minimum QC Inspection of Milling Operations

Inspection Component	Items Inspected	Minimum Inspection Frequency	Point of Inspection	Inspection Method
Equipment	As specified in QC Plan	Per QC Plan	Per QC Plan	Per QC Plan
Environmental Conditions	Protection of Inlets & Utilities	Per QC Plan	Existing Surface	Visual Check
	Removal of Millings & Dust	Per QC Plan	Milled Surface	Visual Check
Workmanship	Milling Depth	Per QC Plan	Milled Surface	Check Measurement
	Cross-Slope & Profile	Per QC Plan	Milled Surface	Check Measurement
	Milled Surface Texture	Per QC Plan	Milled Surface	Visual Check
	Milled Surface Roughness	Once per 500 feet (150 meters) per milled lane	Milled Surface per Subsection 410.67	10 foot (3 meter) standard straightedge
	Sawcut Limit Vertical Face	Per QC Plan	Sawcut Limits	Visual Check

ITEM 415. (Continued)

415.61 Micromilling Equipment Requirements.

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

415.62 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 (3 meter) 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" (1.6 mm). Any point in the surface not meeting these requirements shall be corrected as directed by the Engineer at the Contractor's expense.

415.67 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)

COMPENSATION

415.80 Method of Measurement.

Micromilling - Micromilling will be measured for payment by the number of Square Yards (square meters) 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.

415.81 Basis of Payment.

Micromilling - Micromilling, removal and disposal of existing HMA pavement will be paid for at the contract unit price per Square Yard (square meter). 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.

415.82 Payment Items.

415. Pavement Micromilling Square Yard

<u>ITEM 450.90</u>	<u>CONTRACTOR QUALITY CONTROL</u>	<u>TON</u>
<u>ITEM 451.</u>	<u>HMA FOR PATCHING</u>	<u>TON</u>
<u>ITEM 452.</u>	<u>ASPHALT EMULSION FOR TACK COAT</u>	<u>GALLON</u>
<u>ITEM 453.</u>	<u>HMA JOINT SEALANT</u>	<u>FOOT</u>
<u>ITEM 455.23</u>	<u>SUPERPAVE SURFACE COURSE -12.5 (SSC-12.5)</u>	<u>TON</u>
<u>ITEM 455.32</u>	<u>SUPERPAVE INTERMEDIATE COURSE – 19.0 (SIC-19.0)</u>	<u>TON</u>
<u>ITEM 455.42</u>	<u>SUPERPAVE BASE COURSE – 37.5 (SBC-37.5)</u>	<u>TON</u>
<u>ITEM 455.60</u>	<u>SUPERPAVE BRIDGE</u>	<u>TON</u>
	<u>SURFACE COURSE – 9.5 (SSC-B-9.5)</u>	
<u>ITEM 455.70</u>	<u>SUPERPAVE BRIDGE</u>	<u>TON</u>
	<u>PROTECTIVE COURSE – 9.5 (SPC-B-9.5)</u>	

Work under these Items shall conform to the relevant provisions of Document 00717 SUPERPAVE REQUIREMENTS contained herein and the following:

The Equivalent Single Axle Loads (ESALs) for the design travel lane over a 20-year period for Commonwealth Ave is a traffic level 2, 0.3 to 3.0 Million 18-kip (80-kn) ESALs. The PGAB Grade selected for this Contract is PG 64-28.

The emulsion under this specification shall be Grade RS-1H and shall meet the requirements of AASHTO M 140.

All required sawcutting in the existing pavement in accordance with Sections 450 and 455 (Document 00717) will be included in the contract unit price for each HMA pavement course, except sawcutting asphalt pavement for box widening which will be paid under Item 482.5.

Warm-Mix Asphalt Additive

All Hot Mix Asphalt mixtures shall be modified using a WMA additive capable of lowering plant production temperatures of unmodified binders to below 260°F. The WMA additive shall be a product listed on the Northeast Asphalt User Producer Group (NEAUPG) website (http://www.neaupg.uconn.edu/?attachment_id=345), except that no WMA foaming technology which requires the mechanical injection of steam or water into the liquid asphalt will be permitted.

For HMA mixtures placed on Bridge decks, the WMA additives shall serve as a compaction aide. Mixture production temperatures shall not be lowered for HMA placed on bridge decks.

The WMA additive must be compatible with polyphosphoric acid modified binders, polymer modified binders, and the HMA Producer's HMA anti-stripping agents. The WMA additive shall be introduced in accordance with the Manufacturer's dosing rates and approved blending methods. The Manufacturer of the WMA additive shall have an on-site representative at the beginning of paving operations. The Manufacturer's representative shall be available for additional consultation during the remaining production.

Work shall conform to the provisions of Sections 450 and 455. The WMA mixture design shall incorporate the requirements of AASHTO R35 Appendix X2: Special Mixture Design Considerations and Practices for Warm Mix Asphalt (WMA).

ITEM 450.90 thru 455.7 (Continued)

When the asphalt binder is modified with the WMA additive at the HMA plant, all WMA additive equipment shall be fully automated and integrated into the plant controls and shall record actual dosage rates on the plant printouts.

The HMA QC Plan shall provide mixture production and placement alterations due to the WMA additive and shall incorporate the modification of asphalt binders when the WMA additive is blended with the asphalt binder at the plant. This plan shall specifically address WMA metering requirements, tolerances and other QC measures.

All costs including the WMA additive, equipment, labor, Manufacturer's representative, production of samples and incidental costs required to modify the HMA shall be incidental to the associated HMA pay items with no additional compensation.

ITEM 470.2 **HOT MIX ASPHALT BERM, TYPE A - MODIFIED** **FOOT**

Work under this Item shall conform to the relevant provisions of Section 470 of the Standard Specifications and the following:

CONSTRUCTION

Hot Mix Asphalt Berm, Type A – Modified, shall be constructed by means of an approved extrusion machine in conformance with the dimensions and at the locations shown on the Plans.

COMPENSATION

Hot mix asphalt berm, Type A – Modified will be measured for payment by the foot, complete in place.

Hot mix asphalt berm, Type A – Modified will be paid for at the Contract unit price per foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

ITEM 482.31**SAWING & SEALING JOINTS IN ASPHALT
PAVEMENT AT BRIDGES****FOOT**

The work to be done under this Item consists of making a sealed kerf across the full width of the finished asphalt pavement at bridge abutments where called for on the Plans. The shape, width, and depth of the kerf shall be as shown on the Plans.

Prior to the start of the asphalt pavement operation, the Contractor shall place a mark on each curb or barrier on either side of the paved roadway. These marks shall be aligned with the actual end of the bridge deck and shall be placed so that they will not be covered or otherwise obscured by the asphalt pavement.

After the completion of the paving operation, the Contractor shall snap a straight chalk line on the pavement between these two marks. The Contractor shall then saw cut the pavement along this line to the depth, width and shape as shown on the Plans. The equipment shall be approved by the Engineer prior to commencing work.

After completing the saw cutting, the Contractor shall clean the saw groove of any dust and debris with an oil free air blast. If the groove was wet sawn, the groove shall be cleaned with a water blast to remove any remaining slurry and debris, vacuumed with a Wet-or-Dry vacuum to remove any standing water, and then dried with an air blast from a Hot-Air-Lance.

Once the groove is clean and dry, the Contractor shall fill it completely with a hot-applied bituminous crack sealer meeting the requirements of M3.05.4 in accordance with the manufacturer's application instructions and restrictions regarding ambient and material temperatures. The crack sealer shall be thoroughly cured prior to opening the road to traffic. To reduce tackiness, only boiler slag aggregate (black beauty) shall be scattered over the sealer when required by the Engineer. Conventional sand shall not be used for this purpose.

METHOD OF MEASUREMENT

Item 482.31 will be measured for payment by the Foot, of the actual number of feet of kerf sawed and sealed in the asphalt pavement surface, complete in place.

BASIS OF PAYMENT

Item 482.31 will be paid for at the Contract unit price per Foot, which price shall include all labor, materials, equipment, and all incidental costs required to complete the work.

<u>ITEM 624.1</u>	<u>STEEL THRIE BEAM HIGHWAY GUARD (DOUBLE FACED)</u>	<u>FOOT</u>
<u>ITEM 627.4</u>	<u>STEEL THRIE BEAM TERMINAL SECTION (DOUBLE FACED)</u>	<u>EACH</u>

The work under this item shall conform to the relevant provisions of Section 601 of the Standard Specifications and the following:

The work shall consist of the installation of double faced steel thrie beam highway guard rail at the locations shown on the plans.

All materials shall conform to M8.07.0 of the Standard Specifications.

COMPENSATION

Steel thrie beam highway guard (double faced) will be measured for payment by the foot, along the top edge of the rail, complete in place.

Steel thrie beam terminal section (double faced) will be measured for payment by the each, complete in place.

Steel thrie beam highway guard (double faced) and Steel thrie beam terminal section (double faced) will be paid for at the Contract unit prices per foot and each, respectively, complete in place, including posts, offset blocks, rails, connecting hardware, labor and incidental costs required to complete the work.

<u>ITEM 639.</u>	<u>PRIVACY SCREEN</u>	<u>FOOT</u>
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The work under this item shall conform to the relevant provisions of Section 644 of the Standard Specifications and the following:

DESCRIPTION

The work shall consist of providing and installing a black privacy screen on the 144" Chain Link Fence (Pipe Top Rail) w/Barb (Line Post Option) around the Massachusetts State Police Horse Barn property as shown on the plans and as directed by the Engineer.

Privacy Screen shall have a tight weave pattern with a 90% visibility blockage. It shall be made from high grade closed mesh polypropylene enhanced with UV inhibitors to reduce color fading.

The screen should be finished with binding and grommets on all four sides to ensure a durable, clean fit. The material break strength shall meet or exceed: Warp Tensile 420 pounds, Warp Tear 125 pounds.

The privacy screen shall be stretched taut and securely fastened to the posts. The privacy screen shall be black.

ITEM 655.01 thru 655.04 (Continued)**MATERIALS**

Materials shall meet the requirements specified in the following Subsection of Division III, Materials and the following:

Gravel Borrow	M1.03.0 – Type b
Wooden Rails and Posts	M9.05.3
Timber Preservatives	M9.05.5

Galvanized connections, bolts, washers and nuts shall conform to AASHTO M 232.

Connection angles at post base on bridge shall be galvanized according to AASHTO M 111.

CONSTRUCTION

Two (2) bolts shall be used per each rail to post connection except at rail splices where four (4) bolts shall be used (2 per rail) Butt joints shall be used for all rail splices.

All connections, screws, bolts, anchors, nuts and washers shall be galvanized and are considered incidental to this Item.

All posts and rails shall be ACQ treated. Posts shall have a preservative retention level of 0.60 and rails shall have a minimum preservative retention level of 0.40.

Timber Rail Fence Fabrication and Erection

All posts for timber rail fence shall be machine driven provided that posts are not damaged in the process. If a post cannot be machine driven, it shall be set plumb in mechanically excavated or cored holes and secured in gravel borrow footings according to the plans. Posts shall be spaced as shown on the plans. In setting the posts, precautions shall be taken to ensure proper offset, alignment and leveling to prevent bending or twisting of the rail.

Where fence begins or ends at a flare, the flared section shall be included in the measurement of the applicable fence type.

Timber Rail Fence on Bridge

Timber rail fence shall be used at the existing bridge over the Nashoba Brook. Posts for Timber Rail Fence on Bridge shall be set plumb and placed flat on top of a neoprene pad on the existing concrete curb. Posts shall extend securely from the top of the curb to the required height. Posts shall be spaced as shown on the plans. In setting the posts, precautions shall be taken to ensure proper offset, alignment and leveling to prevent bending or twisting of the rail.

A minimum of two (2) galvanized 5/8" diameter anchors (one on each side) shall be used per each post connection to the top of existing concrete curb. A MassDOT approved mechanical anchor shall be used and submitted for approval to the Engineer prior to installation. All cost associated with the coordination of the anchors is incidental to this Item.

ITEM 655.01 thru 655.04 (Continued)**COMPENSATION**

Timber rail fence, timber rail fence on bridge and timber rail post - 56" tall will be measured for payment by the Foot, complete in place. When there is a transition section between the two types of fences, the transition section shall be measured as part of the timber rail fence.

Timber rail fence, timber rail fence on bridge and timber rail post - 56" tall will be paid for at the respective Contract unit prices per Foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for the gravel borrow, wooden rail and posts, timber preservatives for post buried ends and all required hardware and connection plates, 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:

GENERAL

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 and drop inlets within the project limits and as required by the 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 directed 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.

ITEMS 697.1 (Continued)

The Contractor shall inspect the condition of silt sacks after each rainstorm and during major rain events. Silt sacks shall be cleaned periodically as directed by the manufacturer 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.

COMPENSATION

Silt sacks will be measured for payment by the each, complete in place.

Silt sacks 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. 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 698.3 **GEOTEXTILE FABRIC FOR SEPARATION** **SQUARE YARD**

The work under this item shall consist of placing a geotextile fabric in the construction of the 1.5:1 modified rock fill slopes as shown on the plans and under the stone dust shoulders.

The geotextile fabric shall conform to Department Material Specification M9.50.0 Geotextile Fabric Separation.

CONSTRUCTION

Fabric shall be placed in intimate contact with the crushed stone. Seams shall be overlapped by at least two feet. If the Contractor elects to sew seams instead of overlap, colored thread must be used. The Contractor shall take care not to allow more than two weeks of exposure to direct sunlight. Fabric rolls shall not be dropped more than two feet.

COMPENSATION

Geotextile fabric for separation will be measured for payment by the Square Yard, complete in place. No additional payment will be made for overlapping material.

Geotextile fabric for separation will be paid for at the Contract unit price per Square Yard, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

ITEM 704.2**STONE DUST****TON**

The work under this item shall conform to the relevant provisions of Section 150 and 701 of the Standard Specifications and the following:

The work shall include the furnishing and placing of stone dust for use on shoulders as shown on the Drawings and as required by the Engineer. Geotextile fabric shall be installed between the subbase and the stone dust.

Submittals

Prior to construction, the Contractor shall submit a sample of the stone dust and weed barrier fabric to the Engineer for review and approval.

During construction, the Contractor shall construct a test installation of a 50-foot length of the stone dust on both sides (100 feet total length) of a portion of the constructed trail to ensure the appropriateness of the stone dust material. The test installation shall be installed as per the plans and specifications. The test installation shall remain for approximately 30 days (a longer duration may be necessary so that a substantial rain event may be experienced) to ensure its ability to handle the potential for wash out. Once the test installation has been approved by the Engineer, the material shall be installed for the remainder of the project as called for in the contract documents. Should the test installation not provide suitable results, the gradation shall be refined as per the Engineer's direction. The test installation process shall be repeated until the proper gradation is achieved and approved by the Engineer.

MATERIALS

Stone dust shall consist of clean, inert, hard, durable grains of quartz or other hard durable rock, free from loam or clay, surface coatings and deleterious materials.

Stone dust must meet or exceed the following gradation:

- 100% passing 3/8"
- 90-100% passing #4
- 80-100% passing #8
- 50-80% passing #16
- 25-60% passing #30
- 10-30% passing #50
- 2-10% passing #100
- 0-3% passing #200
- FM = 2.6-2.9

Color shall be dark gray.

Weed barrier fabric shall be a free draining geotextile commonly used to prevent vegetation growth that can be placed between layers of soil.

ITEMS 704.2 (Continued)

CONSTRUCTION

Place, grade and compact at the lines and grades as shown on the plans and as required by the Engineer. The stone dust shall be spread and compacted to yield a compacted depth of 4 inches and shall be compacted to the acceptance of the Engineer using either power rollers or tamping rollers or other devices approved for use by the Engineer.

COMPENSATION

Stone dust will be measured for payment by the Ton, complete in place.

Stone dust will be paid for at the Contract unit price per Ton, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

Geotextile fabric will be paid for separately under Geotextile Fabric for Separation, Item 698.3.

ITEM 707.1

PARK BENCH

EACH

The work under this Item includes furnishing and installing park benches as specified below and on the Plans.

Reference Standards

ASTM - American Society for Testing and Materials

Quality Assurance

Source For each type of product required for the work of this Section, provide products of one manufacturer and source for consistency.

Codes and Standards Perform site furnishings work in compliance with applicable requirements of governing authorities having jurisdiction. Workmanship and finish shall be equal to the best practice of modern shops for each item of work.

Qualifications of Workers Use adequate numbers of skilled workers who are trained in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.

The work of this Section shall be completely coordinated with the work of other Sections. Verify dimensions and work of other trades which adjoin materials of this Section before installing items specified.

ITEM 707.1 (Continued)

Protect site furnishings from paint spatter, splashed concrete, and other construction damage by wrapping and taping in place plastic sheeting or heavy kraft paper until adjacent work is completed. Repair any damage to finish in a manner consistent with manufacturer's recommendations.

Submittals

Shop Drawings: Supply shop drawings at an approved scale for location, installation and erection of each site furnishing item under this Section.

Product Data: Provide manufacturer's product data showing installation and limitations in use of each site furnishing item. Supply Certificates of Compliance for all materials required for fabrication and installation.

Material Selection and Samples: Submit samples showing the complete range of colors, textures and finishes available for all components required for construction.

MATERIALS

Park Bench shall be slats style, black color, surface mounted manufactured by:

Wabash Valley Manufacturing (Bench #AS1119C), ph: 1-800-253-8619

DuMor Inc. ph: 717-436-2106

Victor Stanley, Inc. 1-800-368-2573

or approved equal.

CONSTRUCTION

Site furnishings shall be erected as indicated on the Drawings, plumb, level, snug, and free from rocking. Make necessary shimming and final adjustments.

Shims shall be stainless steel sized so that they do not protrude beyond the base of the item so as to be visible in completed installation.

Exposed metal surfaces shall be finished in accordance with Section M7, Paints and Protective Coatings, except as noted otherwise.

Foundations shall be as shown on the drawings or as recommended by the manufacturer. Anchor bolts shall be cored into the foundations and an approved outdoor epoxy used to set anchor bolts into foundations.

ITEM 707.1 (Continued)

Benches

Benches shall be located as indicated on the Drawings.

Bench shall be foundations thru pavement in accordance with manufacturer's recommendations.

COMPENSATION

Park bench will be measured for payment by the each, complete in place.

Park bench 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. No separate payment will be made for foundations, welded plates, anchor bolts and epoxy, but all costs in connection therewith shall be included in the Contract unit price bid.

ITEM 710.8

GRANITE MILE MARKER

EACH

The work under these items shall consist of furnishing and installing of granite mile markers as shown on the drawings, as required by the Engineer, and following:

MATERIALS

Materials shall meet the requirements specified in the following Subsection of Division III, Materials: GraniteM9.04.8

Stone shall be of structural granite, hard and durable. Samples to be provided to the Engineer and the Town of Concord Planning Department. Granite shall be free from seams that impair its structural integrity of smooth splitting character. Natural variations characteristic of the deposit will be permitted. Granite shall come from an approved quarry. Test samples shall conform to the requirements of ASTM C615. Granite material shall meet to the following minimum requirements:

Abrasion:	70.0 Ha.
Absorption:	0.4% (average).
Compressive strength:	19,000 psi (average).
Modulus of rupture:	1,500 psi (average).

ITEM 710.8 (Continued)

Anti-graffiti sealer shall be a clear, penetrating, protective, ready to use microemulsion concentrate of silanes and aligomeric alkyl alkoxysilozanes. The protective anti-graffiti sealer shall comply with all known regulations limiting Volatile Organic Compounds (VOC) content. Upon reaction with the surface and humidity, it shall be chemically bonded into the substrate. Properly applied, it shall not produce a surface build up, darkening or other effect on the natural color or texture of the surface. Sealer and anti-graffiti coating shall exhibit the following physical properties or equivalents:

Form:	Clear amber liquid
Specific Gravity:	1.000
Flash Point:	77° F.
VOC:	2.65 lbs./gallon (ASTM D5095)
Solids:	100% concentrate.

CONSTRUCTION

The Contractor shall submit shop drawings (showing location and fabrication of each mile marker) and a sample of granite with all finishes to the Engineer for review and approval. After approval by the Engineer, fabrication and engraving of the granite may proceed.

Lifting and handling of all granite work shall be done with fabric or leather straps. No chains will be permitted.

Anti-Graffiti Sealer

All caulking, patching and joint sealants shall be installed prior to application of the sealer. Surfaces shall be cleaned free of dust, surface dirt, efflorescence and contaminants. Surfaces to be treated shall be dry and absorbent to assure good penetration of the sealer.

A test application is necessary on each surface to be treated to insure compatibility and desired results. Tests shall be applied using the same equipment as for job application. Test areas shall be available for inspection by the Engineer throughout the job application.

Apply anti-graffiti sealer in accordance with the manufacturer's instructions. Preferred method of application shall be with low pressure (20 PSI) airless spray equipment or with a heavily saturated brush or roller. Set sprayer to produce a wet stream. Avoid atomization of the material. Apply sufficient material to thoroughly saturate the surface, making sure to brush out excess material that does not penetrate. Apply solution of anti-graffiti sealer within eight hours of dilution.

ITEM 710.8 (Continued)

Flat Surfaces

When applying to flat surfaces, sealer shall be applied in a single saturating application with sufficient material applied so that the surface remains wet for three minutes before penetration into the granite. Surface residues, pools and puddles shall be broomed out thoroughly until they completely penetrate the surface. Excess material should be picked up within a few minutes to avoid a surface buildup. Protect surfaces from rainfall for a minimum of four hours. Sealer requires 72 hours to develop its full water repellent effectiveness.

Vertical Surfaces

When applying by spray, apply in a saturating application from the bottom up. Apply sufficient material to create a 4 inches to 8 inches rundown below the spray contact point. Allow the first application to penetrate the masonry surface for three minutes and then re-apply in the same saturating manner. Less material will be required for the second application. When using a brush or roller, apply uniformly using sufficient material to saturate the surface.

Allow the sealer to penetrate the masonry surface for three minutes. Brush out heavy runs and drips that do not penetrate.

Exposed surfaces for Granite Mile Marker shall be finished as follows:

- Top shall be apex with thermal finish.
- Sides with engraving shall be sawn face with thermal finish.
- Opposite sides shall be sawn with rough cut finish.

One side shall be engraved with the "MILE XX" and the Town name as shown on the drawing. Text for "MILE XX" shall be 2.5" high, Tahoma Font and painted black. Town name shall be 0.75" high, Tahoma font and painted black.

Set Granite Mile Marker plumb and at the height shown on the Drawings. Engineer shall approve exact facing of the bollard front in the field prior to installation. Apply anti-graffiti sealer to entire exposed surface of pier as per manufacturer's written recommendations.

COMPENSATION

Granite mile marker will be measured for payment by the each, complete in place.

Granite mile marker will be paid for at the respective Contract unit price per each, complete in place, which price shall include all labor, materials, equipment, and incidental costs required to complete the work.

ITEM 714.6

SEMAPHORE REPAIR

LUMP SUM

The work shall include repairing and modifying the semaphore at Sta. 20+00 RT as shown on the plans.

The existing semaphore shall be modified by removing the ladder and platform, for the entire height of the structure. Any holes remaining in the cabinets shall be sealed with flat head bolts and made smooth with the cabinet walls.

The equipment within the cabinets shall be removed and the cabinet doors welded shut.

Any cabling between the upper cabinet and the top of the semaphore shall be removed. The weatherhead at the cabinet shall be sealed to prevent moisture intrusion.

A pipe cap shall be installed on the top of the semaphore post, with the size to be determined in the field.

The entire structure shall be cleaned of all dirt and rust. Scrape to remove chipped, flaking and cracked paint to achieve a layer to bond new paint to. The pole and cabinet shall be painted a silver color. The paint shall consist of 3 coats of an exterior paint rated for use on metal and painted surfaces.

COMPENSATION

Semaphore repair will be paid for at the Contract lump sum price, complete in place, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

ITEM 714.8**BATTERY WELL
REMOVED AND RESET****EACH**

The work shall include cleaning, removing, repairing, and resetting the existing battery well at Sta 19+19 RT.

Removal of the contaminated material excavated around the battery well will be paid for separately under Items 181.11 through 181.14.

The battery well represents potential Recognized Environmental Conditions (RECs) defined of a past, current, or future potential release of oil and hazardous material (OHM) at or affecting the BFRT due to the use of chemicals.

An environmental site assessment was conducted along Phase 2 of the Bruce Freeman Rail Trail. Soil samples were collected from five representative battery wells.

The battery wells typically consist of an approximately 2-foot diameter concrete cylinder open on the bottom to underlying soil and covered with a metal lid. Soil in and around the battery wells contained polycyclic aromatic hydrocarbons (PAHs) and metals including arsenic, cadmium, lead, nickel and mercury above MCP soil category S-1 reportable concentrations (RCS-1). The lead and arsenic are likely attributable to the application of pesticides. The lead and PAHs may also be attributable to coal ash.

Batteries, resembling automobile batteries, were still present in some of the battery wells and signal boxes. The batteries contained an acid solution with a layer of oil on top to prevent evaporation. Based on the age of the railroad, oil in the signal batteries, the batteries have the potential to contain PCBs.

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 will 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 materials.

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.

ITEMS 714.8 (Continued)

After remediation, the unit shall be cleaned of all dirt and debris and reset in its current location. The battery well shall be set in a bedding of ¾" crushed stone 24" deep. The metal cover shall be permanently fastened to the concrete base.

COMPENSATION

Battery well removed and reset shall be measured for payment by the each, complete in place.

Battery well removed and reset shall 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. No separate payment will be made for remediation, gravel borrow or crushed stone for backfill, excavation, storage, repairs, and cleaning, but all costs in connection therewith shall be included in the Contract unit price bid. Removal of the contaminated material excavated around the battery well will be paid for separately under Items 181.11 through 181.14.

ITEM 734.2**SIGN-INTERPRETIVE-NPS STANDARD****EACH**

The work under this item shall consist of furnishing and installing an information sign as shown on the drawings, as required by the Engineer, and following:

Sign

The sign shall be a cantilevered model with two side-mounted posts that support the graphic panel mounted at a 45-degree angle.

The sign will include 2 posts, backing panel graphic panel and the outer frame. The sign will be an in-ground installation as shown in the drawings and per manufacturer's recommendation.

The posts will be two inch by three inch (min.) dimensional rectangular stock. The post will be fifty inches from the base and then extending twenty-six and one-half inches at a 45-degree angle.

The frame dimensions will be 38 inches by 26 inches. The visible opening for the graphic panel will be 35 inches by 23 inches. The top rail will be removable to allow installation of the graphic panel.

ITEM 734.2 (Continued)Graphic Panel

The Contractor shall be responsible for the fabrication of the graphic panel. The porcelain enamel graphic panel will be fabricated from 16-gauge steel. Finished panel thickness will be 1/8" thick (max.) to slide into sign frame. Graphic panel header color will be a dark blue (Federal Standard-Blue FS 35052). Panel title text will be white (Federal Standard-White FS 17925). Panel background color will be a light tan (Federal Standard-Tan FS 37855). Text will be black (Federal Color Standard-Black FS 17038). Font will be Verdana. Other text and image details will be worked out through the shop drawing review process to the mutual satisfaction of both parties after the notice to proceed is issued. **Approximate images are located in the appendix.**

The electronic file for the graphic panel text and image will be available from:

Marcia Rasmussen
Director of Planning and Land Management
Town of Concord
141 Keyes Road
Concord, MA 01742
Telephone: (978) 318-3290
Fax: (978) 318-3291
Email: mrasmussen@concordma.gov

The Contractor will provide a full-size mock-up of the panel text prior to fabrication and installation for approval by the Engineer and Cultural Resources Staff (See contact name above).

The sign will be from one of the following sources or approved equal:

Company	Model	Color
KVO Industries, Inc. 1825 Empire Industrial Court, Suite A Santa Rosa, CA 95403 Ph. (707) 573-6868 www.kvoindustries.com	Outline Cantilever Sign Model # 3826 OL CAN-AL	(NPS Black)
Winsor Fireform 3401 Mottman Road SW Tumwater, WA 98512 Ph. (800) 824-7506 www.winsorfireform.com	NPS-Style Cantilevered Low Profile Base (CFF)	(NPS Black)
Best-Ex, Inc. 820 Industrial Court PO Box 454 Baraboo, WI 53913 Ph. (800) 356-4883 www.best-exfab.com	NPS-Style Frame with Cantilever Exhibit Base	(NPS Black)

ITEM 734.2 (Continued)

CONSTRUCTION

The sign will be located as shown on the plans. Final sign post location will be marked and approved by the Engineer prior to start of work.

Sign post holes will be excavated to the dimensions shown on the detail drawings to the appropriate depth and circumference.

The sign will be completely assembled prior to setting it in the hole. Protect the sign from damage during installation. Do not install the graphic panel until the sign has been completely installed.

Set sign to the proper elevation (Refer to manufacturer's specifications and drawings). Check sign again to ensure that it is plumb after backfilling and set with temporary bracing to prevent shifting until backfill concrete completely sets.

Excavation, removal of excavated material, placement of the sign and backfilling the sign post holes, other associated labor, tools and costs are incidental to this item.

Sign Locations	Sign Label in Appendix
Sta. 19+76 RT	Acton Semaphore
Sta. 32+27 RT	Rail Bridge Abutments
Sta. 49+00 LT	Cemetery

COMPENSATION

Sign-interpretive-NPS standard shall be measured for payment by the each, complete in place.

Sign-interpretive-NPS standard will be paid for at the respective Contract unit prices per each, complete in place, which price shall include all labor, materials, equipment and incidental costs required to complete the work.

ITEM 740. ENGINEERS FIELD OFFICE AND EQUIPMENT (TYPE A) MONTH

Work under this item shall conform to the relevant provisions of Section 740 and the following:

Two computer systems, printer system, and a digital camera meeting the requirements set forth below including installation, maintenance, power, paper, disks, and other supplies shall be provided at the Resident Engineer's Office:

All equipment shall be UL approved and Energy Star compliant.

The Computer System shall meet the following minimum criteria or better:

Processor:	Intel, 3.5 GHz
System Memory (RAM):	8GB
Hard Drive:	500GB
Optical Drive:	DVD-RW/DVD+RW/CD-RW/CD+RW
Graphics Card:	4GB
Card Reader:	6-in-1 Card Reader, 2 total USB 3.0, audio
Network Adapter:	10/100 Mbit/s
USB Ports:	6 USB 3.0 ports
Keyboard:	Generic
Mouse:	Optical mouse with scroll, MS-Mouse compliant
OS:	Windows Professional with all security updates
Web Browser:	Latest Internet Explorer with all security updates
Applications:	Latest MS Office Professional with all security updates Latest Adobe Acrobat Professional with all security updates Latest Autodesk AutoCAD LT Antivirus software with all current security updates maintained through the life of the contract.
Monitor:	24" LED with built-in speakers, 1920 x 1200 max resolution
Flash drives:	2 - 32GB USB 3.0
Internet access:	High Speed (min. 24 mbps) internet access with wireless router.

The Multifunction Printer System shall meet the following minimum criteria or better:

Color laser printer, fax, scanner, email and copier all in one with the following minimum capabilities:

- Estimated volume 8,000 pages per month
- LCD touch panel display
- 50 page reversing automatic document feeder (RADF)
- Reduction/enlargement capability
- Ability to copy and print 11" x 17" paper size
- email and network pc connectivity
- Microsoft and Apple compatibility
- ability to overwrite latent images on hard drive
- 600 x 600 dpi capability
- 30 pages per minute print speed (color),
- 4 Paper Trays Standard (not including the bypass tray)
- Automatic duplexing
- Finisher with staple functions
- Standard Ethernet. Print Controller
- Scan documents to PDF, PC and USB
- ability to print with authenticated access protection

ITEM 740. (Continued)

Contractor must supply a maintenance contract for next day service, and all supplies (toner, staples, paper) necessary to meet estimated monthly usage.

A Digital Camera shall meet the following minimum criteria or better:

Resolution:	12 Megapixel
Optical Zoom:	5x
Internal Memory Included:	Yes
Memory:	8 GB SD Card
Screen:	3-inch Clear Photo LCD
Min Operating Temperature:	14°F
Max Depth of Water Resistant:	30feet
Height of Shock Resistant:	5 feet
Battery Power:	2 rechargeable batteries and a battery charger
Carrying Case:	Rain-proof with shoulder strap

The Engineer's Field Office and the equipment included herein including the computer system, printer and camera shall remain the property of the Contractor at the completion of the project. Disks, flash drives, and card readers with cards shall become the property of the Department.

Compensation for this work will be made at the contract unit price per month which price includes full compensation for all services and equipment, and incidentals necessary to provide equipment, maintenance, insurance as specified and as directed by the Engineer.

ITEM 751.72**COMPOST TOPDRESSING****SQUARE YARD**

The work under this Item shall conform to the relevant provisions of Section 751 of the Standard Specifications and the following.

Work shall consist of furnishing and pneumatically applying compost as specified below. Compost shall be applied as a thin mulch blanket over prepared loam or prepared soil and shall be used in conjunction with seeding or planting unless specified otherwise. The intent of compost topdressing is to provide temporary soil stabilization and organic matter for plant growth.

For areas where compost is proposed with seeding, seed shall be broadcast and seeding shall occur in conjunction with compost topdressing, as specified under the relevant seeding item.

Submittals

Contractor shall submit to the Engineer samples and certified test results 60 days prior to application of compost. Test will be for compost, not a soil test, as specified below. Vender certification that material delivered meets the test results shall be submitted if requested.

No materials shall be delivered until the required submittals have been approved by the Engineer. Delivered materials shall match the approved samples. Approval of test results does not constitute final acceptance. The Engineer will reject any material that does not meet the Specifications.

MATERIALS

Compost may be a blended product of compost and fine wood chips.

Compost testing shall be by a laboratory approved by the US Compost Council using the Testing Method for the Examination of Compost and Composting (TMECC) protocols.

- Organic matter content shall be minimum 30 percent (dry weight basis).
- Moisture content shall be 30-60 percent (wet weight basis).
- Bulk Density <1000 lb/cy
- pH shall be 5.5-7.5
- Conductivity shall be a maximum of 4 mmhos.
- Where soil is intended for vegetation (plants or grass), compost shall be tested for stability by CO₂ method and shall produce a maximum of 8mg CO₂-C per gram of organic material per day.

Particle size shall not exceed $\frac{3}{4}$ inch.

No kiln-dried wood, construction debris or ground palette is allowed.

The Engineer shall approve the Contractor's equipment for application.

ITEM 751.72 (Continued)

CONSTRUCTION METHODS

Application of compost material shall not begin until the Engineer has approved the site and soil conditions. The Contractor shall notify the Engineer when areas are ready for inspection and application of compost.

Prior to application of compost, all areas to be topdressed shall have been graded to an even surface, and all debris and stones 2 inches or larger shall be removed. Surface preparation shall be compensated under applicable item for placement of loam, sand, ordinary borrow, topsoil rehandled and spread, or other specified substrate.

Compost topdressing shall be pneumatically applied (blown on) to a depth of one half to one inch unless specified otherwise on the plans.

For areas where compost is proposed with seeding, seed shall be broadcast and shall occur in conjunction with compost topdressing, as specified under the relevant seeding item.

COMPENSATION

Compost topdressing will be measured for payment by the square yard, complete in place.

Compost topdressing will be paid for at the Contract unit price per square yard, which price shall include all labor, materials, equipment, and incidental costs required to complete the work.

Surface preparation of substrate receiving compost topdressing shall be compensated under applicable item for placement of loam, sand, ordinary borrow, topsoil rehandled and spread, or other specified substrate.

Seeding will be compensated for under the appropriate seeding item.

ITEM 756. NPDES STORMWATER POLLUTION PREVENTION PLAN LUMP SUM

This Item addresses the preparation and implementation of a Storm Water Pollution Prevention Plan required by the National Pollutant Discharge Elimination System (NPDES) and applicable Construction General Permit (CGP) issued by the U.S. Environmental Protection Agency (EPA).

Pursuant to the Federal Clean Water Act, construction activities which disturb one acre, or more are required to apply to the EPA for coverage under the NPDES General Permit for Storm Water Discharges from Construction Activities. On February 16, 2012 (77 FR 12286), EPA issued the final NPDES Construction General Permit (CGP) for construction activity. The Contractor shall be fully responsible for compliance with the CGP. Should a fine or penalty be assessed against it, or MassDOT, as a result of a local, state, or federal enforcement action due to non-compliance with the CGP, the Contractor shall take full responsibility.

The NPDES CGP requires the submission of a Notice of Intent (NOI) to the EPA prior to the start of construction (defined as any activity which disturbs land, including clearing and grubbing). There is a 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 (SWPPP) 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 CGP also requires the preparation and implementation of a SWPPP in accordance with the afore-mentioned statutes and regulations. The Plan will include the CGP 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 Engineer for approval at least 4 weeks prior to any site activities. It is the responsibility of the Contractor to comply with the CGP 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 the project and to include in the SWPPP the methods and means necessary to comply with applicable conditions of said permits (reference to Part 9.1.1 of the 2012 CGP).

ITEM 756. (Continued)

It is the responsibility of the Contractor to complete the SWPPP in accordance with the EPA CGP, provide all information required, and obtain any and all certifications as required by the CGP. 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 Engineer prior to implementation.

Included in the CGP 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 CGP requires that inspections be performed by a qualified individual. MassDOT requires proof of completion of a 4-hour minimum sedimentation and erosion control training class current to the latest CGP. This individual can be, but not limited to, someone that is either a certified inspector, certified professional, or certified storm water inspector. The documentation shall be included as an appendix in the SWPPP. The Engineer must approve the contractor's inspector. This individual shall be on-site during construction to perform these inspections. In addition, if the Engineer determines at any 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 CGP. 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. All Control measures must be properly selected, installed, and maintained in accordance with manufacturer specifications and good engineering practices. If periodic inspections or other information indicates a control has been used inappropriately or is no longer adequate, it is the responsibility of the Contractor to replace or modify the control for site conditions at no additional cost to the Department. The Contractor must maintain all control measures and other protective measures in effective operating condition and shall consider replacement of erosion controls for each construction season.

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.

The Contractor is advised The CGP provides specific requirements for temporary and final stabilization. This shall be incorporated into the project schedule. The permit defines specific deadline requirements for Initial Stabilization ("immediately", i.e., no later than the end of the next work day following the day when earth-disturbing activities have temporarily or permanently ceased) and for Complete Stabilization Activities (no later than 14 calendar days after the initiation

ITEM 756. (Continued)

of stabilization). Stabilization criteria for vegetative and non-vegetative measures are provided in the CGP.

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, etcetera. 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 <https://www.epa.gov/npdes/stormwater-discharges-construction-activities#ereporting> 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

Item 756 will be paid at the contract unit price, lump sum, which price shall include all work detailed above, including plan preparation, required revisions, revisions/addenda during construction, monthly reports and filing fees.

Payment of 50% of the contract price shall be made upon acceptance of the Storm Water Pollution Prevention plan. Payment of 40% of the contract price shall be made in equal installments for implementation of the Stormwater Pollution Prevention plan. Payment of the final 10% of the contract price shall be paid upon satisfactory submissions of a Notice of Termination (NOT) when final stabilization has been achieved.

<u>ITEM 765.421</u>	<u>SEEDING – MID-HEIGHT UPLAND MIX - PART SHADE</u>	<u>SQUARE YARD</u>
<u>ITEM 765.554</u>	<u>WETLAND MIX – SEASONALLY FLOODED (E154)</u>	<u>SQUARE YARD</u>

The work under this item shall conform to the relevant provisions of Section 765 of the Standard Specifications and the following:

The work shall consist of planting and establishing a stand of grass in the areas shown on the plans or as required by the Engineer. For the purposes of these specifications, the term “grass” shall apply to all the forbs, grasses, sedges, and rushes included in the materials.

All seeding shall be done by a company having a minimum of five years of experience with native grass establishment. Prior to beginning work, the seeding Contractor shall furnish proof of qualifications to the Engineer for approval. Proof of qualifications includes, if requested, providing documentation (photos and contacts) to demonstrate knowledge and expertise with native seeding and proof of having completed successful native seeding projects.

Seeding shall be done within 48 hours of placement of loam and final grading. Mulch for seed shall be Compost Topdressing or hydromulch as specified below, and shall be incidental to this item.

SEEDING SEASON

Seeding seasons shall be April 1 through May 15 and October 1 through December 1 for dormant seeding. *Seeding that occurs outside of these periods, shall be increased by 50%.*

MATERIALS

Seed

Samples and Submittals

- 1) Certificate of Materials. 60 days prior to ordering, the Contractor shall submit to the Engineer the manufacturer or supplier’s notarized Certificate of Materials. This document shall not be used as proof of purchase, proof of material delivered, or proof of material seeded, but simply to verify supplier availability of seed listed on the date certified. The species listed shall match those specified on the plans or herein, however, cultivars may vary due to availability. Substantial substitutions or changes in the mix from that specified on the plans or herein shall be approved by MassDOT Landscape Design Section.

ITEM 765.421 and 765.554 (Continued)

- 2) Seed Tag Certification. All seed lots have a seed analysis tag as required by State and Federal law. The contractor shall submit seed tags for each bag of seed used on the project site or ensure that each tag is photo documented by the Engineer. Number of tags shall match number of bags sent by the supplier to meet rate of Pure Live Seed specified on the plans. Tag must include: kind and variety of seed; lot number; origin of seed; net weight; % purity; germination; dormant seed; germination test date; inert matter; weed, noxious and other cropseed; and name and address of company responsible for the analysis. Seeding may be considered unacceptable for payment if no tags are submitted.
- 3) Certificate of Compliance. Prior to payment, contractor shall submit a bill of lading or a signed, dated and notarized Certificate of Compliance from the Supplier that serves as proof of purchase. This document shall include kind and variety of seed, lot number, net weight shipped, date of sale, invoice number under which seed was purchased, and name and address of Supplier or Manufacturer. All information must be included on the notarized form, including lot number and net weight shipped for specified job. This information shall match Seed Tag Certification and quantity of seed applied on the job. Seeding may be considered unacceptable for payment if information is incomplete.
- 4) Seed Sample. Contractor may be asked, prior to seeding, to submit a seed sample for testing.

Seed mix shall be a custom blend as shown on the plans or shall be as specified below. Seed cultivars shall be those that are as regional to New England or the local ecotype as possible.

Any species substitutions shall be with a species having similar characteristics and native to New England. Substantial changes in the mix shall be approved by MassDOT Landscape Design Section.

Herbaceous Species may be substituted with similar species native to Massachusetts if those specified are not available. Please check with MassDOT Landscape Design on grass substitutions.

ITEM 765.421 and 765.554 (Continued)**Item 765.421 Seeding – Mid-Height Upland Mix – Part Shade**

	<u>Botanical Name</u>	<u>Common Name</u>	<u>% PLS By Weight</u>
Grass			
	Festuca rubra	Creeping Red Fescue	69.5%
	Panicum virgatum 'Shelter'	Switchgrass 'Shelter'	5.0%
	Panicum clandestinum 'Tioga'	Deer Tongue 'Tioga'	5.0%
	Elymus virginicus	Virginia Wild Rye	4.0%
	Elymus canadensis	Canada Wild Rye	4.0%
	Schizachyrium scoparium 'Albany Pine'	Little Bluestem 'Albany Pine'	4.0%
	Agrostis perennans	Upland Bentgrass	4.0%
			<u>95.5%</u>
Herb/Forb			
	Chamaecrista fasciculata	Partridge Pea	1.5%
	Rudbeckia hirta	Black-eyed Susan	1.2%
	Aster laevis	Smooth Aster	0.8%
	Solidago bicolor	White Goldenrod	0.4%
	Monarda fistulosa	Wild Bergamot	0.4%
	Asclepias syriaca	Common Milkweed	0.2%
			<u>4.5%</u>
			<u>100.00%</u>

Seeding Rate:

Apply this mix at **50 lbs PLS/acre** on areas of less than 3:1 slope and 150 lbs PLS on areas of greater than 3:1 slope.

Add 30 lbs/acre of a cover crop. For a cover crop use either grain oats (1 Jan to 31 July) or grain rye (1 Aug to 31 Dec). Cover crop shall be incidental to seeding item.

ITEM 765.421 and 765.554 (Continued)**Item 765.554 Wetland Mix – Seasonally Flooded**

	<u>Botanical Name</u>	<u>Common Name</u>	<u>% PLS</u> <u>By</u> <u>Weight</u>
Grass			
	Elymus riparius	Riverbank Wild Rye	20.00%
	Andropogon gerardii NY Eco	Big Bluestem NY Eco	12.00%
	Carex lupulina	Hop Sedge	10.00%
	Panicum clandestinum 'Tioga'	Deer Tongue 'Tioga'	10.00%
	Carex vulpinoidea	Fox Sedge	10.00%
	Carex scoparia	Broom sedge	8.00%
	Sorghastrum nutans NY Eco	Indiangrass NY Ecotype	8.00%
	Panicum virgatum	Switch Grass	8.00%
	Juncus effusus	Soft Rush	2.00%
	Juncus tenuis	Path Rush	1.00%
			<u>89.00%</u>
Herb/Forb			
	Verbena hastata	Blue Vervain	4.00%
	Desmodium canadense	Showy Tick Trefoil	2.00%
	Eupatorium maculatum	Joe-pye Weed	1.00%
	Asclepias incarnata	Swamp Milkweed	1.00%
	Aster novae-angliae	New England Aster	1.00%
	Eupatorium perfoliatum	Boneset	0.70%
	Helenium autumnale	Common Sneezeweed	0.50%
	Aster puniceus	Aster - Swamp	0.50%
	Mimulus ringens	Monkey Flower	0.20%
	Vernonia noveboracensis	New York Ironweed	0.10%
			<u>11.00%</u>
			100.00%

Seeding Rate:

Species ecotype shall be as native to New England region as possible. Apply this mix at 20 lbs PLS/acre.

FOR USE WITH SLOPES: Add 30 lbs/acre of a cover crop. For a cover crop use either grain oats (1 Jan to 31 July) or grain rye (1 Aug to 31 Dec). Cover crop shall be incidental to seeding item.

Fertilizer

No fertilizers shall be applied.

ITEM 765.421 and 765.554 (Continued)**Water**

Water, including hose and all other watering equipment required for the work, shall be furnished by the Contractor to the site at no additional cost. Water shall be suitable for irrigation and free from ingredients harmful to plant life. All plants injured or work damaged due to the lack of water or the use of too much water shall be the Contractor's responsibility to correct.

Mulch

Mulch for seeding and topdressing shall be incidental to this item. Mulch shall be:

- Compost Topdressing meeting the material and submittal requirements of Item 751.72, Compost Topdressing and as specified below under Seeding and Mulching.

OR

- Hydromulch per the manufacturer's recommendation. Mulch for hydroseeding shall be wood fiber only.

Photo Documentation

Contractor shall submit photo documentation to the Engineer and Landscape Design Section. Each photo shall be date stamped. Photos shall be submitted after the following stages of construction:

- Soil preparation
- Seed and hydromulch/compost topdressing
- Germination
- Grass establishment after one full growing season (growing season is June-September)

CONSTRUCTION**Surface Preparation**

Soil preparation and seeding shall occur only when the bed is in a friable condition, not muddy or hard. Bare soils shall be raked to remove large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter. Ruts and depressions shall be filled with additional loam or compost and the soil shall be re-graded to a smooth and even finish corresponding to the required grades.

When seeding over existing or compacted soil, surface will be prepared by raking or tracking to a depth of 2 inches prior to seeding and prior to Compost Topdressing (when applicable).

Surface preparation shall be compensated for under Item 751. Loam Borrow.

Surface preparation shall be approved by the Engineer prior to seeding.

Seeding over Various Substrates

Loam: Seeding shall occur within 48 hours of site preparation to prevent loss of topsoil. Seeding shall be hydroseeding or broadcast as specified below.

ITEM 765.421 and 765.554 (Continued)

Compost Topdressing: Compost Topdressing shall be applied as specified under that item. Seed should be broadcast at the same time as compost application to ensure a thin cover of compost over seed. *When seeding is done after application of Compost Topsoil the rate shall be increased by 50% and area shall be hydromulched.*

Compost Mulch over Modified Rock: Compost Mulch shall be applied as specified under that item and shall be such that only the voids in the rock are filled so that seed has an organic substrate for germination. Seed shall be broadcast after compost application. No hydromulch is required.

Seeding Methods

No seeding or surface preparation work shall be done if soils are muddy or dry and compacted.

Broadcast Seeding: Seed shall be broadcast spread using a cyclone or whirlwind seeder or hand broadcast. Small or light-seeded species such as bluestem may be mixed with approved filler (e.g., sawdust, rice, kitty litter, or clean damp sand) to achieve an even distribution. Broadcast seeding shall be undertaken in two separate passes at ninety degrees to each other. One-half the seeding rate shall be applied in each direction.

To ensure seed to soil contact with broadcasting of seed, seed shall be tracked or rolled with a weighted roller.

All broadcast seeding shall be followed by hydromulching unless seeding is done as part of Compost Topdressing and as specified above.

Hydroseeding shall include hydromulch.

Hydromulching shall be per the Standard Specifications and per the manufacturer's directions.

Seed and Grass Care

During Germination: Contractor shall care for seeded areas as determined necessary by the Engineer and the MassDOT Landscape Architect. Care may include irrigation and weed control as necessary for germination.

During Establishment: Following germination of seeded species, the contractor shall maintain the stand of grasses to ensure healthy growth. Work shall include mowing or weed-whacking for weed control, irrigation if necessary, and monitoring for invasive plants.

Watering shall provide uniform coverage without eroding soil or grassed surfaces. Treatment of invasive plants shall be per the direction of MassDOT Landscape Architect.

ITEM 765.421 and 765.554 (Continued)

The Contractor shall provide all labor, equipment, materials, and water required for establishment. Contractor shall water all seeded areas as necessary to a depth of 2 inches or greater.

Over-seeding

Areas that are invaded by weeds shall be mowed as low as possible and over-seeded as directed. Soil that is compacted shall be raked or roughened prior to over-seeding. Following over-seeding, soil shall be lightly tamped to ensure seed to soil contact.

Over-seeding and mulch for over-seeding shall be incidental to this item.

ESTABLISHMENT

Native upland grasses and forbs will not look like turf grass. Many of the native grasses are bunch type grasses and will not form a uniform growth or have a sod-type appearance. However, seeded area shall show general uniform growth of the seeded species throughout the area. Areas with significant gaps of bare soil, generally greater than 2-3 feet in diameter, will require over-seeding.

A well-established stand of grasses at the end of one full growing season (June-September), as determined by the Engineer and the MassDOT Landscape Architect, will be required for acceptance. At least 80-90 percent of the grass established shall be the seeded species and any invasive or aggressive weeds (mugwort, ragweed, or knapweed) shall have been cut or otherwise managed.

METHOD OF MEASUREMENT AND BASIS OF PAYMENT

Items 765.421 and 765.554 will be measured for payment by the square yard after one full growing season (June-September) has elapsed between seed application and inspection and upon approval of establishment by the Engineer and the MassDOT Landscape Architect.

Items 765.421 and 765.554 will be paid for at the Contract unit price per Square Yard upon receipt of required submittals as specified above and upon approval of established stand of grass as specified above.

This price shall include all labor, materials, equipment and incidental costs required to complete the work, including but no limited to, seeding, rolling to ensure seed-to-soil contact, care during germination and establishment, irrigation, mulching, over-seeding and photo documentation. Site preparation, including raking, tilling, removal of debris and stones, and other work to the prepare site for seeding shall be compensated for under Item 751, Loam Borrow.

ITEM 767.12**COMPOST FILTER TUBES****FOOT**

The work under this item shall conform to the relevant provisions of Section 751 and 767 of the Standard Specifications and the following:

This work shall include the furnishing and placement of a linear, compost-filled tube for the purpose of slowing the velocity of and filtering suspended sediments from storm water flow.

MATERIALS

Material for the filter tubes shall be compost meeting M1.06.0, except that no manure or bio-solids shall be used. In addition, no kiln-dried wood or construction debris shall be allowed. Particle size analysis: 98% shall pass through a 3-inch (75mm) sieve; 30-50% shall pass 3/8 inches (10mm) sieve.

Tubes for compost filters shall be a minimum of 12 inches (300 mm), a maximum of 18" (450mm) in diameter. Tube material shall be a knitted mesh with 1/8" - 3/8" (3-10 mm) openings and made of 100% biodegradable (cotton, hemp or jute) materials. Additional tubes shall be used at the direction of the Engineer.

Stakes for anchors, if required, shall be nominal 2 x 2 stakes.

CONSTRUCTION METHODS

Tubes of compost may be filled on site or shipped. Tubes shall be placed, filled and staked in place as required to ensure stability against water flows. All tubes shall be tamped to ensure continuous contact with the soil. Stakes shall not puncture compost tube fabric.

The Contractor shall ensure that the filter tubes function as intended at all times. Tubes shall be inspected after each rainfall and at least daily during prolonged rainfall. The Contractor shall immediately correct all deficiencies, including, but not limited, to washout, overtopping, clogging due to sediment, and erosion. The contractor shall review location of tubes in areas where construction activity causes drainage runoff to ensure that the tubes are properly located for effectiveness. Where deficiencies exist, such as overtopping or wash-out, additional staking or compost material shall be installed as directed by the Engineer. Contractor shall remove sediment deposits as necessary to maintain the filters in working condition. The functional integrity of filter tubes shall be maintained in sound condition at all times. Filter tubes that are decomposing, cut, or otherwise compromised shall be repaired or replaced as directed by the Engineer and be incidental to this item. At specific locations, such as at gully points, steep slopes, or identified failure points in the sediment capture line, compost filter tube may be reinforced by either staked hay bales and/or silt fence at the direction of the Engineer. Such reinforcing shall be incidental to the cost of this item and shall not exceed 10 percent of the overall length of compost filter tube required for the project.

ITEM 767.12 (Continued)

Stakes shall be removed by the Contractor when site conditions are sufficiently stable to prevent surface erosion, and after receiving permission to do so from the Engineer. Biodegradable fabric and material shall be left in place to decompose on-site unless directed otherwise by the Engineer in urban or residential locations. In those instances, the Contractor shall rake out compost so that it blends evenly and is no greater than 1-2 inches in depth on soil substrate. Raked compost shall then be seeded with a mix appropriate to the surrounding vegetation.

COMPENSATION

Compost Filter Tubes will be measured for payment by the Foot, furnished and installed, approved and maintained, complete in place for the duration of the contract.

Compost Filter Tubes will be paid for at the Contract unit price per Foot, which price shall include all labor equipment, materials and incidental costs required to complete the work.

<u>ITEM 772.356</u>	<u>FIR - FRASER 5-6 FEET</u>	<u>EACH</u>
<u>ITEM 773.436</u>	<u>PINE - WHITE 5-6 FEET</u>	<u>EACH</u>
<u>ITEM 774.642</u>	<u>SPRUCE - WHITE 7-8 FEET</u>	<u>EACH</u>
<u>ITEM 775.047</u>	<u>HORNBEAM - EUROPEAN 8-10 FEET</u>	<u>EACH</u>
<u>ITEM 777.036</u>	<u>OAK - NORTHERN RED 2-2.5 INCH CALIPER</u>	<u>EACH</u>
<u>ITEM 777.138</u>	<u>OAK - PIN 2-2.5 INCH CALIPER</u>	<u>EACH</u>
<u>ITEM 777.673</u>	<u>SWEETGUM 2-2.5 INCH CALIPER</u>	<u>EACH</u>
<u>ITEM 778.161</u>	<u>BIRCH - RIVER 'HERITAGE' 8-10 FOOT CLUMP</u>	<u>EACH</u>
<u>ITEM 783.037</u>	<u>SHAD TREE - ALLEGHENY CLUMP 4-5 FEET</u>	<u>EACH</u>
<u>ITEM 789.333</u>	<u>BAYBERRY SHRUB - NORTHERN 2-3 FEET</u>	<u>EACH</u>
<u>ITEM 789.669</u>	<u>BLUEBERRY - LOWBUSH 6-9 INCH HEIGHT</u>	<u>EACH</u>
<u>ITEM 794.731</u>	<u>SUMMERSWEET SHRUB 18-24 INCH</u>	<u>EACH</u>
<u>ITEM 795.053</u>	<u>VIBURNUM - HIGHBUSH CRANBERRY 3-4 FEET</u>	<u>EACH</u>
<u>ITEM 795.057</u>	<u>VIBURNUM - LEATHERLEAF 24-30 INCH</u>	<u>EACH</u>
<u>ITEM 795.069</u>	<u>VIBURNUM - NANNYBERRY 24-30 INCH</u>	<u>EACH</u>
<u>ITEM 795.151</u>	<u>WINTERBERRY - MALE 18-24 INCH</u>	<u>EACH</u>
<u>ITEM 795.157</u>	<u>WINTERBERRY - FEMALE 24-30 INCH</u>	<u>EACH</u>
<u>ITEM 796.03</u>	<u>KODIAK BLACK BUSH HONEYSUCKLE</u>	<u>EACH</u>

The work under these items shall conform to the applicable requirements of Section 771, PLANTING TREES, SHRUBS AND GROUND COVER, of the Supplemental Specifications.

As indicated on the plans, plantings are schematic and shall be staked out in the field and confirmed with the MassDOT Landscape Design Section and the Town of Concord Division of Natural Resources Director.

ITEM 826.8 **TELEGRAPH POLE AND OVERHEAD WIRE** **LUMP SUM**
REMOVED AND DISCARDED

The work under this Item shall conform to the relevant provisions of Section 813 of the Standard Specifications and the following:

The work under this item shall consist of removing overhead wires from the telegraph poles along the rail road. After all wires have been removed the utility poles shall be removed and discarded.

Any downed wires and/or poles shall be removed and be included as part of this item.

COMPENSATION

Telegraph pole and overhead wire removed and discarded 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.

ITEM 853.21 **TEMPORARY BARRIER REMOVED AND RESET** **FOOT**

DESCRIPTION

Work under this item shall conform to the relevant provisions of Section 850 and shall consist of removing, transporting and resetting temporary barrier systems and limited deflection temporary barrier systems from alignments established along the roadway to new alignments in accordance with the details shown on the plans, as required by the construction and staged construction operations and as required by the Engineer for the channelization of traffic and/or work zone protection.

The work shall also include furnishing and installing all hardware and associated materials per the details and/or manufacturer's specifications for anchored or restrained temporary barrier systems. The work shall also include necessary patches and repairs caused by the temporary barrier system to damaged pavement surfaces or any adjacent longitudinal barrier once the system has been removed.

Temporary limited deflection temporary barrier systems shall be removed from existing locations and reset in accordance to the Construction Methods stated in the respective barrier items.

Damage to the pavement surface or adjacent permanent barriers caused by removing or resetting temporary barrier shall be repaired as directed by the Engineer at the Contractor's expense.

ITEM 853.21 (Continued)**COMPENSATION**

Temporary barrier removed and reset will be measured for payment by the foot, complete in place.

Temporary barrier removed and reset will be paid for at the Contract unit price per foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for removing, relocating, resetting, realigning, transporting and maintaining the temporary barrier system and/or limited deflection temporary barrier system, but all costs in connection therewith shall be included in the Contract unit price bid.

The Contractor will be paid for this item each time the barrier is relocated either to a new work zone, to off-season storage, or back to the project from storage. The Contractor will not be separately compensated for any work necessary to maintain or re-align units or replace damaged units. No payment will be made for removing and resetting barriers for the purpose of gaining access to the construction work zone. No payment will be made for removing, relocating and resetting any barriers moved for the convenience of the Contractor.

For temporary barrier systems that require anchorage systems, the cost of furnishing, installing and removing the anchorage and hardware and the restoration of pavement surfaces or adjacent permanent barrier systems to facilitate anchorage shall be considered incidental to the cost of the item.

ITEM 853.33 TEMPORARY BARRIER – LIMITED DEFLECTION (TL-3) **FOOT****DESCRIPTION**

Work under this item shall consist of furnishing, installing, maintaining and final removal of limited deflection TL-3 temporary barrier systems for channelization of traffic and/or work zone protection. Limited deflection temporary barrier systems shall have a maximum dynamic deflection of 24 inches or less and shall be used in areas where the available clear area behind the barrier system is 24 inches or less.

MATERIALS

The following limited deflection temporary barrier systems are acceptable for use:

1. BarrierGuard 800; Highway Care International.
http://www.highwaycareint.com/product_info/44/barrierguard800
2. J-J Hooks F-Shape Temporary Concrete Barrier; Easi-Set Industries. <http://jjhooks.com/>
3. ZoneGuard; Hill & Smith, Inc. <http://www.hillandsmith.com/zoneguard/>
4. Texas DOT X-Bolt F-Shaped Concrete Safety Barrier

ITEM 853.33 (Continued)

The Contractor may submit alternate materials to the Engineer for approval if the limited deflection temporary barrier system meets the following criteria:

1. The system has been tested by an independent laboratory that is accredited by FHWA to crash test roadside hardware;
2. The system meets the minimum requirements of the *AASHTO Manual on Assessing Safety Hardware* (MASH) at Test Level (TL) 3 or higher; and
3. The system has a federal-aid eligibility letter from FHWA.

Copies of the testing results and the federal-aid eligibility letter shall be submitted and approved by the Engineer prior to procurement of an alternate temporary barrier system.

The Contractor shall supply shop drawings to confirm the available clear area behind the barrier equals or exceeds the maximum dynamic deflection of MASH Test 3-11 during testing procedures taken at an independent laboratory that is accredited by FHWA to crash test roadside hardware.

Delineators shall be installed on all limited deflection temporary barrier systems in conformance with the relevant provisions of Section 850.69 and shall be incidental to the temporary barrier systems.

Temporary impact attenuators that are listed on the Qualified Traffic Control Equipment List shall be used whenever a blunt end of the limited deflection temporary barrier system is facing traffic within the clear zone unless it is protected by a second barrier system or secured to a separate barrier system or bridge railing by a method approved by the manufacturer.

CONSTRUCTION METHODS

Limited deflection temporary barrier systems shall be placed in line with the drawings. Installation shall be per the manufacturer's specifications, details, and the approved shop drawings.

The Contractor shall not place any breaks in the limited deflection temporary barrier system that will result in sections that are shorter than the stated minimum length-of-need (LON) under MASH Test 3-11. Exceptions shall be allowed for gate systems or changeable length segments placed over expansion joints if those barrier segment types have been tested and meet the minimum requirements of MASH Test 3-11 with the adjoining limited deflection barrier system.

Within the LON section, limited deflection temporary barrier systems shall only be placed on paved surfaces unless otherwise tested and certified under MASH TL-3 for those conditions.

ITEM 853.33 (Continued)

Damage to the pavement surface caused by the limited deflection temporary barrier during installation, while in service, and/or during removal shall be repaired as directed by the Engineer at the Contractor's expense

Limited deflection temporary barrier systems that require anchorage systems shall conform with the relevant provisions of Section 850.70.

METHOD OF MEASUREMENT

Temporary barrier – limited deflection (TL-3) will be measured for payment by the foot, complete in place.

PAYMENT

Temporary barrier – limited deflection (TL-3) will be paid for at the Contract unit price per foot, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for furnishing, installation, maintenance and final removal, but all costs in connection therewith shall be included in the Contract unit price bid.

For limited deflection temporary barrier systems that require anchorage systems, the cost of furnishing and installing the anchorage and hardware and the restoration of pavement surfaces or adjacent permanent barrier systems to facilitate anchorage shall be considered incidental to the cost of the item.

Payment for limited deflection temporary barrier removed and reset will be made under Item 853.21.

<u>ITEM 853.501</u>	<u>TEMPORARY IMPACT ATTENUATOR REMOVED AND RESET</u>	<u>EACH</u>
<u>ITEM 853.73</u>	<u>TEMPORARY IMPACT ATTENUATOR BI-DIRECTIONAL, NON-REDIRECTIVE (TL-3)</u>	<u>EACH</u>

DESCRIPTION

Work under Item 853.501 shall conform to the relevant provisions of Section 850 and shall consist of maintaining, removing and reinstalling temporary impact attenuators where indicated on the plans or as directed by the Engineer.

Work under Item 853.63 shall conform to the relevant provisions of Section 850 and shall consist of furnishing, installing, maintaining and final removal of temporary impact attenuator systems for protection of the ends of temporary barrier and other roadside hazards in work zones. All work shall be in conformance with the specifications of the manufacturer and in close conformance with the locations, lines, and grades shown on the plans.

MATERIALS

The Contractor shall supply a temporary impact attenuator that meets the same or higher crash Test Level (TL) as the adjacent temporary barrier, unless otherwise shown on the plans. The temporary attenuator shall be listed on the Department's Qualified Traffic Control Equipment List.

The temporary impact attenuator shall be designed to fit within reasonably close tolerance of the dimensions given on the plans.

The Contractor shall supply shop drawings for the temporary attenuator and for any anchorage system and for any transitions or connections between the temporary attenuator and the adjacent barrier or other roadside hazard.

The side of the temporary attenuator that faces traffic shall include a Type 3 Object Marker that conforms to the language found in Sections 2C.64 and 2C.65 of the *Manual on Uniform Traffic Control Devices*.

Unless a separate barrier system protects it from opposing traffic, only temporary impact attenuators that are certified for bi-directional use shall be used in medians.

ITEM 853.501 & 853.73 (Continued)

CONSTRUCTION METHODS

Installation means and methods shall be per the manufacturer's specifications and/or drawings.

Temporary Impact Attenuators Removed and Reset consists of removing temporary impact attenuators, relocating and reinstalling at a new location per the specifications and recommendations of the manufacturer and as shown on the plans or as directed by the Engineer.

Excavation for temporary attenuator foundations and anchorage shall be made to the required depth and to a width that will permit the installation and bracing of forms where necessary. All soft and unsuitable material shall be replaced with compacted gravel borrow.

The Contractor shall supply the Engineer instructions for installation and the manufacturer's recommended routine inspection and maintenance program. The cost of inspection and maintenance of temporary attenuators shall be considered incidental in nature.

Damaged temporary impact attenuators shall be replaced by the Contractor within 24 hours or as directed by the Engineer, at the Contractor's expense. A truck mounted attenuator that meets the same or higher TL, or other means of protecting the damaged temporary impact attenuator, shall be deployed until the repairs or replacement has been completed, at the Contractor's expense.

METHOD OF MEASUREMENT

Temporary impact attenuator removed and reset and temporary impact attenuator unidirectional, redirective (TL-3) will be measured for payment by the each, complete in place.

PAYMENT

Temporary impact attenuator removed and reset and temporary impact attenuator unidirectional, redirective (TL-3) will be paid for at the respective Contract unit prices per each, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for furnishing, foundations and anchorages, installation, maintenance and final removal, but all costs in connection therewith shall be included in the Contract unit price bid.

ITEM 864.31 SLOTTED PAVEMENT MARKER ONE-WAY WHITE EACH**Description**

The work to be done under this item shall consist of furnishing and installing one-way white reflectorized pavement markers (slotted in pavement) in accordance with the construction plans, the relevant provisions of Traffic Standard TR.6.3 “Typical Pavement Markings for Freeways”, and the following:

- Markers shall be installed along the broken white lane lines (skip lines) at the midway point between successive skip lines at 80-foot intervals on the mainline.

Construction Methods

The work shall include cutting the tapered pavement slot to the dimensions shown on the typical details for the one-way markers, application of the manufacturer’s recommended epoxy adhesive, and placing the reflectorized pavement marker in the proper position within the slot so that the reflective face is visible and perpendicular to oncoming traffic and so that the top of the marker is set 1/8+ inch below the top of the adjacent pavement.

Surface preparation and installation shall be strictly in accordance with the manufacturer’s instructions.

Materials

Reflectorized pavement markers shall be 3M Series 290, Avery Dennison Lifelite Model 948 BW, Ray-O-Lite Model 200 or an approved equal.

COMPENSATION

Slotted pavement marker one-way white will be measured for payment by the each, complete in place.

Slotted pavement marker one-way white will be paid for at the Contract unit price each, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for cutting the tapered pavement slot, furnishing and installation of the reflectorized markers, but all costs in connection therewith shall be included in the Contract unit price bid.

ITEM 945.10
ITEM 948.60
ITEM 948.61

DRILLED MICROPILES
MICROPILE VERIFICATION LOAD TEST
MICROPILE PROOF LOAD TEST

FOOT
EACH
EACH

GENERAL

This work shall consist of constructing micropiles as shown on the plans, approved working drawings, and as specified herein. The Contractor is responsible for furnishing all materials, equipment, labor, services, and supervision; and for selecting means and methods for the installation and testing of micropiles for this project.

Micropiles shall consist of permanent casing sections and fully reinforced grout sections bonded with bedrock. Permanent casings shall be included as part of the micropiles, and shall remain in place after grouting is complete. Temporary casings shall be installed if necessary to facilitate micropile construction and shall be removed during or after grouting. The Contractor is responsible for drilling through obstructions encountered during pile installation.

The micropiles load capacities shall be confirmed by verification and proof load testing. Testing must meet the test acceptance criteria specified herein. The bond length of the micropile may be modified by the Engineer, pending results of load testing performed as an initial part of the work.

MATERIALS

The materials for micropiles shall meet the following requirements:

Permanent/Drill Steel Casing used as Reinforcement: Permanent steel casing/pipe used as reinforcement shall be new 'Prime' steel meeting the requirements of any API 5L PSL1 pipe with a minimum yield strength of 35 ksi or better with SR15 supplemental requirements. The grade of the prime steel casing shall conform to the properties shown on the Plans. Steel pipe that is to be welded, the Carbon Equivalency, as defined in AWS D1.1 Section XI.1, shall be less than or equal to 0.45, as demonstrated by mill certificates. The sulfur content shall not exceed 0.05%, as demonstrated by mill certificates.

Permanent steel casing shall consist of ERW (Electric Resistance Welded) and/or seamless steel casing and shall be designed to withstand the design loadings determined by the Engineer or shown on the Plans and the verification/proof test loading described in this specification. Joints shall develop the full vertical capacity, and at least 60% of the moment capacity of the casing. As installed, there shall be no joints within three feet or as shown on the plans from the bottom of the pile cap.

The steel casing shall have certified mill test reports and shall be submitted for record purposes as the materials are delivered. The steel shall be traceable back to the mill certifications, and be free from defects (dents, cracks, tears, etc.). Two coupon tests shall be provided with each truckload delivery.

New "mill secondary" steel pipe/casing will not be accepted even if accompanied by coupon test results.

Permanent steel casing shall be installed a minimum of 12 inches into intact bedrock.

ITEM 945.10 thru 948.61 (Continued)

Reinforcing Bars: Central reinforcing steel shall be full-length, continuously threaded bars. The bars shall conform to ASTM A615/AASHTO M31 Grade 60 or Grade 75, or AASHTO M 275 Grade 150 as shown on the Contract Documents. The grade and size of the central reinforcement shall conform to any minimum and/or maximum properties shown on the Plans.

Reinforcing Bar Couplings: Reinforcing bar couplers shall be in accordance with Section M8.01.9. Couplings shall develop at least 125 percent of the specified yield strength of the rebar in compression and tension. Third party testing is required to verify that the reinforcing bar couplings can develop at least 125 percent of the specified yield strength of the rebar in compression and tension.” Acceptance of the couplers shall be approved by the Engineer.

Admixtures for Grout: Admixtures shall conform to the requirements of ASTM C494 (AASHTO M194) and shall be selected from the Qualified Construction Materials List where applicable. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations or micropile top connections. Accelerators are not permitted. Admixtures containing intentionally added chlorides are not permitted. Admixtures shall be from the same manufacturer and shall be compatible with the grout and mixed in accordance with the manufacturer’s recommendations. Their use will only be permitted after appropriate field tests on fluid and set grout properties.

Admixtures that control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the review and acceptance of the Engineer.

Cement: All cement shall conform to ASTM C150 (AASHTO M85) Type I, Type II, Type III, or Type V and shall be the product of one manufacturer.

Centralizers and Spacers: Centralizers and spacers shall be fabricated from schedule 40 PVC pipe or tube, or material non-detrimental to the reinforcing steel. Wood shall not be used.

They shall be securely attached to the reinforcement; sized to position the reinforcement to provide the grout cover specified in the table below; sized to allow grout tremie pipe insertion to the bottom of the drill hole; and sized to allow grout to freely flow up the drill hole and casing.

Minimum Grout Cover for Steel Reinforcement

Condition	Minimum Cover on Bar (in.)	Minimum Cover on Coupler (in.)
Micropiles in Soil	1	¼
Micropiles in Rock	½	¼
Coated or Encapsulated Bars	½	¼

Grout: Neat cement mixture with a minimum 3-day compressive strength of 50 percent of the 28-day unconfined compressive strength and any minimum and/or maximum properties shown on the Plans. The grout shall be proportioned and mixed as to provide a fluid grout capable of maintaining

ITEM 945.10 thru 948.61 (Continued)

the solids in suspension without appreciable bleed. Preparation and placement of grout shall be in accordance with the recommendations of “Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete,” ACI 304.

Plates and Shapes: Structural steel plates and shapes for pile top attachments shall conform to M8.05.0, ASTM A709, and have minimum yield strength of 50 ksi.

Water: Water for mixing grout shall conform to AASHTO T26 and shall be potable, clean, and free from substances that may be injurious to cement and steel.

Fillers: Inert fillers such as sand (conforming to ASTM C144/AASHTO M45) may be used in the grout in special situations, such as presence of large voids in the ground or when grout take and travel are to be limited, with prior written approval by the Engineer.

CONSTRUCTION METHODS**QUALIFICATIONS**

The Micropile Contractor must be experienced in the construction and load testing of micropiles and have successfully constructed at least 5 projects in the last 5 years involving construction totaling at least 100 micropiles with similar capacity and requirements specified in these plans and specifications. The Micropile Contractor shall have previous micropile drilling and grouting experience in soil/rock similar to project conditions and shall have available and be thoroughly familiar with the specialized type of equipment needed to perform work of this type.

The on-site foremen and drill rig operators shall also have experience on at least 3 projects over the past 5 years installing micropiles of equal or greater capacity than required in these plans and specifications.

Prior to the Pre-construction Meeting, the Micropile Contractor shall submit the following information to verify the firm’s experience and the qualifications of personnel scheduled to perform the micropile design (load test frame) and construction:

1. Submit a list of at least five micropile projects successfully completed in the last five years. Include construction details, structural details, load test reports, and client contact for each project listed.
2. Submit a list of the equipment and resources the Micropile Contractor plans to mobilize and utilize for the performance of the project.
3. Provide the names and detail the experience of the micropile designer, on-site supervisor, foremen, and drill rig operators for this project.
4. A signed statement that the Micropile Contractor has inspected both the project site and all the subsurface information including any soil or rock samples made available in the Contract Documents.

Work on any micropiles shall not be started, nor materials ordered until the qualifications and submittals have been accepted by the Engineer. The Engineer may suspend the micropile construction if the Micropile Contractor substitutes unapproved personnel during construction.

ITEM 945.10 thru 948.61 (Continued)

Requests for substitution of field personnel shall be submitted to the Engineer for acceptance. Additional costs resulting from the suspension of work will be the Micropile Contractor's responsibility, and no extension in contract completion date resulting from the suspension of work will be allowed.

The Micropile Contractor shall have, on site during all micropile construction activity, a minimum of one Quality Control (QC) person responsible for QC of the micropiles during all phases of construction, who will monitor and document all QC inspection and testing activities required by the specifications and outlined in the accepted procedures and Working Drawings. The QC person shall be a certified NETTCP Concrete Technician.

MICROPILE PRE-CONSTRUCTION SUBMITTALS

The Contractor shall prepare and submit to the Engineer: shop drawing, micropile installation plan, construction procedures, load testing procedures, and equipment calibration for review and acceptance. Verify the limits of the micropile structure before preparing the detailed working drawings. The Contractor shall allow the Engineer four (4) weeks to review the submittal after a complete set has been received. Work shall not begin, nor materials ordered until all submittals have been received, reviewed, and accepted in writing by the Engineer.

The micropile submittals shall include:

A. Plans

1. A plan view of the micropile layout identifying the locations of micropiles, numbering system for records, and verification test and proof test micropile locations.
2. An elevation view of the test micropile(s) showing:
 - I. A typical detail of test micropiles defining the micropile length, reinforcement, inclination, and load test bonded and unbonded test lengths.
 - II. Permanent casing length and diameter, casing plunge length, and grout bond zone length.
 - III. Estimated soil/bedrock strata.
 - IV. Instrumentation to be installed.
 - V. Minimum drill hole diameter.
 - VI. Splice type and locations.
 - VII. Centralizers and spacers.
 - VIII. Corrosion protection details.
 - IX. Grout design strength.

Details for constructing micropile structures around utilities, as applicable.

ITEM 945.10 thru 948.61 (Continued)**B. Construction Procedures**

1. Detailed step-by-step description of the proposed micropile construction procedure, including personnel, testing, and equipment to assure quality control. This step-by-step procedure shall be shown in sufficient detail to allow the Engineer to monitor the construction and quality of the micropiles. Include methods of drilling the holes, advancing the casing, drilling through or removing obstructions, flushing drilled holes, installing reinforcement, and grout pressures.
2. If welding of casing is proposed, submit the welding procedure. All welding shall be done in accordance with the current AWS Structural Welding Code.
3. Information on space requirements for installation equipment that verify the proposed equipment can perform at the site.
4. Plan describing how surface water, drill flush, and excess waste grout will be controlled and disposed.
5. Certified mill test reports for the central reinforcing steel. The ultimate strength, yield strength, elongation, and material properties composition shall be included.
6. Certified mill test reports for the permanent casing. Certification that the permanent casing meets the supplemental requirements of SR15 shall be included.
7. Proposed Grouting Plan. The grouting plan shall include complete descriptions, and details for the following:
 - i. Grout mix design and type of materials to be used in the grout including certified test data and trial batch reports. The Micropile Contractor shall also provide specific gravity and density of the wet mix design.
 - ii. Methods and equipment for accurately monitoring and recording the grout depth and grout volume as the grout is being placed.
 - iii. Estimated curing time for grout to achieve specified strength. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance, and start of production work. During production, grout shall be tested in accordance with the Grout Testing Requirement specified herein.
 - iv. Procedure and equipment for Micropile Contractor monitoring of grout quality. At a minimum, the Micropile Contractor shall verify the specific gravity of the mixed grout prior to placement of the grout into each drilled micropile.

ITEM 945.10 thru 948.61 (Continued)**C. Load Testing Procedures**

Detailed plans and procedures for the proposed micropile load testing method. This shall include all drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and pile top movements in accordance with the Micropile Load Testing section of this specification.

D. Equipment Calibration

Calibration reports and data for each test jack, pressure gauge, master pressure gauge, and electronic load cell to be used. The calibration tests shall have been performed by a certified testing laboratory, and tests shall have been performed within 90 calendar days of the date submitted. Testing shall not commence until the Engineer has reviewed and accepted the jack, pressure gauge, master pressure gauge, and electronic load cell calibration data.

PRE-CONSTRUCTION MEETING

A mandatory pre-construction meeting will be scheduled by the Engineer and held prior to the start of micropile construction. The Design Consultant, MassDOT Resident Engineer, Prime Contractor, and Micropile Contractor, including QC personnel, shall attend the meeting. The preconstruction meeting will be conducted to clarify the construction and QC requirements for the work, to coordinate the construction schedule and activities, specifically those pertaining to excavation for micropile structures, installation of temporary sheeting, anticipated subsurface conditions, micropile installation and testing, micropile structure survey control, and site drainage control.

SITE DRAINAGE CONTROL

The Contractor shall control and properly dispose of drill flush and construction related waste, including excess grout, in accordance with related specifications within the Contract Documents, and all applicable local codes and regulations. Provide positive control and discharge of all surface water that will affect construction of the micropile installation. Maintain all pipes or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost. Upon substantial completion of the work, remove surface water control pipes or conduits from the site.

EXCAVATION

Coordinate the work and the excavation so the micropile structures are safely constructed and remain stable at all times. Perform the micropile construction and related excavation in accordance with the plans and accepted submittals. No excavation deeper than those specified herein or shown on the plans will be made above or below the micropile structure locations without written acceptance of the Engineer.

ITEM 945.10 thru 948.61 (Continued)**MICROPILE INSTALLATION****A. General**

The Micropile Contractor shall select the drilling method, the grouting procedure, and the grout pressure used for installation of the micropiles. The construction method shall incorporate any special construction requirements specified on the plans. The production micropiles and its construction method shall be identical to the accepted verification test piles.

When the plans require uncased drilling of the micropile into bedrock, the permanent and/or temporary casing shall be drilled a minimum 12 inches into intact bedrock or to a depth within the bedrock so as to prevent subsidence of over burden into the uncased and/or bond zone portion of the drill hole (i.e. the rock socket).

Piles shall be installed only in the presence of the Engineer's or MassDOT's Representative.

B. Drilling

The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to overlying or adjacent structures, buried structures, or utilities.

Temporary casing or other accepted method of pile drill hole support is required, when drilling within 10 feet of an existing foundation, or utility, and/or in caving or unstable ground, to permit the pile shaft to be formed to the minimum design drill hole diameter. The casing shall be of the type and thickness that can be installed without distortion. Casings that fail, fracture, or otherwise distort during drilling or after drilling shall, unless otherwise directed, be withdrawn or replaced at the Contractor's expense. The drill hole must be open along its full length to at least the design minimum drill hole diameter prior to placing grout and reinforcement. The Contractor's proposed method(s) to provide drill hole support and to prevent detrimental ground movements shall be reviewed by the Engineer. Detrimental ground movement is defined as movement which requires remedial repair measures, in order to maintain site conditions as determined by the Engineer. Do not progress a new hole, pressure-grout, or post-grout, within a radius of 5 pile diameters or 5 feet, whichever is greater, of a micropile until the grout for that micropile has set 24 hours or longer. Do not allow vibration or excessive wheel loads to influence piles during installation and construction.

Use of drilling fluid containing bentonite or any other non-reverting drilling fluid is not permitted. Use of polymer slurry to remove cuttings from the cased hole shall be approved by the Engineer.

Piles shall be installed using equipment capable of penetrating boulders, cobbles, bedrock, dense till material, granite blocks, timber, concrete, or other man-placed materials that hinder the advance of the pile.

Use of drop-type impact hammers and blasting are not permitted. Prior to the use of down the hole air drilling methods the Contractor shall provide temporary fencing or barriers as necessary to prevent cuttings from leaving the work area and entering the adjacent traffic lanes.

ITEM 945.10 thru 948.61 (Continued)

Micropiles shall not be installed using auger cast methods.

Permanent casing must be installed in a manner which will not loosen the adjacent soils and will result in intimate contact between the casing and the soil. Driving of casing will not be allowed. Drilling shall be performed such that cuttings and/or wash fluid return through the inside of the casing. External flush will not be allowed. The method of drilling used shall prevent the loss of ground due to erosion, jetting, or blow-in at the bottom of the casing. No open-hole drilling will be allowed unless accepted by the Engineer.

C. Ground Heave or Subsidence

During construction, the Contractor shall observe the ground conditions in the vicinity of the micropile construction site on a daily basis for signs of ground heave or subsidence. Immediately notify the Engineer if signs of movements are observed. The Contractor shall immediately suspend or modify drilling or grouting operations if ground heave or subsidence is observed, if the micropile structure is adversely affected, or if adjacent structures are damaged from the drilling or grouting. If the Engineer determines that the movements require corrective action, the Contractor shall take corrective actions necessary to stop the movement or perform repairs. When due to the Contractor's methods or operations or failure to follow the specified/accepted construction sequence, as determined by the Engineer, the costs of providing corrective actions will be borne by the Contractor.

D. Pipe Casing and Reinforcing Bars Placement and Splicing

Reinforcement shall be placed prior to grouting the drill hole. Reinforcement surface shall be free of deleterious substances such as soil, mud, grease, or oil that might contaminate the grout or coat the reinforcement and impair bond. Reinforcement in the bond zone [i.e. rock socket] shall extend the minimum required length.

The Contractor shall install all micropiles to the planned elevations.

Centralizers and spacers shall be provided at a maximum spacing of 10 feet on center. The upper- and lower-most centralizers shall be located a maximum of 5 feet from the top and bottom of the micropile, respectively. Centralizers and spacers shall permit the free flow of grout without misalignment of the reinforcing bar(s) and permanent casing. The reinforcing steel shall be inserted into the drill hole to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole. The Contractor shall re-drill and reinsert reinforcing steel when necessary to facilitate insertion.

Lengths of casing and reinforcing bars to be spliced shall be secured in proper alignment and in a manner to avoid eccentricity or angle between the axes of the two lengths to be spliced. Splices and threaded joints shall meet the requirements of the Material section. Threaded pipe casing joints shall be located at least two casing outside diameters (O.D.) from a splice in any reinforcing bar. When multiple bars are used, bar splices shall be staggered at least 1 foot.

ITEM 945.10 thru 948.61 (Continued)**E. Grouting**

Micropiles shall be grouted the same day the load transfer bond length is drilled, or the bond length shall be flushed prior to grouting procedures commence. The grouting equipment shall produce a grout free of lumps and undispersed cement. Admixtures, if used, shall be mixed in accordance with manufacturer's recommendations. The Contractor shall have means and methods of measuring the grout quantity and pumping pressures during the grouting operations. The grout pump shall be a positive displacement pump equipped with a pressure gauge to monitor grout pressure. A second pressure gauge shall be placed at the point of injection into the pile top. The pressure gauge shall be capable of measuring pressures of at least 145 psi or twice the actual grout pressure used, whichever is greater. The grout shall be kept in agitation prior to pumping. Grout shall be placed within one hour of mixing. The grouting equipment shall be sized to enable each pile to be grouted in one continuous operation. The grout volume being pumped shall be measured to an accuracy of 10 percent.

The hole shall be flushed with clean water immediately prior to grouting, to remove all contaminated water and cuttings. The hole shall be flushed through the grout pipe fully extended to the bottom of the hole with the temporary casing (if any) in place. The water shall be pumped at a high velocity until the wash water at the top of the casing is clear. After flushing, the depth of the hole shall be measured to confirm that the hole is clean and no sediment exists at the bottom of the drilled rock-socket/bond length. Installation of the steel reinforcing and grouting shall be done immediately after flushing. In case of delay, the hole shall be re-flushed and rechecked prior to grouting as directed by the Engineer.

The grout shall be injected from the lowest point of the drill hole, and injection shall continue until uncontaminated grout flows from the top of the pile. Temporary casing, if used, shall be extracted in stages ensuring that, after each length of casing is removed, the grout level is brought back up to the proposed level before the next length is removed. The use of compressed air to directly pressurize the fluid grout takes is not permissible. The tremie pipe or casing shall always extend below the level of the existing grout in the drill hole during grouting procedures. The grout takes shall be controlled to prevent excessive heave or fracturing of rock or soil formations. The entire micropile shall be grouted to the design cut-off level. Upon completion of grouting, the grout tube may remain in the hole, but must be filled with grout.

If the Contractor elects to use a post-grouting system, Working Drawings and relevant details including grouting pressure, volume, location and mix design, shall be submitted to the Engineer for review.

ITEM 945.10 thru 948.61 (Continued)**CONSTRUCTION QUALITY ASSURANCE****A. Location and Survey**

Micropiles shall be located and marked using survey and a template by the Contractor who shall maintain and be responsible for all location and elevation stakes.

B. Construction Tolerance

1. Centerline of piling shall not be more than 3 inches from indicated plan location.
2. Pile shall be plumb within 2 percent of total-length design plan alignment.
3. Battered piles inclined up to 1:6 shall be within 4 percent of design plan alignment.
4. Battered piles inclined greater than 1:6 shall be within 7 percent of design plan alignment.
5. Top elevation of pile shall be plus 1 inch or minus 2 inch maximum from vertical design elevation indicated.
6. Centerline of reinforcing steel shall not be more than 3/4 inches from indicated center of pile.
7. Minimum volume of grout placed shall be the 110% of the theoretical volume of the whole micropile length from bottom to top at time of grouting.

C. Grout Testing**Quality Control**

Grout within the micropile verification and proof test micropiles shall be quality control tested by the Micropile Contractor to ensure that it attains the minimum required compressive strength prior to load testing. To meet this requirement, a minimum of two sets of three, 2-inch grout cubes or 3-inch cylinders shall be cast for testing at 3 day and 28 day intervals unless the Micropile Contractor chooses to test at additional intervals.

During production pile installation, micropile grout shall be sampled and cured in accordance with AASHTO R64 (for cubes) or T23 (for cylinders). Testing by the Micropile Contractor for final compressive strength shall be in accordance with AASHTO T106 (for cubes) or T22 (for cylinders). The frequency shall be no less than one set of three cubes/cylinders from each grout plant each day of operation or per every 2 micropiles, whichever occurs more frequently.

Grout samples shall be taken directly from the grout plant (on-site mixer and pump). The Micropile Contractor shall provide grout cube or cylinder compressive strength and grout density test results to the Engineer within 24 hours of testing.

Grout consistency as measured by grout density shall be determined by the Micropile Contractor per API RP-13B-1 at a frequency of at least one test per pile, conducted just prior to start of pile grouting. The Baroid Mud Balance used in accordance with API RP-13B-1 is an approved device for determining the grout density of neat cement grout. The measured grout density shall be within $\pm 10\%$ of the density specified in the grout mix design submittal.

ITEM 945.10 thru 948.61 (Continued)

Acceptance

MassDOT will determine whether it will test 2-inch cubes or 3-inch by 6-inch cylinders for its Acceptance testing. The Contractor will be required to provide to MassDOT a sufficient amount of approved 2-inch cube molds or 3-inch cylinders. If it is determined that MassDOT will test 3-inch cylinders then a correlation between the 2-inch cube results and the 3-inch cylinders must be determined by MassDOT.

MassDOT will take the following sets of grout samples for acceptance testing:

1. Verification Test Piles – 4 sets of cubes or cylinders for 3-, 7-, and 28-day strength testing.
2. Proof Test Piles – 4 sets of cubes or cylinders for 3-, 7-, and 28-day strength testing.
3. Production Piles – 1 set of cubes or cylinders for 28-day strength testing per each day of operation or per every 2 micropiles, whichever occurs more frequently.

Pile verification or proof load testing shall not be performed until MassDOT has confirmed the grout has reached the minimum design strength.

D. Micropile Installation Records

The Contractor shall prepare and submit to the Engineer full-length installation records for each micropile installed. The records shall be submitted within one work shift after that pile installation is completed. The data shall be recorded on a micropile installation log. A separate log shall be provided for each micropile. The log for each micropile shall contain the following minimum information:

1. Project name, structure name, micropile number, and contract number.
2. Date and time of drilling, grouting, and completion.
3. Bottom elevation of the proposed footing and final top elevation of the micropile, to the nearest 0.1 feet.
4. Plumbness and deviation from design location and batter.
5. Micropile as-built information such as pile inclination, casing diameter and wall thickness, reinforcement size and length, casing length below bottom of footing, taped measurement inside casing to check cleanout, plunge length (cased bond length), bond length below casing, total pile length below and above bottom of footing, All dimensions shall be provided to the nearest 0.1 feet.
6. Drilling method, drill bit type and size, and drill operator's name.
7. Table showing the descriptions and approximate top and bottom elevation of each soil or rock layer encountered during pile drilling.
8. Grout mix, density, and quantity used, for initial grout and post-grout (if any) including cement type and admixtures.
9. Maximum and average grout pressure used during installation.
10. Damage (if any) to pile, description of any deviations from the design location and batter or from the approved pile design and installation procedures, and description of any unusual occurrences during drilling (including obstructions), installation, and grouting.

ITEM 945.10 thru 948.61 (Continued)

The example micropile installation log in the “Micropile Design and Construction Guidelines Manual,” Report No. FHWA-NHI-05-039 or FHWA-SA-97-070 can be used as a reference in developing the micropile installation log.

The Contractor shall also submit within 2 weeks after installation of all piles, an as-built plan, certified by a surveyor, showing the as-installed location of all piles to the nearest ½ inch.

MICROPILE LOAD TESTING**A. General**

The Contractor shall perform pre-production verification pile load testing on one sacrificial pile per bond zone bearing stratum and proof pile load testing on one pile per substructure unit or five percent of the piles, whichever is greater, in conformance with the approved working drawings and testing procedures. The location of the verification test shall be within 10 feet of the footprint of a substructure unit, but at least 5 feet from any production pile as selected by the Contractor and accepted by the Engineer. The production proof test pile(s) shall be at a location selected by the Contractor and accepted by the Engineer.

The load tests shall conform to the requirements of ASTM D1143 (vertical compression load testing) or ASTM D3689 (vertical tension load testing) except as modified herein. The maximum test loads shall be 150% of the Factored Design Load (FDL) for the micropile verification test and 100% of the FDL for Micropile Proof Test. The Factored Design Load is defined as the Factored Axial Design Load (compression and/or tension) as shown on the Plans. The maximum test loads shall be as specified above but not more than 80% of the structural capacity of the micropile elements, to include steel yield in tension, steel yield or buckling in compression, or grout crushing in compression. The structural elements of the verification test micropile may be modified for testing the FDL of the micropile as accepted by the Engineer. The Alignment Load (AL) should not be more than 0.04% FDL.

Before starting the work, the Contractor shall submit to the Engineer for acceptance, a pile load test plan including a written description of the equipment and methods which are intended to be used. The methods must be of an accepted type and shall be altered as necessary to meet the acceptance of the Engineer. The pile load test plan and description shall be prepared and stamped by a professional engineer registered in the Commonwealth of Massachusetts.

Grout within the micropile verification test pile shall attain the minimum required 3-day compressive strength prior to load testing. The top elevation of the test pile shall be determined immediately before the load testing. The head of each micropile shall be cut-off level or capped to produce a level horizontal bearing surface.

The Contractor shall provide all personnel and equipment needed to perform the test, measure loads and movements, and record test data. A representative of the Department or the Engineer may observe and witness the test and record data independently. No testing is to be performed unless all the agreed representatives are present.

ITEM 945.10 thru 948.61 (Continued)

Testing equipment shall include dial gauges, dial gauge support, jack and pressure gauge, electronic load cell, and a reaction frame. The Contractor shall provide a description of test setup and jack, pressure gauge and load cell calibration curves in accordance with the submittals Section.

Design the testing reaction frame to be sufficiently rigid and of adequate dimensions such that excessive deformation of the testing equipment does not occur. Provide a reaction frame capable of safely supporting 125 percent of the maximum test load. Align the jack, bearing plates and stressing anchorage such that unloading and repositioning of the equipment will not be required during the test.

Apply and measure the test load with a hydraulic jack and pressure gauge. The pressure gauge shall be graduated in 100 psi increments or less. The jack pressure gauge shall have a pressure range not exceeding twice the anticipated maximum test pressure. The jack shall be positioned at the beginning of the test such that unloading and repositioning during the test will not be required.

Calibrate the test load jacking system including the hydraulic jack couplings, gas pump, pressure gauge, and hydraulic load cell prior to the test so that the load applied is controlled to within 3 percent of the total applied load. Submit calibration reports prior to the start of the pile load test. Monitor the creep test load hold during verification tests with both the pressure gauge and the electronic load cell. Use the load cell to accurately maintain a constant load hold during the creep test load hold increment of the verification test.

Readings of settlement and rebound shall be referred to a fixed benchmark and shall be made using at least three dial gauges (micrometer dial extensometers) graduated to 0.001 inches and located 120 degree intervals around the micropile. The gauges shall be mounted on a reference beam supported at each end by reliable supports located at least 10 feet from the center of the test pile and independent from the jack, pile, or reaction frame.

The dial gauges shall have a travel sufficient to allow the test to be done without having to reset the gauges. Visually align the gauges to be parallel with the axis of the micropile. Readings shall be taken at intervals specified in the Verification Test and Proof Test section.

The Contractor shall establish a survey reference point on the test pile and another reference point at the center of the reference beam. The reference points shall consist of graduated scales machine-divided into 0.02 inch and attached securely to the pile and reference beam. The reference points shall be monitored using survey equipment during the pile load test.

Protect the settlement measuring system against rain, wind, frost, and any other disturbances that could affect the reliability of the settlement observations. Provide sun shading for the measuring system for the duration of the test and for a minimum of 1 hour prior to the start of the test.

ITEM 945.10 thru 948.61 (Continued)**B. Micropile Verification Test**

The Contractor shall perform pre-production verification pile load testing on sacrificial piles at a location selected by the Contractor and accepted by the Engineer. The location of the verification tests shall be within 10 feet of footprint of a substructure unit but at least 5 feet away from any production pile. Testing shall be performed in compression or tension in accordance with ASTM D1143 or ASTM D3689, respectively, except as modified herein.

Verification load tests shall be performed to verify that the Contractor installed micropiles will meet the required FDL and load test acceptance criteria and to verify that the length of the micropile bond zone is adequate. The drilling-and-grouting method and casing outside diameter shall be identical to those specified for the production piles as indicated on the Plans..

Verification test piles shall be installed at the location accepted by the Engineer. The steel core may need to have a higher strength or a larger diameter than for the production piles to accommodate the test load.

Verification test piles shall include at least two, 3/4-inch diameter PVC Schedule 40 pipes cast into the test pile to allow telltales to be installed for load testing. The pipes shall be securely fastened in straight alignment to prevent displacement during grouting. The pipes shall be sealed at the bottom with threaded steel caps and at the top with threaded PVC plugs. The pipes shall extend within one foot of the top and bottom of the bearing stratum (i.e. unbonded zone of the pile) at the test pile location. Strain gages may be substituted for telltales.

The micropile verification load test results must verify the micropile design and installation methods, and be reviewed and accepted by the Engineer prior to beginning installation of production micropiles. The test pile and reaction piles shall not be used as production piles.

Test verification pile to a maximum Test Load of 150% of the Factored Design Load (FDL) defined above, as indicated on the Plans. The verification pile load test shall be made by incrementally loading the micropile in accordance with the following cyclic load schedule:

ITEM 945.10 thru 948.61 (Continued)

Step	Loading	Applied Load	Hold Time (min.)
1	Cycle 1	AL	-
		0.075 FDL	4
		0.15 FDL	4
		0.225 FDL	4
		0.30 FDL	4
		0.375 FDL	4
2	Cycle 2	AL	1
		0.15 FDL	1
		0.30 FDL	1
		0.375 FDL	1
		0.45 FDL	4
		0.525 FDL	4
		0.60 FDL	4
		0.675 FDL	4
		0.75 FDL	4
3	Cycle 3	AL	1
		0.30 FDL	1
		0.60 FDL	1
		0.675 FDL	1
		0.75 FDL	1
		0.875 FDL	4
		0.90 FDL	4
		0.975 FDL	10 or 60 (Creep Test)
4	Cycle 4	AL	1
		0.30 FDL	1
		0.60 FDL	1
		0.90 FDL	1
		0.975 FDL	1
		1.05 FDL	4
		1.125 FDL	4
		1.20 FDL	4
		1.275 FDL	4
		1.35 FDL	4
		1.425 FDL	4
		1.50 FDL	4
		1.20 FDL	4
		0.90 FDL	4
		0.60 FDL	4
0.30 FDL	4		
AL	15		

ITEM 945.10 thru 948.61 (Continued)

Creep Test: Pile top movement shall be measured at each load increment. The load-hold period shall start as soon as each test load increment is applied. The verification test pile shall be monitored for creep at the 0.975 FDL. Depending on performance, either a 10 minute or 60 minute creep test shall be performed at the 0.975 FDL test load where movements shall be recorded at 1, 2, 3, 5, 6, and 10 minutes. When the pile top movement between 1 and 10 minutes exceeds 0.04 inches, the 0.975 FDL test load shall be maintained an additional 50 minutes. Movements shall be recorded at 20, 30, 50, and 60 minutes. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for micropile verification load tests are:

1. If the pile is tested in compression, acceptance will be based on the Davisson criteria. For this criterion, the ultimate load is defined as the load at which settlement measured relative to the top of the pile prior to the start of testing exceeds the sum of:
 - I. The theoretical elastic compression of the pile assuming the load applied at the top of the pile act over the full length of the pile, and
 - II. 0.15 inches plus 1 percent of the pile tip diameter.
2. If the pile is tested in tension, the ultimate load is defined as the load that produces an upward movement under load of 0.5 inch at the pile tip. The movement at the pile tip is:
 - I. Measured directly by tell-tale, or
 - II. Computed by deducting the theoretical elastic elongation of the pile from the upward movement measured relative to the top of the pile prior to the start of testing.
3. At the end of the 0.975 FDL increment, the test pile shall have a creep rate not exceeding 0.04 inch/log cycle time (1 to 10 minutes) or 0.08 inch/log cycle time (6 to 60 minutes or the last log cycle if held longer). The creep rate shall be linear or decreasing throughout the creep load hold period.
4. Failure does not occur at any load increment up to and including the maximum test load, 1.50 FDL. Failure is defined as load where the slope of the load versus head settlement curve first exceeds 0.025 in/kip.

At the completion of verification testing, test piles shall be removed down to the elevation specified on the plans or by the Engineer.

ITEM 945.10 thru 948.61 (Continued)

For the verification load tests, reports must be written and submitted to the Engineer within 3 working days of the load test completion. This report will either confirm the micropiles' resistance and bond lengths specified on the plans or reject the piles based upon the test results. This report shall be reviewed and acceptance by the Engineer prior to beginning installation of production micropiles. The contents of the verification load test report shall include:

1. Brief project description.
2. Description of site and subsurface conditions including information on the ground conditions at the location of the load test and a comparison to actual conditions encountered.
3. Key personnel including the drill rig operator, the superintendent, the grout plant operator, and any other personnel involved in the installation and testing of the micropile.
4. Micropile installation data including information such as length of the micropile (cased and uncased), number of bags of cement used to construct the micropile, size and type of casing and reinforcement, geology encountered (e.g. soil material, rock material, and water levels) during drilling, grouting record and grout testing results.
5. Results of load test including load-movement curves/figures and filled-out data sheets.
6. Statement of load test requirements and acceptance criteria.
7. Comparison of load test requirements and acceptance criteria.
8. Summary statement on the load test results.

If a tested micropile fails to meet the acceptance criteria, the Contractor shall modify the design, the construction procedure, or both. These modifications may include but not limited to modifying the installation methods, increasing the bond length, regrouting the pile via preplaced regrout tubes or changing the micropile type. Any modification that necessitates changes to the structure design shall be submitted as a revision to the Working Drawings and require the Engineer's review and acceptance. Additional load testing may be required until an acceptable pile load test meets the designated load test requirements.

ITEM 945.10 thru 948.61 (Continued)**C. Micropile Proof Test**

Proof test piles to a maximum test load of 1.00 FDL as defined above. Proof tests shall be made by incrementally loading the micropile in accordance with the following cyclic load schedule:

Step	Loading	Applied Load	Hold Time (min.)
1	Cycle 1	AL	-
		0.10 FDL	4
		0.20 FDL	4
		0.30 FDL	4
		0.40 FDL	4
		0.50 FDL	4
		0.60 FDL	4
		0.70 FDL	4
		0.80 FDL	4
		0.90 FDL	4
		1.00 FDL	10 or 60 (Creep Test)
		0.75 FDL	4
		0.50 FDL	4
		0.25 FDL	4
		AL	4

Creep Test: Pile top movement shall be measured at each load increment. The load-hold period shall start as soon as each test load increment is applied. The proof test pile shall be monitored for creep at the 1.00 FDL. Depending on performance, either a 10 minute or 60 minute creep test shall be performed at the 1.00 FDL test load where movements shall be recorded at 1, 2, 3, 5, 6, and 10 minutes. When the pile top movement between 1 and 10 minutes exceeds 0.04 inches, the 1.00 FDL test load shall be maintained an additional 50 minutes. Movements shall be recorded at 20, 30, 50, and 60 minutes. Dial gauges shall be reset to zero after the initial AL is applied.

The acceptance criteria for Micropile Proof Load Test are the same as those for the Micropile Verification Load Test, except as modified below:

1. The creep test shall be held at the end of the 1.00 FDL increment.
2. Failure does not occur at any load increment up to and including the maximum test load, 1.00 FDL

Within 3 days of the completion of each proof load, the Contractor shall submit a report confirming the micropiles' capacities and bond lengths specified on the plans or reject the piles based upon the test results. The contents of the proof load test report shall be the same as those in the report for the Micropile Verification Load Test.

ITEM 945.10 thru 948.61 (Continued)

If a proof-tested micropile fails to meet the acceptance criteria, the Contractor shall immediately proof test another micropile within that substructure. For failed piles and further construction of other piles, the Contractor shall modify the construction procedure. Failed micropiles shall be replaced at the Contractor's expense. Any modification that necessitates changes to the structure design shall require the Engineer's prior review and acceptance. Verification and proof tests will be re-performed if the micropile type is changed.

NON-CONFORMING PILES

Non-conforming piles include piles that are installed out of tolerance, are damaged, the volume of grout placed is less than the theoretical volume of the hole, or the grout tests do not indicate the specified strength has been achieved. The Contractor shall submit a written remedial action plan to the Engineer for approval. The remedial action plan shall indicate how to correct the problem and prevent its reoccurrence. To mitigate or remediate non-conforming piles, the Contractor may be required to provide additional piles or supplement piles to meet specified requirements at no additional cost to the Owner.

METHOD OF MEASUREMENT

Drilled Micropiles will be paid for at the contract unit price per Foot.

Micropile Verification Load Test and Micropile Proof Load Test shall be measured for payment per Each.

BASIS OF PAYMENT

Drilled Micropiles shall be paid at the contract unit price per Foot, complete in place and accepted. Payment for drilled micropiles shall be considered complete compensation for providing all materials, labor, equipment, proper disposal of drilling spoil, and incidentals to complete the work. There will be no separate measurement for mobilization and demobilization associated with this item. Any difference in the required length of permanent casing and micropile installed and accepted by the Engineer from the estimated lengths shall be measured for payment and/or credit. There will be no payment for differences in required length of temporary casing. The Micropile Contractor is also responsible for estimating the grout take. There will be no extra payment for grout overruns.

The Contractor shall anticipate encountering obstructions as noted herein and shall utilize equipment and methods necessary to advance through or remove the obstructions. The presence of obstructions, any lost production, replacement piles, and the removal of obstructions, if necessary, shall not be measured or paid for separately. Any costs associated with the presence of obstructions shall be considered incidental to the Drilled Micropiles Item.

ITEM 945.10 thru 948.61 (Continued)

Drilling tools that are lost during the drilling shall not be considered obstructions and shall be promptly removed by the Contractor without compensation. If removal will degrade the hole, the hole shall be abandoned with a new hole located by the Engineer. All costs due to lost tool removal, drilling a new hole and filling the abandoned hole shall be borne by the Contractor.

Micropile Verification Load Test and Micropile Proof Load Test shall be paid at the contract unit price per each completed and accepted test, for which payment shall be considered complete compensation for providing all design, materials, labor, equipment, load test report, and incidentals to complete the work including the installation and materials of the test pile and reaction piles, if used. This payment shall also include full compensation for cutting the pile to the elevation necessary to properly incorporate the pile in the structure. If a pile is not to be incorporate in the structure, this payment item includes cutting the pile to the grade necessary to avoid its interference with the proposed construction. Payment for Micropile Verification Load Tests shall also include full compensation for installing the test pile. Micropiles installed as test piles for Proof Load Tests, if incorporated in the final structures, the length of pile installed in place shall be paid for at contract unit price of Drilled Micropiles.

Payment Items

945.10	Drilled Micropiles	Foot
948.60	Micropile Verification Load Test	Each
948.61	Micropile Proof Load Test	Each

ITEM 986.2

MODIFIED ROCKFILL

CUBIC YARD

The work under this item shall conform to the relevant provisions of Section 983 of the Standard Specifications and the following:

DESCRIPTION

The work to be performed under this Item shall consist of the furnishing and installing of Modified Rockfill at the locations shown on the plans and cross sections.

There shall be 2' of modified rock fill placed over 1' of crushed stone. A layer of geotextile fabric for separation shall be placed between stone layers.

COMPENSATION

Modified rockfill will be measured for payment by the cubic yard, complete in place. The measurement shall not include the volume of crushed stone bedding.

Modified rockfill will be paid for at the Contract unit price per cubic yard, which price shall include all labor, materials, equipment and incidental costs required to complete the work. No separate payment will be made for excavation but all costs in connection therewith shall be included in the Contract unit price bid.

Crushed stone will be paid for separately under Crushed Stone, Item 156.

Geotextile will be paid for separately under Geotextile Fabric for Separation, Item 698.3.

Compost will be paid for separately under Compost Topdressing, Item 751.72.

Seeding will be paid for separately under Seeding, Item 765.421

ITEM 991.1 CONTROL OF WATER – STRUCTURE NO. C-19-040 LUMP SUM

The work under this item shall conform to the relevant provisions of Subsection 140.60 of the Standard Specifications, the Contract Drawings, and the following:

The work shall consist of installing and maintaining a temporary water control system in areas where culvert installation or retaining wall construction is performed as specified herein and shown on the Contract Drawings. The Contractor shall furnish all labor, materials and equipment required for completing the work.

The operations of Control of Water neither shall cause the accumulation of siltation nor any adverse effect to the water or the environment.

Work under this item shall include all materials, equipment, and labor needed to construct and install temporary control of water systems.

The temporary control of water systems shall be non-permanent which does not harm the ecology of the river, land under water, and surrounding land and shall be comprised of sand bag cofferdams or other approved impervious curtains, and dewatering to facilitate construction activities. Operations of Control of Water shall not adversely affect the quality of the required construction.

Work under this Item also includes pumping operations, installation of earth berms, sandbags, filter fabrics, weirs, stone, and all other means to collect, settle, and discharge water into Nashoba Brook during construction. Additionally, installation of crushed stone for bridge foundations required beyond the payment limits specified in the contract drawings shall be considered incidental to this Item.

As part of the work under this item, it is the responsibility of the Contractor to determine the need and extent of dewatering required.

SUBMITTALS

Prior to the commencement of any work at the site, the Contractor shall submit to the Engineer for review and approval, a detailed plan for water control, including the construction of the water control system, and a culvert and retaining wall footing placement sequence plan with a timetable and details specific to each of the phases of construction. The submittals shall include working drawings and calculations detailing the methods and materials proposed to account for all anticipated loads and construction conditions necessary to permit the work while maintaining a safe work area and protecting property from damage.

ITEM 991.1 (Continued)

The Water Control Plan shall include a Sedimentation and Erosion Control Plan and a Water Flow Diversion and Containment Plan. The plans shall be adequate in detail to define specifics regarding materials, sizes, connections and incidental items associated with the work. The furnishing of such plans shall not serve to relieve the Contractor's responsibility for the safety of the work or his/her responsibility for the successful completion of the project. The proposed plans submitted shall be designed and stamped by a Professional Engineer registered in the Commonwealth of Massachusetts. The Contractor's attention is directed to the Order of Conditions included herein, for additional information on submittal requirements.

The Contractor shall make his/her own evaluation of existing conditions, groundwater level, water flow, the effects of his/her proposed temporary works and construction methods, and shall provide in his/her design for all loads and construction conditions necessary to permit construction of the specified structures while maintaining public safety, and protecting completed work and all third party property from damage due to his operations. The Contractor shall also provide a description and details of the intended methods to prevent debris, including airborne particles, from entering Nashoba Brook during the entire project duration.

Sedimentation and Erosion Control Plan: The Contractor shall submit to the Engineer, plans and details of the intended sedimentation treatment basin system that will be used along with dewatering techniques, and its location at the bridge site. All discharge resulting from dewatering activities shall be directed to temporary sedimentation treatment basins at locations approved by the Engineer. At no time shall said discharge be directly released into the river. The proposed plan shall include methods and equipment necessary to discharge water from the sedimentation treatment basins. Sedimentation treatment basins shall be sized appropriately to adequately dewater from the proposed work zone while allowing sufficient time for sediments to settle out of the water, and with a depth such that a minimum of 18 inches of freeboard is maintained throughout its use.

Water Flow Diversion and Containment Plan: The Contractor shall submit plans and details along with a complete description showing any proposed systems for control of water and dewatering plan to the Engineer for his approval prior to the start of the work. The proposed plan shall include methods and equipment necessary to perform the work and shall include water discharge methods and equipment to bring water from the work zone to sedimentation treatment basin.

CONSTRUCTION METHODS

This work shall also include dewatering the excavation footprint of the culvert and wingwall footings, as needed to conduct the work. The dewatering discharge shall be directed to a temporary sedimentation treatment basin. Where sandbags are used, the bags shall not decay nor rip or tear during the installation, its service life within the waterway, or during the removal process. The Contractor shall not disturb the stream bed in order to avoid migration of silts and sands further downstream. The Contractor is responsible for researching the seasonal groundwater levels and flow characteristics of the Nashoba Brook to determine appropriate details.

ITEM 991.1 (Continued)

Measures to control the discharge of sediment or pollutants into the water resource areas shall include, but not be limited to the following:

1. Site construction areas outside the buffer zones and on relatively flat ground.
2. Schedule the work within the resource areas to avoid periods of anticipated high water (i.e. spring floods) and inclement weather.
3. Management of construction operations involving hazardous materials, such as refueling and maintenance of equipment within the resource areas.
4. Installation and continuous maintenance of water control measures throughout the project.
5. Treatment of all discharge resulting from dewatering activities through a sedimentation/detention basin to control turbidity. At no time shall the discharge from dewatering activities be directly released into a resource area.

The locations of any sedimentation/retention basins will be determined by the Contractor based on the selected methods of construction. Placement of the basins shall be in an upland area that is within the existing right of way.

All dewatering and related water control work shall be conducted in such a manner as to prevent siltation or contamination of the waterway. At a minimum, the settling basin shall be constructed of an earthen berm lined with geotextile fabric and surrounded by staked hay bales. The basin shall meet or exceed the following criteria:

1. The size and location of the basin shall be determined based on the size of the Contractor's pump and the anticipated groundwater levels and the need to perform culvert and footing placement in the dry.
2. The outlet/weir of the dewatering basin shall not cause erosion of the surrounding area. An approved method of controlling erosion, such as an erosion control blanket, stone, etc., shall be used at the outlet of the basin.
3. The Contractor shall not allow any sediment within the settling basin to accumulate to a depth of greater than 12 inches at any point in the basin, nor shall the water level be allowed to rise to a height of more than 24 inches.
4. The sedimentation treatment basin shall be designed with a minimum of 18 inches of freeboard, which must be maintained at all times.
5. The Contractor shall inspect the settling basin(s) at least twice daily when in operation.

ITEM 991.1 (Continued)

6. Damages shall be repaired immediately.
7. The settling basin outlet shall be cleaned daily.
8. The sediments within the settling basin shall be disposed of as approved by the Engineer.

Upon completion of water control, the materials and equipment used to maintain the cofferdam(s) (if needed) and sedimentation treatment basin(s) shall become the property of the Contractor and shall be removed by the Contractor from the site. The area affected shall be restored to its natural condition in a manner subject to the Engineer's approval.

METHOD OF MEASUREMENT AND PAYMENT

Control of Water – Structure No. C-19-040 will be paid for at the Contract lump sum price, which shall include, but not be limited to, the design of the water control systems, as well as all equipment, materials and labor needed for the installation, maintenance, removal, disposal of the materials used for water control, disposal of any siltation materials caused by the pumping operation, and installation crushed stone required beyond the anticipated payment limits specified in the plans. All costs required for permits, transport, special handling, inspection, testing, etc., shall be included in the Contract bid price, which shall also include all labor, materials, equipment, tools, and incidental costs required to complete the work.

ITEM 995.01**BRIDGE STRUCTURE,
BRIDGE NO. C-19-039 (BUJ)****LUMP SUM****SCOPE OF WORK**

Work under this Item shall conform to applicable provisions of Section 995 of the Standard Specifications and specific requirements stipulated below for component parts of the subject Item. For those component parts where no specific requirement is stipulated, the Standard Specifications shall apply, except for payment.

Work under this Item shall include all materials, equipment and labor needed to construct the following:

- Concrete abutments, pier, wingwalls, and curtain walls
- Keeper blocks
- Approach slabs
- Steel reinforced elastomeric bearings
- Metalized and painted steel girders
- Concrete deck slab, end diaphragms, and backwalls
- Protective screen
- Bituminous damp-proofing
- Membrane waterproofing

The work does not include any items listed separately in the proposal. Payment for materials shown on the Plans as being part of this bridge structure or which may be incidental to its construction and are not specifically included for payment under another Item shall be considered incidental to the work performed under this Item and shall be included in the unit price of the component of which they are a part.

ELASTOMERIC BRIDGE BEARING PAD**DESCRIPTION OF WORK**

The work to be performed under this item shall conform to the relevant provisions of Section M9.14.5 and the following:

SUBMITTALS

The Contractor shall submit to the Engineer for approval the following documents:

1. Prior to fabrication:
 - a. Written notification in accordance with M9.14.5
 - b. Shop drawings for approval in accordance with Section 5.02 of MassDOT's Supplemental Specifications to the Standard Specifications for Highways and Bridges.
 - i. Fabrication shall not begin until written approval of the submitted shop drawings has been received from the Department.
2. Upon delivery of bearing pads:
 - a. A Certificate of Compliance certifying that the elastomeric bearing pads meet the requirements of the contract specifications.

- i. A Mill certificate and certificate of compliance for the steel laminates shall accompany the bearing pads.
- b. Independent testing results as required below.
- c. Additional elastomeric bearing pads for MassDOT Acceptance testing as required below.

MATERIALS

Elastomer: The elastomeric compound shall be composed of 100% low temperature Grade 3 virgin crystallization resistant polychloroprene (neoprene).

Steel Laminates: The steel laminates shall meet the requirements of AASHTO M 251.

Internal Load Plates: The internal load plates shall conform to AASHTO M 270 Grade 36.

FABRICATORS

The National Transportation Product Evaluation Program (NTPEP) shall find the bearing pad fabrication plant to be in compliance with the Elastomeric Bridge Bearing Pad Technical Committee Work Plan.

FABRICATION

Bearing pads shall be fabricated to conform to the “Method B” design method outlined in the AASHTO LRFD Bridge Design Specifications.

The bearing dimensions including elastomer thickness and edge cover, number and thickness of steel reinforcing laminates, dimensions of load plates (if any), and the design shear modulus of the elastomer shall be as shown on the Plans.

The tolerances on the overall dimensions for the bearings shall be according to Table 2 of AASHTO M 251, except that the tolerance on the overall vertical dimension shall be limited to -0, +1/8” regardless of the design thickness.

SAMPLING

Sampling of bearing pads for testing shall be random and performed on a lot basis. Lots shall be divided into sublots of 10 bearings. For MassDOT Acceptance samples taken at the project, the sampling rate shall be one randomly selected full size bearing per every ten per lot. A lot shall be defined as the smallest number of bearings determined by the following criteria:

1. A lot shall not exceed a single contract quantity
2. A lot shall consist of bearings of the same size and configuration
3. A lot shall consist of bearings produced in a continuous manner from the same batch of elastomer and cured under the same conditions

All pads required for testing purposes in accordance with Subsection M9.14.5 of the Standard Specifications shall be considered as incidental to this item. The quantities listed in the Schedule

of Basis for Partial Payment only include the number of bearings required for construction and do not include the additional bearings required for conformance and destructive testing as outlined herein.

INDEPENDENT TESTING

Independent testing shall be performed by a nationally recognized testing laboratory approved by the Engineer which shall provide certified test results. Each Lot of bearings as defined above shall be randomly sampled and tested. The minimum testing shall be in conformance with Sections 8 and 9 of AASHTO M 251 as specified below:

1. Materials shall meet Section 4 of M 251
2. Dimensions per Section 8.4 of M 251
3. Elastomer per Section 8.6 of M 251
4. Compressive Strain at maximum dead and live load (service) per Section 8.8.1 of M 251
 - a. The compressive deflection of each bearing shall not exceed 10% of the design effective rubber thickness at a compressive load equal to the maximum design load
5. Short Duration Compression Test per Section 8.8.2 of M 251
6. Shear Modulus of the Elastomer per Section 8.9.1 of M 251
 - a. The shear modulus shall be between 0.136 and 0.184 ksi.
7. Tensile Strength, Ultimate Elongation per ASTM D412
8. Shear Bond Strength per ASTM D429
9. Heat Resistance per ASTM D573
10. Compression Set per ASTM D395
11. Low Temperature Brittleness per ASTM D746 for Elastomer Grades 3

PACKAGING, HANDLING, AND STORAGE

The bearing pads shall be packaged, handled and stored in accordance with Section 18.1.3 of the AASHTO LRFD Bridge Construction Specifications. On the top of each completed bearing it shall be clearly identified and marked in accordance with M 251 Section 7. In addition, a 1/32" deep direction arrow shall be inscribed into the bearing which will allow the bearing to be aligned with the up-station direction. All marks shall be permanent and be visible after the bearing is installed.

INSTALLATION

The bearing pads and bridge seat bearing areas shall conform to Section 901.65A(3).

ACCEPTANCE

Requirements for providing notification to the Department prior to the start of bearing pad production as well as the provisions for random sampling of the bearings by the Department at the job site for additional destructive testing shall be in accordance with M9.14.5 and this specification. The Department shall use the results of the Independent testing as well as their own testing in the Acceptance of the bearing pads.

4000 PSI – 1½ IN. – 565 CEMENT CONCRETE**4000 PSI – ¾ IN. – 610 CEMENT CONCRETE****4000 PSI – ¾ IN. – 585 HP CEMENT CONCRETE**

The work to be done under this item shall conform to the relevant provisions of Subsection 901 of the Supplemental Specifications and the following:

4000 PSI, 1½ IN., 565 Cement Concrete shall be used to construct the abutment footings and stems, wingwall footings and stems, pier footing, approach slabs, and curtain walls.

4000 PSI, ¾ IN., 610 Cement Concrete shall be used to construct the backwalls and keeper blocks.

4000 PSI, ¾ IN., 585 HP Cement Concrete shall be used to construct the deck slab, end diaphragms, curbs, pier column and cap and those other areas designated by the Engineer, and/or as designated on the Plans. This concrete shall conform to all material requirements contained in Subsection M4.06.1 of the Supplemental Specifications, with the exception of cementitious content, which shall be limited to a maximum of 585 pounds per cubic yard.

PLACEMENT, FINISHING AND CURING OF CAST IN PLACE CONCRETE DECKS

The construction of the cast in place concrete deck shall be in accordance with Subsection 901.66 of the Supplemental Specifications and as modified by the following.

These procedures shall be followed only when the concrete bridge deck shall be cast entirely in the field. These procedures do not apply to any precast deck components, including precast full depth concrete deck panels and decks cast as part of a prefabricated bridge unit (PBU), or closure pours used to connect precast decks in the field.

Subsection 901.66 A

The entire existing Subsection 901.66 A shall be replaced by the following:

At least 30 calendar days prior to the proposed start of placing the concrete bridge deck, the Contractor shall submit to the Engineer for approval a Placement and Curing Plan that will specify all of the steps, methods, equipment and personnel that Contractor shall use to construct the concrete deck in compliance with these specifications. Approval of this plan will not relieve the Contractor of the responsibility for the satisfactory performance of his/her methods and equipment. The Placement and Curing Plan shall, at a minimum, specify:

1. The method that will be used to convey the concrete from the truck to all locations on the deck where it will be placed. This will also include the conveyance equipment, rate of concrete placement and the estimated time for the completion of all concrete placement, consolidation and finishing operations up to the start of curing.
2. The type and number of finishing machines and work bridges including the plan for erecting the rails and operating the finishing machine. This will include proof of the following minimum operator qualifications for the bridge deck finishing machine:
 - a) Five years experience operating machines or similar type and manufacturer as that proposed.
 - b) Proof of no less than five bridge decks of similar size, placed using a machine of the same manufacturer as that proposed.

Or, as a substitute for a. and b.:

- c) A representative of the manufacturer of the bridge deck finishing machine shall be present on the site a minimum of 24 hours in advance of the proposed deck placement to approve the setup of the machine and rail system, and the representative shall be present for the entire duration of the placement of the deck concrete using the bridge deck finishing machine.
3. The sequence of concrete pours, including any retarders or other concrete admixtures and dosage rates required to complete the placement, consolidation and finishing operations prior to curing in accordance with the Contractor's intended sequence of operations.
4. The provisions for consolidating the concrete including the number of vibrators and number of personnel that will be dedicated exclusively for this operation.
5. The method for curing the concrete deck. This will include the number of personnel that will be exclusively dedicated for this operation, the means for pre-wetting the burlap, the location of the wet burlap at the work site, the means for conveying the wet burlap to the work bridges and the amount of wet burlap that will be required to completely cover the deck. It shall also include a letter certifying that the fogging equipment attached to the finishing machine produces atomized water droplets with an average droplet diameter of 0.003 inches (76 μm) or less that are uniformly distributed at a rate of at least 0.10 gallons/square foot/hour (4 liters/square meter/hour)
6. Consideration of weather conditions that can be anticipated at the time of placement of the deck concrete. When cold weather can be reasonably expected either within 7 days before the anticipated concrete placement, or during the 14 day wet curing period, the Contractor shall include detailed procedures for the production, transportation, and placement of the concrete, including: provisions for enclosures to protect the placed concrete, including a plan of heating devices, types and locations around structure and the means for holding the enclosure securely in place; cold weather curing procedures; and the means for monitoring the temperature of concrete during cold weather.
7. Equipment that will be used to measure ambient air temperature, concrete temperature and relative humidity of the air at the construction site.
8. The number of all other personnel, in addition to the ones already identified in bullets 4 and 5, who will be engaged in the concrete placement operation and their assigned tasks. All personnel, including the ones already identified in bullets 4 and 5, shall have the experience and skills appropriate to their working assignment
9. A contingency and backup plan in case of equipment failure.

A pre-placement meeting shall be held between the Contractor and the Engineer at least 2 weeks prior to the start of any concrete placement for the deck slab. The Contractor and the Engineer shall review all aspects of the approved Placement and Curing Plan.

Twenty four (24) hours before the scheduled start of concrete placement, the Engineer shall verify that all equipment and materials identified in the Placement and Curing Plan are onsite and have been tested to insure that they are in working order and are functioning as required. Upon the successful completion of this verification, the Engineer shall allow the concrete placement to proceed. If any equipment or material such as burlap is missing or equipment is malfunctioning, the concrete placement operations shall be canceled and shall not be re-scheduled until such time as the missing equipment or material is delivered to the site or the equipment has been repaired and is demonstrated to be in working order and functioning as required. The Contractor shall be responsible for any costs associated with the cancellation and rescheduling of the concrete placement operation that is due to missing equipment or material or malfunctioning equipment.

Subsection 901.66 B

The following shall be added to the requirements of the existing Subsection 901.66 B:

Cement concrete for bridge decks shall not be placed when the ambient air temperature exceeds 85°F (29°C) or is expected to exceed 85°F (29°C) during the placement of the deck. The Contractor shall measure the ambient air temperature, relative humidity of the air at the construction site and concrete temperature. Concrete temperature will be taken from the same sample used for slump and air content tests. These measurements will be taken prior to the commencement of concrete placement to determine the evaporation rate using Figure 1 and every hour thereafter until the end of the concrete placement, consolidation and finishing operation to check the evaporation rate in order to determine if it remains within the limits specified. To document the readings, the Bridge Deck Placement Environment form shown below shall be filled out by the Contractor and submitted to the Engineer.

Bridge Deck Placement Environment						
City/Town:				Date:		
Bridge Number:				Contract Number:		
Start Station:				End Station:		
X	Time Measured	Air Temp.	Relative Humidity (%)	Concrete Temp.	Wind Velocity	Evaporation Rate
Prior to Casting						
Hourly						
After Casting						
Signature - Contractor's Authorized Representative:				Printed Name:		
Signature - MassDOT Resident Engineer:				Printed Name:		

The existing Subsection 901.66 B 1 shall be replaced by the following:

1. Misting the surface of the concrete with pressurized equipment attached to the finishing machine until the curing cover is applied. The water mist shall be distributed at a rate of at least 0.10 gallons/square foot/hour (4 liters/square meter/hour). For example, on a deck that is 30 feet (9.1 meters) wide, the system must be able to apply at least 3.0 gallons of water per linear foot per hour (36.4 liters/meter-hour). The nozzles must produce an atomized fog mist that will maintain a sheen of moisture on the concrete surface without ponding. The atomized water droplets shall have an average droplet diameter of 0.003 inches (76 µm) or less. The area of coverage from each nozzle shall overlap all adjacent coverage areas by at least 12 inches (305 millimeters). Water that drips from the nozzles shall not be allowed to fall onto the concrete that is being cured.

The following shall be added to the requirements of the existing Subsection 901.66 B:

4. Reschedule the placement until such time as the environmental conditions are acceptable, such as at night or during early morning hours.

Subsection 901.66 D

The entire existing Subsection 901.66 D shall be replaced by the following:

The concrete shall be consolidated by means of approved high frequency internal vibrators (9000 – 12,500 vibrations per minute in concrete) that shall be applied in a manner to ensure the consolidation of the concrete throughout the full depth of the deck in advance of the finishing machine. The Contractor shall take preventive measures to insure that the vibrators during operation shall not damage the epoxy coated reinforcement. The Contractor shall have no less than 2 approved vibrators in service at all times during the placement of the first 30 cubic yards (27 cubic meters) per hour of cement concrete placed and shall have additional vibrators in service at all times at the rate of one vibrator per each additional 30 cubic yards (27 cubic meters) per hour of cement concrete placed. These vibrators shall be in operation in addition to the surface vibratory action from the vibrating pan(s) of the finishing machine. Consolidation by the vibrators shall leave the concrete free from voids and insure a dense surface texture, but the vibration of the concrete shall not be continued so long as to cause segregation or bleeding. A small uniform quantity of concrete shall be maintained ahead of the screed on each pass. At no time shall the quantity of concrete carried ahead of the screed be so great as to cause slipping or lifting.

EXPOSED CONCRETE DECK CRACK SEALING

Concrete crack sealing shall only be performed on concrete decks whose surface is to remain exposed as called for on the Plans. Concrete crack sealing shall not be performed on any concrete decks where any waterproofing membrane with an asphalt wearing surface shall be installed, since the waterproofing membrane seals any cracks present in the concrete deck surface from water infiltration.

After the 14 day concrete bridge deck curing period has been completed and prior to the application of loaded vehicles, the Engineer shall survey the entire deck to determine if there are any cracks present. The Engineer shall determine width of cracks found using a crack width indicating comparator card made of clear plastic with lines of specified width on the cards. These cracks are assumed to be non-moving and to have been caused by inadequate control of shrinkage or temperature stresses during curing. Cracks that are of structural concern shall be repaired by other methods determined by the Engineer. All required crack sealing and crack repairs shall be performed by the Contractor without additional compensation. The Contractor shall be required to seal cracks even if the environmental conditions during placement and curing satisfied specification requirements.

The type of Cement Concrete crack sealing required shall be determined as a function of the surface type and maximum crack width as follows:

Top surfaces of exposed concrete bridge decks with slopes up to and including 15%:

- Cracks less than 0.006" (0.15 mm) wide shall be ignored;
- Cracks greater than or equal to 0.006" (0.15 mm) wide and less than 0.020" (0.50 mm) wide

shall be sealed with an approved methacrylate;

- Cracks greater than or equal to 0.020" (0.50 mm) wide shall be sealed using either epoxy injection or methacrylate with a sand filler.

Undersides of bridge decks and top surfaces of exposed concrete bridge decks with slopes greater than 15%:

- Cracks less than 0.006" (0.15 mm) wide shall be ignored;
- Cracks greater than or equal to 0.006" (0.15 mm) wide and less than 0.020" (0.50 mm) wide shall be sealed with an approved silane sealer;
- Cracks greater than or equal to 0.020" (0.50 mm) wide shall be sealed using epoxy injection.

Before sealing, the concrete must be clean, sound, and free of any contaminants and surface moisture. Any other surface contaminants shall be removed by abrasive blast cleaning. Once all concrete surface contaminants are removed, the concrete shall be swept clean and blown off using oil-free compressed air immediately prior to applying the sealer.

Crack sealing materials shall be applied by skilled applicators under a supervisor with proven successful experience in applications with a similar scope of work. All crack sealing materials shall be applied strictly in accordance with the manufacturer's instructions within the allowable ambient temperature range restrictions. If a heated enclosure is used to accomplish this, the heating units shall be properly vented to the outside of the enclosure to prevent products of combustion from exhausting within the enclosure.

Silane Crack Sealer shall consist of a clear, breathable, high-performance, 100 percent solids by weight Silane sealer for protecting new and existing concrete surfaces. It must penetrate deeply, sealing out water, chloride ions, and acids, and prevent damage from freeze/thaw cycles. The Silane Crack Sealer material shall be listed on the MassDOT QCML.

The methacrylate crack sealer shall consist of a high molecular weight low viscosity methacrylate monomer. The methacrylate material shall, as a minimum, provide the following as applied properties:

Property	Value	Test
Viscosity	< 25 cps	ASTM D2393-86
Bond Strength	> 1500 psi	ASTM C882
Tensile Elongation	> 3%	ASTM D638

A dam shall be created on either side of the crack with silicone caulk. Methacrylate shall then be poured into the valley created by this dam. The methacrylate shall be refilled as necessary as it seeps into the crack to ensure the crack is completely filled. If large quantities of methacrylate are used and the crack is not getting filled, the crack should be filled with pre-bagged dried silica sand filler and the crack shall then be re-filled with methacrylate. Once the methacrylate stops seeping into the crack, the Contractor shall remove the silicone caulk dams and any remaining methacrylate contained within with a putty knife or other tool that can scrape them off the concrete surface.

Epoxy injection crack sealing shall be performed using an Epoxy-Resin for Cement Concrete Crack

Injection that conforms to AASHTO M235, Type IV, Grade I. The cracks shall be cleaned with compressed air. Surface mounted injection ports shall then be installed over the centers of the cracks and mounted with rapid setting epoxy material. The spacing of these ports shall be contingent upon the crack sealing material and the injection equipment chosen. Socket porting shall be allowed provided that a hollow drill bit and vacuum system is used to prevent debris from entering the cracks. The crack widths shall be noted during port installation. After the ports are installed, the crack surfaces shall be sealed with a high modulus, 100% solids, moisture tolerant epoxy paste adhesive. This material shall be capped with fine sand before it is cured. After the capping material has cured, the cracks shall be injected with the epoxy resin compound. The injection pressure used to seal the cracks shall be based upon a number of factors including crack width, crack depth, and the epoxy material used. Injection shall be accomplished using a metered system. The system shall be equipped with a pressure gauge accurate for the pressures anticipated for this work. Injection shall start at the widest point of the crack and shall continue until the narrowest portions of the crack have been filled. Injection shall continue until refusal. If epoxy is observed at adjacent ports, the adjacent port shall be capped and injection shall continue until refusal occurs. Once refusal occurs, injection shall continue at the next wet port until refusal is reached.

After the methacrylate and/or epoxy injection crack sealing has been completed and prior to cutting grooves in the concrete deck surface in accordance with Subsection 901.66 H 2 of the Supplemental Specifications, those deck areas where the repairs were made shall be ground down to the clean concrete substrate using a grinder in order to remove any cured methacrylate and/or epoxy paste remaining on top of the bridge deck surface. All surface mounted injection ports shall also be removed or ground down to the level of the surface of the bridge deck.

THERMAL SPRAYED COATING (METALIZING) SHOP APPLIED

PURPOSE

This section provides the requirements for shop performed surface preparation; the application of a thermal spray coating (TSC/metalizing); the application of a coating system; and includes field application of coatings and repairs and touch up of all coatings after site erection of the coated structure.

GENERAL INFORMATION

1. All fabrication shall be completed prior to the application of a thermal sprayed coating. (TSC)
2. All surfaces to be coated shall be cleaned in accordance with SSPC SP-5.
3. All TSC shall be sealed with an approved sealer, except for faying surfaces.
4. After site erection of the structure, perform field touch-up of any damaged coating.
5. All fasteners shall be galvanized and coated with the intermediate and topcoat if applicable.
6. The products of only one thermal spray wire manufacturer and one coating manufacturer shall be used on the entire project.
7. All field painting shall be in accordance with applicable sections of Item 961 of the MassDOT Standards and Specifications.

MATERIALS

Abrasives

Provide abrasives that are clean, dry, and sized properly to provide the specified surface profile. The profile shall be dense, uniform and of sufficient angularity to be acceptable for the application of TSC.

Abrasives shall conform to the following as applicable:

- SSPC-AB 1 for mineral slag abrasives
- SSPC-AB 2 for recycled ferrous metal abrasives
- SSPC-AB 3 for new steel abrasives

Thermal Spray Feedstock

The contractor shall provide material certificates from the supplier that includes the chemical composition and lot number of the wire. MassDOT will perform random sampling of wire from lots provided. Wire shall conform to ASTM A833. See table below for application and selection of wire type, thickness, and coating system.

Environmental Zone 3 shall be used for this project.

ENVIRONMENTAL ZONE*	WIRE TYPE	THICKNESS (mils)**	COATING SYSTEM***
1	Zinc-Aluminum	6-9	Three Coat
	Zinc-Aluminum	6-9	Sealer Only
2	Zinc- Aluminum	8-11	Three Coat
	Zinc-Aluminum	9-12	Sealer Only
3	Zinc Aluminum	9-12	Three Coat
	Zinc Aluminum	12-15	Sealer Only

***Zone 1** – Bridges in rural environments, not over waterways, and not over high speed state or interstate highways with potential for salt spray and heavy salt use and de-icing chemical use.

***Zone 2** – Bridges in urban environments, near industrial and manufacturing plants, power plants, or warehouses, over heavy road traffic, or over waterways.

***Zone 3** – Bridges in marine environments, over or close to saltwater waterways, or over high speed state or interstate highways with potential for salt spray and heavy salt use and de-icing chemical use.

** Mil thickness on faying surfaces shall meet the requirements of the slip certificate.

*** Coating systems shall consist of a three coat paint system applied over the metalized surface or a clear sealer applied over the metalized surface.

SUBMITTALS

Submit the following information to the MassDOT - Highway for approval a minimum of thirty days prior to beginning any coating operations:

- A. Manufacturer's recommendation and field history for the coating system proposed. Include data sheets for all selected coatings to be applied.
- B. Procedures for shop surface preparation, the application of the TSC and application of coatings.
- C. Procedures for coating of field connections.
- D. Procedures for field touch-up surface preparation, application of TSC and application of coating.
- E. Proposed abrasive for use in the shop.
- F. Proposed thermal spray wire to be used and product data sheets. Provide certification of Class B slip coefficient.

- G. A copy of SSPC-QP3/AISC (SPE) certification. This certification must be in effect at the time of bid and must remain in effect throughout the duration of the project.
- H. Quality Systems Manual
- I. Work schedule. Contractor must notify the Engineer a minimum of seven days prior to starting work.

QUALITY CONTROL

- A. The shop performing the application of TSC and coating shall be certified by the American Institute of Steel Construction (AISC) Sophisticated Paint Endorsement (SPE) quality program, or under the Society for Protective Coatings (SSPC) QP3 program, “Standard Procedure for Evaluating Qualification of Shop Painting Applicators” and shall maintain certification throughout the project.
 - 1. The coating applicator shall have completed a minimum of three structural steel TSC projects that utilized the same coating system as that being specified on this project. Provide project locations, TSC/painting; name, e-mail address, and the telephone number of the owner or owner’s representative.
- B. Provide an on-site Quality Control Specialist (QCS) who shall function as a TSC inspector with a minimum of five years of each TSC and coating application experience; and possess SSPC BCI Level 1 or NACE Certified Level 3 or other related certification as accepted by the MassDOT - Highway. The QCS shall not be a foreman or a member of the Contractor’s production staff. The QCS’s sole purpose shall be quality control testing, inspection and reporting.

PRE-APPLICATION MEETING

A pre-application meeting will be held prior to any steel fabrication that includes the application of thermal spray applied coatings. This meeting is separate from the pre-construction meeting for the entire project.

The following parties are required to attend this meeting: TSC/applicator, QCS, and MassDOT – Highway Representatives. Other project personnel should attend as may be needed.

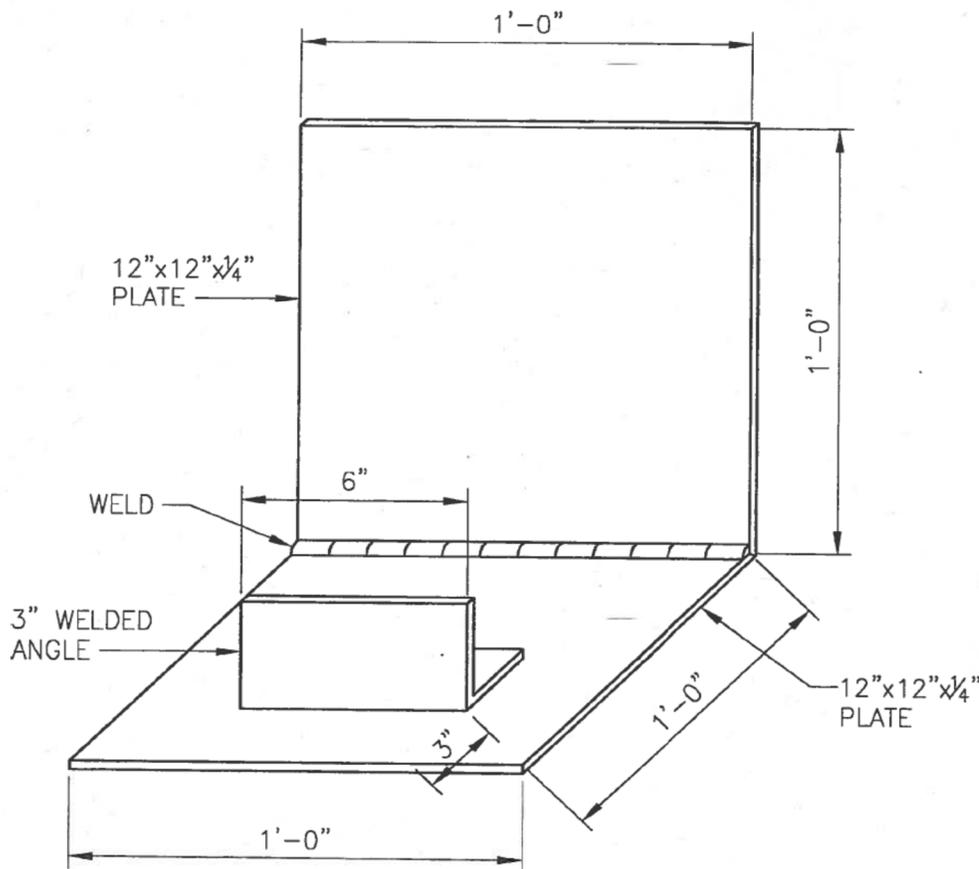
PERSONNEL QUALIFICATION

The applicators of the thermally applied material shall be individually qualified to apply the TSC as follows:

- 1. Each applicator must complete a practical test designed to demonstrate the ability to set up and operate the equipment to apply the material to the specified thicknesses to a minimum of 10 square feet of representative steel surfaces, and to successfully pass the surface preparation, bend, and cut tests specified herein. Administer the qualification testing, document the results in writing, and retain the bend test coupons for the duration of the project.
- 2. At the discretion of MassDOT - Highway, requalify the applicators at any time during the project to reconfirm the proficiency and the quality of the workmanship being provided. This may be required at any time due to unacceptable or failing results of the bend test, cut test, or poor workmanship.

SHOP QUALIFICATIONS

Prior to proceeding with the production blast cleaning operations prepare a minimum of five Job Reference Standards (JRS) test plates. Blast clean all surfaces of each test plate using the same equipment and abrasive that will be used for the production work. After acceptance of the surface cleanliness and profile, apply the TSC to all surfaces of each test plate. After acceptance of the TSC apply the sealer to be used with the three coat system to three test plates excluding the bottom surface of all test plates. After curing apply a coat of epoxy to two of the three test plates excluding the bottom surface. After curing apply a coat of the polyurethane topcoat to one test plates on all surfaces excluding the bottom surface. Apply the clear sealer to the last remaining TSC plate. Bottom surfaces of the prepared plates shall be used for cut testing as specified. Surface preparation and application shall be witnessed by a MassDOT representative. *See drawing below for dimensions and construction*



Configuration of JRS Test Plates

SURFACE PREPARATION

For cleaning that utilizes compressed air, utilize only clean, dry air. Conduct blotter test(s) in accordance with ASTM D4285 a minimum of one time each shift for each compressor system in use to verify that the air supply is free of moisture and oil contamination. Conduct the tests in the presence of the MassDOT – Highway Representative.

Weld Spatter, Sharp Edges, Flame-Cut Steel, Holes, Fins, and Silvers

Remove slag, flux deposits, fins, slivers, burrs, and weld spatter from the steel. Grind any sharp edges around holes. Break all flame-cut and sheared edges. If blast profile is degraded by grinding restore profile by abrasive blasting.

Solvent Cleaning

Where oil and grease are present on the bare steel, remove by solvent cleaning to SSPC-SP 1 prior to blast cleaning. If contamination remains after blast cleaning, reclean with solvent prior to application of the TSC.

Cleaning of galvanized bolts prior to the application of paint to bolted connections in the shop or in the field all galvanized fasteners shall be cleaned of all lubricating wax. Cleaning shall be in accordance with SSPC-SP-1, Solvent Cleaning, method 4.1.1. The contractor is responsible to identify the solvent and method needed to remove all lubricant. Cleanliness will be determined by the use of a white cloth wipe test. The test will be performed by the engineer using a clean white cloth and the same solvent used by the Contractor for cleaning. The cloth shall be wetted and rung to a damp condition, placed on selected fasteners and rubbed with a twisting motion around the entire exposed surface of the previously waxed surfaces of the fastener. A minimum of 3 alternating rotations shall be done. Acceptance of cleanliness is with no color transfer to the cloth. A minimum of 10% of the bolts at each bolted connection shall be tested for cleanliness.

Abrasive Blasting

Blast clean all steel to, SSPC-SP5 “White Metal Surface Cleanliness.” Determine the SP5 condition by use of SSPC-Vis 1. In the event of a conflict between the pictorial standard and the written definition the written definition shall prevail. Abrasive blast cleaned surfaces shall have a dense, uniform pattern of sharp, angular depressions and ridges, between 3.5-5.0 mils.

Surface preparation is defined as complete when all remedial repairs have been performed and the piece is accepted by both QC and MassDOT QA.

Verification of the profile height will be performed in accordance with ASTM D 4417 Method C.

Manual Blasting shall have a minimum of one profile depth measurement every 10 to 20 ft², of blasted surface.

Automated Blasting shall have a minimum of two profile depth measurements every 100 ft². When acceptable results are obtained on three consecutive days in which testing is conducted, the test frequency may be reduced to two spot readings for every 1,000 ft² providing the preparation method remains unchanged. If unacceptable results are encountered during testing or the preparation method has changed in any way, testing will revert back to a frequency of two tests per every 100 ft², until acceptable results are once again achieved over a three day period.

Profile replica tape shall be filed with the project inspection records. The Engineer with the use of a surface profile comparator will randomly inspect angularity of the profile.

The use of steel shot is not permitted.

TSC AND COATING APPLICATION

Storage, Testing and Sampling

The Contractor shall provide protection from the elements and insure that the paint is not subjected to temperatures outside the manufacturer's recommended extremes.

Before the Contractor will be permitted to use any paint, the material provided for application shall have been sampled, tested and approved in accordance with Section M7. MassDOT's Research and Materials Laboratory needs a minimum of fourteen days after the receipt of samples to test and approve.

Mixing and Thinning

Before the paint is applied, each component shall be mechanically mixed to ensure the pigment is completely dispersed. Mixing of components shall be accomplished by mechanical mixing, boxing or hand mixing of components will not be allowed. Any special precautions or requirements for mixing by the manufacturer shall be followed. Paint shall be kept thoroughly mixed in spray pots or containers during application. The pot life shall not be exceeded or attempts made to extend pot life with the addition of solvent.

If it is necessary for any reason to thin paint it will be done in the presence of the Engineer, in accordance with the manufacturer's recommendations. Thinning must be performed using a measuring cup marked in ounces or milliliters. Other methods, such as eyeballing, are not acceptable. Thinner shall be supplied from and recommended by the same manufacturer as the paint system.

For multi component paints, the mixing of half or partial kits is not allowed. If the need for small quantities of paint is anticipated, the contractor should order materials accordingly.

Application

Prior to the application of any coating material, the Engineer's approval must be obtained. All surfaces painted prior to the Engineer's approval, shall require the complete removal of the coating applied.

Thermal Sprayed Coating

Apply the TSC within six hours after the final abrasive blast cleaning is performed. If the steel is blast cleaned and remains unmetalized for longer than six hours, or if cleaned steel exhibits evidence of rustback, blast clean it again prior to metalizing. Remove abrasive residue and dust from the surface. Apply the metalizing only after the MassDOT – Highway Representative has accepted the prepared surface.

Bend Testing for Evaluation of the TSC

Conduct bend tests of applied TSC each day prior to production application. Unless otherwise directed by the MassDOT - Highway, each day that TSC will be applied, conduct bend testing before beginning the production work. For each TSC applicator, blast clean five carbon steel coupons measuring 0.05 inches in thickness, 2 inches width, and between 5 and 8 inches in length. Use the same equipment and abrasive used for the production work. Have each applicator apply the TSC to five coupons in accordance with the requirements of this Section to dry film thickness between 8 and 15 mils. Conduct 180° bend testing on all five coupons using the appropriate mandrel in accordance with the requirements and acceptance criteria of SSPC-CS 23. Minor cracks that cannot be lifted from the substrate with a knife blade are acceptable. If lifting on any

of the coupons is possible, modify the surface preparation/TSC process until acceptable results are achieved before proceeding with the production work.

Apply the TSC in accordance with the requirements of the material supplier, this specification, approved procedures and SSPC-CS 23.

The completion of TSC is defined as after the spraying of TSC is complete and all remedial repairs have been performed and the piece is accepted by both QC and MassDOT QA.

Touch-up of bare steel and/or TSC damage shall be done with organic zinc rich primer. The total area subject to repair shall be no more than .50 % of the total square foot of the piece requiring repair. The dry film thickness of the applied coating shall be a minimum of 5 mils. Surface preparation for all repair areas shall be as specified in, "Surface Preparation and Abrasives" paragraph 3. The maximum individual repair shall be limited to 1 square foot. Areas larger than 1 square foot shall be re-blasted and the TSC applied in accordance with this document.

Sealer Coat

Apply the seal coat to the TSC after the MassDOT – Highway Representative has accepted the TSC. The seal coat shall be thin enough when applied to penetrate into the body of the TSC and seal the porosity. Added thickness to porous TSC should not be measurable. Typically the seal coat is applied at a spreading rate resulting in a theoretical 1.5 mils dry film thickness. Apply the seal coat in accordance with the manufacturer's instructions as soon as possible after the application of the TSC but in no case greater than 6 hours. Verify that the TSC surface is clean and dry prior to the application of the sealer. If grease, oil, or similar contaminants become deposited on the TSC, remove them in accordance with SSPC-SP 1 prior to the application of the seal coat.

Paint

Applied coatings shall not exhibit, runs, sags, holidays, wrinkling, pinholes, nap hair, topcoat gloss or color variations, or other film discontinuities.

Repair of unacceptable areas that involve removal of the coating system or part of it, shall require surface preparation and coating equal to that specified. Repair procedures used for any unacceptable coating shall be those supplied by the contractor and approved by the Engineer.

Application of full coats of paint shall be accomplished by spray equipment. Spray equipment shall meet the requirements of the coating manufacturer and be in proper working order.

Application by brush and roller will be allowed for limited access areas. Brushes and roller covers recommended by the coating manufacturer shall be used. Areas brushed and rolled will have a uniform thickness and be free of defects and excessive coating thickness.

All coating shall be applied according to the latest manufacturer's data sheet or approved recommendations. The maximum recoat times of the primer, intermediate and finish coats shall not be exceeded.

Application of coatings shall not be done when the relative humidity is above 85% or when the surface temperature of the steel is less than 5°F above the Dew Point. Paint shall not be applied when the surface temperature is below 50°F or when the surface temperature is above 110°F.

If requested by the Engineer the Contractor shall provide written instructions from the coating manufacturer indicating the length of time that each coat must be protected from cold or inclement weather (e.g., exposure to rain) during its curing or drying period.

Paint shall not be applied when, in the Engineer's judgment, conditions are or will become unsatisfactory for application and proper cure. All changes as to the application parameters other than specified must be the manufacturer's and presented in writing and approved by the Engineer. Ambient conditions should be closely monitored so that proper cure/drying is achieved prior to recoat. In no case shall a succeeding coat of paint be applied before the previous coat has cured/dried sufficiently for recoat as per manufactured data sheet.

If required, contaminated surfaces shall be cleaned in accordance with SSPC- SP 1 Solvent Cleaning method 4.1.1.

Measurement of the ambient conditions shall be done in accordance with ASTM, E 337 Test Method for "Measuring Humidity with a Psychrometer" (the Measurement of Wet and Dry bulb Temperatures).

When the primer has cured sufficiently for recoat, all bridge components to be painted shall receive a full intermediate coat.

When the intermediate coat has cured sufficiently for recoat, all bridge components to be painted shall receive the finish coat.

Coating Thickness

Apply the shop and field coats to the dry film thicknesses as specified.

1. Determine the cumulative dry film thickness of each coat using a magnetic dry film thickness gage in accordance with SSPC-CS 23 and SSPC-PA 2 with the following exceptions:
 - a. Take readings on each 100 square-foot increment of the surface.
 - b. The minimum specified thickness of the TSC must be achieved at each individual spot measurement location (i.e., the 20 percent under run allowed by SSPC-PA 2 is not permitted for the metalizing).
2. If the thickness of any coat (TSC, seal coat, intermediate coat or top coat) is less than specified, apply additional material in accordance with the manufacturer's instructions and this Section before applying the next coat. Before applying additional TSC, visually confirm that there is no evidence of oxidation or contamination on the surface.
3. Thickness of applied TSC greater than the contract specified shall be reported to the MassDOT-Highway QA inspector in writing prior to the end of the shift. The thickness of the applied TSC shall not be more than 120% of the specified range for the zone specified.
4. Application of TSC to faying surfaces that require a slip rating shall not be more than the maximum thickness specified in the environmental zone chart for each zone included in the materials section of this specification.
5. The minimum adhesion value of the unsealed TSC shall be the average of 3 spot reading resulting in an average of 700psi for each 500 sq/ft.

Access for MassDOT - Highway Inspection

Provide safe access and sufficient time for MassDOT - Highway inspections for any and all phases of the work, including but not limited to surface preparation, the application of each coat (including field coat), and for an inspection of the completed system.

Quality Control Documentation

Copies of Quality Control daily inspection and testing documents will be provided to the MassDOT – Highway Representative within 24 hours

BITUMINOUS DAMP-PROOFING

The work under this Item shall conform to the applicable provisions of Section 970 of the Standard Specifications and the specific requirements stipulated below for the component parts of this Item. For those component parts where no specific requirement is stipulated under Item 970, the Standard Specification shall apply except for coal tar pitch materials of any type shall not be used.

Work under this Item shall include all materials, equipment, and labor necessary to apply bituminous damp proofing to below grade concrete structures as shown on the plans and as provided in this special provision.

MATERIALS

- A. Primer: Use asphalt for primer according to ASTM D 41.
- B. Seal Coat: Use one of the following:
 - 1. Hot-Applied Asphalt Seal Coat. Refer to ASTM D 449, Type I.
 - 2. Cold-Applied Asphalt Seal Coat. Refer to ASTM D 449, Type I.
 - 3. Cold-Applied Emulsified Asphalt Seal Coat. Refer to ASTM D 1227, Type III.

SUBMITTALS

- A. Certification: The Contractor shall furnish a notarized Certificate of Compliance that all materials conform to the requirements of this specification.

CONSTRUCTION METHODS

Bituminous Damp Proofing for Below Grade Concrete Structures shall consist of a primer plus two (2) seal coats (mopped or sprayed). All coats shall be allowed to dry before applying the next coat. All other construction methods shall conform to Section 970.60.

SCHEDULE OF BASIS FOR PARTIAL PAYMENT

At the time of the bid, the Contractor shall submit on his/her proposal form a schedule of unit prices for the major component Sub-Items that make up Item 995.01 as well as his/her total bridge structure Lump Sum cost for Bridge Superstructure, Bridge No. C-19-039 (BUJ). The bridge structure Lump Sum breakdown quantities provided in the proposal form are estimated and not guaranteed. The total of all partial payments to the Contractor shall equal the Lump Sum contract price regardless of the accuracy of the quantities furnished by the Engineer of the

individual bridge components. The cost of labor and materials for any Item not listed but required to complete the work shall be considered incidental to Item 995.01 and no further compensation will be allowed.

The schedule on the proposal form applies only to Bridge Structure No. C-19-039 (BUJ). Payment for similar materials and construction at locations other than at this bridge structure shall not be included under this Item. Sub-Item numbering is presented for information only in coordination with MassDOT Standard Nomenclature.

ITEM 995.01 (Continued)

<i>Sub-Item</i>	<i>Description</i>	<i>Quantity</i>	<i>Unit</i>	<i>Unit Price</i>	<i>Total</i>
655.02	Timber Rail Fence on Bridge	430	FT		
660.1	Metal Pipe Rail	640	FT		
901.	4000 PSI, 1.5 IN., 565 Cement Concrete	620	CY		
904.	4000 PSI, ¾ IN., 610 Cement Concrete	25	CY		
904.4	4000 PSI, ¾ IN., 585 HP Cement Concrete	245	CY		
910.1	Steel Reinforcement for Structures - Epoxy Coated	109,360	LB		
911.1	Shear Connectors	1,840	EA		
933.	Elastomeric Bridge Bearing Pad	12	EA		
960.1	Structural Steel – Coated Steel	358,340	LB		
970.	Bituminous Damp-proofing	275	SY		
972.	Strip Seal Joint System	61	FT		

Total Cost of Item 995.01 = _____

ITEM 995.011 CULVERT STRUCTURE, CULVERT NO. C-19-040 (BUK) LUMP SUM

The work under this item shall conform to the relevant provisions of Section 995 of the Standard and Supplemental Specifications and these Special Provisions. This Item includes all material and labor necessary to complete the work in accordance with the schedule of Items included herein under Basis for Partial Payments and all other Items that are part of the work for which payment is not provided for elsewhere.

Work under this Item shall include all materials, equipment and labor needed to construct the following: precast concrete box culvert, headwalls, and retaining walls including concrete, reinforcing steel, bituminous damp-proofing and any incidentals required to complete the work.

The work does not include any items listed separately in the proposal. Payment for materials shown on the Plans as being part of this culvert structure or which may be incidental to its construction and are not specifically included for payment under another item shall be considered incidental to the work performed under this Item and shall be included in the unit price of the component of which they are a part.

The following Special Provisions shall apply to items included under Item 995.011:

STEEL REINFORCEMENT FOR STRUCTURES – EPOXY COATED

Steel reinforcement for structures and steel reinforcement for structures – epoxy coated shall conform to the applicable provisions of Section 901 and Subsections M8.01.0 and M8.01.7 of the Standard Specifications and the following:

Mechanical splices, if used, shall be compatible with epoxy coated rebar. Mechanical splices shall be as listed on the MassDOT qualified products list and shall develop 125% of the yield strength of the connected bars. Splices shall not have rebar stops. Mechanical splices and reinforcing supports shall be considered as included in the price per pound of Steel Reinforcement for Structures - Epoxy Coated, as stated by the Contractor and approved by the Engineer in the "Basis for Partial Payments".

Submittals

Details of splices, including manufacturer, sequence of installation and all relevant technical data shall be submitted to the Engineer for approval prior to installation.

Materials

Reinforcing bars shall be deformed bars rolled from new billet steel conforming to the requirements of ASTM A615 grade 60 and shall be epoxy coated, unless otherwise noted on the Contract Drawings. Epoxy coated reinforcing bars shall conform to AASHTO-M284.

4000 PSI, 1.5 IN., 565 CEMENT CONCRETE

The work under this heading shall conform to the relevant provisions of Sections 901 and the relevant provisions of Materials Section M4 of the Standard Specifications and the following:

Work under this Item shall conform to the applicable provisions of Section 995 of the Standard Specifications and the specific requirements stipulated below for the component parts of this Item. For those component parts where no specific requirement is stipulated, the Standard Specifications shall apply except for payment.

Work under this Item shall include all materials, equipment and labor needed to construct the following: retaining wall footings, retaining walls, headwalls, curtain walls, and culvert to wingwall closure pours

The work does not include any items listed separately in the proposal. Joint fillers, joint sealers, and construction joints shall be considered as incidental to the work involved in the furnishing and placing of concrete.

Construction Methods

Strict placing, vibrating, and form stripping practices shall be followed to achieve quality concrete. Voids and forming accessory holes shall be patched as necessary to match the surrounding texture and color to produce a uniform appearance.

PRECAST CONCRETE BOX CULVERT UNITS

GENERAL

This work shall consist of designing, fabricating, and installing a precast concrete box culvert and appurtenances. The box culvert sections shall conform to the dimensions (span and rise) and geometry shown on the Plans. Headwall and wingwall reinforcement and/or mechanical splicers for the headwall reinforcing shall be cast into the exterior sections as shown on the plans.

The work under these Sub-Items consist of fabricating, transporting and installing precast concrete box culvert sections and highway guardrail sections and includes all necessary labor, materials, and equipment to complete the work as shown on the Plans. The work shall conform to the MassDOT Standard Specifications and the requirements of the current AASHTO LRFD Bridge Construction Specifications, supplemented by the current relevant provisions of the latest edition of PCI MNL-116 (The Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products), except as noted herein. MassDOT contract documents shall take precedence over the AASHTO LRFD Bridge Construction Specifications and PCI MNL-116. M4.02.14 of the MassDOT Standard Specifications is superseded in its entirety by the requirements specified below.

QUALITY ASSURANCE

Quality Assurance.

Quality Assurance includes all the planned and systematic actions necessary to provide confidence that a product or facility will perform satisfactorily in service. It is an all-encompassing term that includes Quality Control by the Contractor and Acceptance by the Engineer. Quality Control is the system used by the Contractor to monitor and assess their production processes at the plant facility and installation activities at the project site to ensure that the final product will meet the specified level of quality. Acceptance includes all factors used by the Engineer to determine the

corresponding value for the product. Engineer Acceptance inspection at the plant facility is intended as a means of facilitating, and does not replace Contractor Quality Control.

Plant.

Fabricators shall be approved by MassDOT in accordance with Standard Specifications, Division I, Section 6.01 as well as MassDOT's concrete mix design prequalification program. The precast concrete plant shall be certified by the National Precast Concrete Association (NPCA) or the Precast/Prestressed Concrete Institute (PCI). All concrete for a given element shall be produced by a single company and plant, unless otherwise approved by the Engineer.

Fabricator Quality Control.

All precast concrete units shall be fabricated in accordance with the latest edition of PCI MNL-116 unless modified herein. QC inspection and testing shall be performed to ensure that the product is fabricated in accordance with the Contract Documents and PCI MNL-116. Copies of QC inspection and testing reports shall be provided to the MassDOT Representative.

A. Personnel.

The Fabricator shall submit to the designer proof of the following Quality Control Personnel:

1. A QC Manager with a minimum of 4 years continuous experience in the manufacture of precast concrete bridge units for state transportation agencies.
2. A Technician/Inspector having the Precast/Prestressed Concrete Institute (PCI) Technician/Inspector Level I or NorthEast Transportation Training and Certification Program (NETTCP) Precast Concrete Inspector, or higher.

B. Equipment.

The Plant Facility shall have the following equipment:

1. Air Content Meter Type A or B: AASHTO T 152
2. Air Content Meter Volumetric Method: AASHTO T 196 for lightweight concrete
3. Slump Cone: AASHTO T 119
4. Cylinder Molds AASHTO M 205
5. Concrete Testing Machine: AASHTO T 22
6. Screening Sieve: AASHTO T 27, AASHTO T 11
7. Curing Box: AASHTO T 23
8. Spread Test Base Plate for Self-Consolidating Concrete: ASTM C1611
9. All other equipment prescribed by AASHTO and ASTM standards for the tests to be performed by the Fabricator as specified
10. All other necessary items such as ovens, scales, hot plates, pans, thermometers, etc. that are necessary to perform the required tests

C. Inspection.

Quality Control personnel shall monitor and inspect the fabrication of each unit. Quality Control personnel shall record the maximum and minimum temperatures of the concrete, as appropriate, throughout the entire fabrication of the unit (prior to placement of concrete, during placement and during curing). Refer to Construction Methods – Plant Fabrication, Temperature Monitoring. A record of the inspection shall be reported on the Fabricator's Quality Control inspection report. Quality control inspection reports and documentation shall be provided to the Department's Inspector upon request.

D. Sampling and Testing.

At a minimum, Quality Control personnel shall randomly sample each Sublot of concrete produced and perform slump, air content, temperature, and compressive strength testing. A Sublot is defined as the concrete produced for each manufactured unit. In addition to random sampling and testing, the Fabricator shall perform slump, air content, temperature, and compressive strength testing on concrete that has been retempered with admixtures or hold-back water during production.

The Fabricator shall make a minimum of twelve (12) total cylinders (4 x 8 in.) per Sublot for 80% f^c (indicating stripping/curing termination), 7-day, 28-day, and/or 56-day testing. Sampling and testing shall conform to the requirements of Section M4.02.13 of the MassDOT Standard and Supplemental Specifications and AASHTO R 60, except that cylinders shall be cured in the same location and environment as the precast units they represent until concrete reaches 80% f^c after which the 28-day cylinders shall be standard cured per ASTM C31 and all other cylinders shall be field cured per ASTM C31. Cylinders may be cured in an alternate location if Engineer-approved match cure equipment is utilized that maintains the same concrete temperature and environment as the curing concrete in real time, using thermocouples, controllers and heaters.

E. Certificate of Compliance.

The Fabricator shall provide a Certificate of Compliance in accordance with Standard Specifications, Division I, Section 6.01, stating that QC test cylinders have achieved the design strength, f^c . A Certificate of Compliance shall accompany each shipment and shall be presented to the Engineer or designee upon delivery to the site.

F. Placement, Finishing and Curing Plan.

At least 30 days prior to the start of fabrication, the Contractor shall submit a proposed Placement, Finishing and Curing Plan to the Engineer for approval. This shall be an independent submittal, separate from the fabrication shop drawings. The Placement, Finishing and Curing Plan shall include the following:

- Method of placement
- Method of consolidation
- Method of finishing
- Method of curing
- Method and materials to be used for moisture retention
- Cylinder curing methods, location, temperature control and humidity control
- Method of controlling temperatures during placement and curing
- Method of monitoring and recording the temperature of concrete
- Proposed curing duration and temperature range

G. Dunnage Plan.

At least 30 days prior to the start of fabrication, the Contractor shall submit a proposed Dunnage Plan to the Engineer for approval. This shall be an independent submittal, separate from the fabrication shop drawings. The Dunnage Plan shall include the following:

- Proposed layout of units for storage in yard and during shipping
- Proposed layout of units during shipping
- Support and blocking point locations
- Support and blocking materials

H. Documentation.

The Fabricator shall maintain records of the following QC Documents as per PCI certification and at a minimum, the following:

1. PCI or NPCA certification documentation
2. Current qualifications and certifications for QC Manager and QC Technicians
3. Certificates of Compliance
4. Approved Shop Drawings
5. Approved Placing, Finishing and Curing plan
6. Approved Dunnage Plan
7. Manufacturer's Certification of Compliance for all admixtures
8. Completed QC inspection checklists
9. QC test report forms for all testing
10. Up-to-date approved mix designs
11. Trial batch test results
12. Non-Conformance Reports (NCRs)
13. Documentation of test results:
 - a.) Element identification
 - b.) Time and date of casting of each element
 - c.) QC concrete cylinder test results
 - d.) Quantity of concrete produced and batch printout
 - e.) Form-stripping date and repairs if applicable
 - f.) Curing methodology, equipment, materials and duration
 - g.) Temperature and moisture records during curing period

Acceptance.

The Engineer will perform Acceptance inspection, sampling, and testing to ensure conformance to the Standard and Supplemental Specifications as modified by the requirements herein, during fabrication and installation. All concrete units shall be accepted based on MassDOT's Acceptance inspection and testing results. Compressive strength results that do not reach Design Strength, f'_c , shall result in a Non-Conformance Report (NCR) issued by the Engineer.

A. Inspection.

An Engineer's Representative (Inspector) will be assigned to perform Acceptance activities during the fabrication of the precast units. This will include the examination of materials, work procedures, and the final fabricated product. The Inspector will monitor the adequacy of the Fabricator's QC activity and perform Acceptance inspection and testing, independent of the QC inspection and testing. Fabrication shall only proceed when the QC and Inspector are present at the plant facility.

The Fabricator shall allow the Inspector unrestricted access to the necessary areas of the plant facility during work hours. Work done while the Inspector has not been provided access shall be automatically rejected.

At least seven (7) days prior to the scheduled start of fabrication, the Fabricator shall contact the Engineer to provide notice of the scheduled start date. The Fabricator shall review the fabrication schedule with the Inspector prior to the start of fabrication.

Acceptance inspection and testing at the plant facility is intended as a means of facilitating the work. It does not constitute final "acceptance" of the product and will not relieve the Fabricator or Contractor from any responsibility in regard to imperfect material or workmanship and the necessity for replacing or correcting non-conforming product.

MATERIALS

Materials.

Materials shall meet the following specifications (if applicable):

General	M4.00.00
Portland Cement	M4.01.0
Blended Hydraulic Cements	M4.01.1
Fly Ash	M4.01.2
Cement Concrete	M4.02.00
Cement	M4.02.01
Aggregates	M4.02.02
Lightweight Aggregates	M4.02.03
Water	M4.02.04
Cement Concrete Additives	M4.02.05
Mortar for Filling Keyways	M4.04.0
Slag	AASHTO M 302
High Performance Cement Concrete	M4.06.1
Controlled Density Fill – Non-Excavatable	M4.08.0
Reinforcing Bars	M8.01.0
Epoxy Coated Reinforcing Bars.	M8.01.7
Cement Mortar	M4.02.15
Mortar for Filling Keyways	M4.04.0
Mechanical Reinforcing Bar Splicer	M8.01.9
Lifting Devices	PCI MNL-116

Mix Design.

The concrete for the precast concrete units shall be High Performance Cement Concrete, with mix design compressive strength, aggregate size, and cement content as shown on the plans and as previously approved by the MassDOT Research and Materials Section. Fabricator shall utilize a MassDOT approved mix design for these items. Concrete shall be controlled, mixed, and handled as specified in the pertinent portions of MassDOT Standard Specifications, and shall conform to the requirements specified herein.

Reinforcement Material.

The size, grade and coating of steel reinforcement and/or welded wire fabric shall be as indicated on the plans.

CONSTRUCTION METHODS – PLANT FABRICATION

Drawings.

Prior to performing any work under this Section, the Contractor shall have received approval for all shop drawings for the unit being worked on and any special Contract requirements, provided that a complete shop drawing package is provided for that unit.

The Contractor shall bear full responsibility and costs for all materials ordered or work performed prior to approval of the shop drawings or written authorization from the Engineer.

An approval stamp shall appear on every shop drawing sheet. Wet-stamping or wet-signing is not required, provided that the stamp and reviewer name are legible. The Fabricator's name and address shall appear on each sheet.

Resubmittal of "Approved As Noted" shop drawings is not necessary for minor revisions, provided that the correction can be clearly understood and is unambiguous without possibility of

misinterpretation. Shop drawings with questions or comments that require a response and/or additional information from the Fabricator must be resubmitted.

Contractor shall submit scaled shop drawings to the Engineer of Record for review and approval. The details of all inserts, anchors, mechanical reinforcing bar splicers, and any other items required to be cast into the members (whether detailed on the Contract drawings or provided for the Contractor's convenience) shall be shown on the shop drawings. Members shall not be fired or drilled into for attachment purposes. All hardware shall be galvanized except as otherwise noted. The shop drawings shall not include procedures for placement, finishing, and curing of concrete. These details shall be included in the Placement, Finishing and Curing Plan that is to be submitted to MassDOT Research and Materials Section as described under *Placement, Finishing, and Curing Plan*.

Box Culverts, Three-Sided Frames and Arches.

The Contractor shall submit design computations for the box culvert, rigid frame or arch units to the Engineer for review and approval. The computations shall be prepared in accordance with the latest AASHTO LRFD Bridge Design Specifications and the 2013 MassDOT LRFD Bridge Design Manual using English units and HL-93 live loading. The design computations shall consider all loadings as are appropriate for each stage of fabrication, shipment, construction, and upon completion. Design computations and shop drawings shall be prepared by a Professional Engineer licensed to practice in the Commonwealth of Massachusetts. Prior to fabrication, three sets of complete shop drawings (full size prints 24x36 in.) shall be submitted to the Engineer for approval showing, as a minimum, the following information:

1. Plan layout of the structure indicating the piece mark of each frame unit
2. The name and manufacturer of all reinforcing steel
3. Complete details of all precast units, including all dimensions and tolerances, locations and types of reinforcement, finish treatments, and concrete strengths at lifting and at 28 days
4. Joint dimensions and details including type and brand of joint sealing materials
5. Locations and methods of forming lifting holes, type and location of lifting devices, and the method of handling and transporting all precast units to the job site

The box dimensions provided on the plans are shown to establish the size of the proposed opening. The width and thickness of the box unit may vary depending upon the manufacturer's specifications provided that the opening size is maintained and all sections are consistent geometry (with the exception of unit length). The Contractor shall be responsible for modifying the dimensions of the units to compensate for elastic shortening, shrinkage, grade corrections, and other phenomena that make in-process fabricating dimensions different from those shown on the drawings. Approval of the shop drawings shall not relieve the Contractor from responsibility for the correctness of the dimensions shown.

Placement of Reinforcement – The minimum cover of concrete over the reinforcement shall be 2 inches. Reinforcement shall be assembled utilizing any combination of single or multiple layers of welded-wire fabric or deformed billet-steel bars. The welded-wire fabric or deformed billet-steel bars shall meet the spacing requirements shown on the plans and as approved by the Engineer. All reinforcement tie wires shall be epoxy coated.

Joints - The precast reinforced concrete box culvert shall be produced with joints/keyways per the manufacturer's recommendations, and as approved by the Engineer. The ends shall be manufactured such that when the sections are laid together they will make a continuous line of frames with a smooth interior surface free of appreciable irregularities, and in compliance with the permissible variations. The joints shall be sealed as recommended by the manufacturer.

Mechanical attachment of the box sections to each other is required. Shop drawings to provide details of how the box sections will be connected.

As a minimum, the joints between the culvert elements must be sealed by placing sections of 1½” diameter preformed mastic in each joint. The joint is then covered with a 9 inch self-adhering strip of rubberized asphalt flashing meeting the culvert manufacturer’s minimum specifications.

Joint sealing materials shall be compatible with the bituminous damp-proofing as shown on the plans and are subject to the review and approval of the engineer.

Marking - The following information shall be clearly marked on the interior of each box by indentation, waterproof paint, or other approved means:

- Culvert span and rise;
- Date of manufacture and lot number;
- Name and trademark of the manufacturer.

Damp-proofing - Bituminous damp-proofing shall be applied to all exterior box surfaces to be in contact with soil, as shown on the plans or as directed by the Engineer. This work shall conform to Section 970 of the Standard Specifications.

Pre-Production Meeting.

The Contractor shall notify the Engineer to determine if a pre-production meeting will be required to review the specification, shop drawings, curing plan, schedule, and discuss any specific requirements. The meeting shall be held prior to scheduling a Inspector (refer to Quality Assurance, Acceptance, A. Inspection), and at least seven (7) days prior to the scheduled casting of any precast unit or control section. The Contractor shall schedule the meeting, which shall include representatives of the Fabricator and the Department.

Reinforcement

The reinforcing bars shall be installed in accordance with Section 901.62 of the Supplemental Specifications, including tolerances for cover and horizontal spacing of bars. Components of mechanical reinforcing bar splicers shall be set with the tolerances shown on the plans. The reinforcing bars and mechanical reinforcing bar splicers shall be assembled into a rigid cage that will maintain its shape in the form and which will not allow individual reinforcing bars to move during the placement of concrete. This cage shall be secured in the form so that the clearances to all faces of the concrete, as shown on the plans, shall be maintained.

Tolerances.

Fabrication shall comply with tolerances specified on the plans. In the absence of specifications on the plans, tolerances shall comply with the latest version of the PCI MNL 135, Precast Tolerance Manual.

Forms.

Concrete shall be cast in rigidly constructed forms, which will maintain the units within specified tolerances to the shapes, lines and dimensions shown on the approved fabrication drawings. Forms shall be constructed from flat, smooth, non-absorbent material and shall be sufficiently tight to prevent the leakage of mortar. When wood forms are used, all faces in contact with the concrete shall be laminated or coated with a non-absorbent material. All worn or damaged forms, which cause irregularities on the concrete surface or damage to the concrete during form removal, shall be repaired or replaced before being reused. Any defects or damage of more than minor nature,

due to form work, stripping or handling, shall be cause for rejection, as defined in Repairs and Replacement, unless approved for repair through the NCR process.

Mixing of Concrete.

The concrete shall be proportioned as specified in M4.02.06 and mixed in accordance with M4.02.10. Copies of batch tickets shall be provided to the Inspector.

Placement of Concrete.

Before concrete placement operations begin, the Fabricator shall make all necessary arrangements and have all materials on hand for curing and protecting the concrete. Concrete placement shall not proceed until the Inspector is satisfied that all necessary steps have been taken to ensure adequate compliance with these Specifications. The Fabricator shall minimize the time to concrete placement (measured from start of mixing to completion of placement). In no event shall time to placement exceed 90 minutes. If the concrete mix is retempered during production, then additional sampling and testing shall be performed according to the Quality Assurance, Fabricator Quality Control, E. Sampling and Testing section, above.

During placement, the concrete shall maintain a minimum temperature of 50°F and a maximum temperature of 90°F. Concrete shall not be deposited in the forms until the Inspector has inspected and accepted the placement of the reinforcing steel. All items encased in the concrete shall be accurately placed in the position shown on the Plans and firmly held during the placing and setting of the concrete. Clearance from the forms shall be maintained by supports, spacers, or hangers and shall be of approved shape and dimension. Delays or shutdowns of over 30 minutes shall not be allowed during the continuous filling of individual forms.

Consolidation of Concrete.

Suitable means shall be used for placing concrete to prevent segregation or displacement of reinforcing or forms. The concrete shall be thoroughly consolidated by external or internal vibrators or a combination of both. Vibrators shall not be used to move concrete within the forms. Vibrators shall be used as specified in 901.63C and as directed by the Engineer. Concrete shall be placed and consolidated in a way that minimizes the presence of surface voids or bug holes on the formed surfaces.

If using Self-Consolidating Concrete, refer to the requirements provided under the Self-Consolidating Concrete section.

Exposed Surfaces of Precast Units.

As soon as conditions permit, before the concrete has fully hardened, all dirt, laitance, and loose aggregate shall be removed from the exposed concrete surfaces. Contractor shall not allow foot traffic on the uncured concrete until it has reached sufficient strength to prevent damage.

Temperature Monitoring.

The Fabricator shall limit the maximum concrete temperature to 158°F, and control the temperature of the concrete to ensure that it does not fall below 50°F before 80% f'_c is reached and 40°F before 100% f'_c is reached. Concrete temperature refers to the maximum and minimum internal temperature of the concrete. Temperatures shall be monitored using continuously recording temperature measuring devices that are accurate to within 1.8°F. At least two temperature sensors (thermocouples) shall be positioned to record the maximum and minimum anticipated concrete temperatures. The anticipated minimum temperature shall be measured with one or more thermocouples at a distance no greater than 2" from the surface of the thinnest section. The anticipated maximum temperature shall be measured with one or more thermocouples at the

center of the thickest section. Proposed temperature measurement locations shall be submitted to the Engineer for approval. Temperature recording devices shall be located within the curing enclosure and calibrated as required by PCI MNL-116 Section 4.18.4. The Fabricator shall measure and record internal concrete temperatures (T_i) as follows:

- Prior to placement of concrete to verify that $T_i \geq 50^\circ\text{F}$.
- Immediately after placement to verify that $T_i \geq 50^\circ\text{F}$ is maintained.
- During curing at regular intervals not to exceed one hour until verification of f'_c and concrete has cooled to within 40°F of the temperature of the ambient storage location.

Maximum heat increase and cool down rates shall comply with PCI MNL-116, Section 4.19. The Contractor shall furnish temperature logs recorded at a minimum frequency of once per hour to the Inspector as required, with each post-pour QC inspection report.

Methods of Curing.

During the concrete placement and curing cycle, the Fabricator shall conform to the curing requirements as specified in the following methods.

A. Water Spray Curing.

The curing cycle shall begin immediately after the concrete has hardened sufficiently to prevent surface damage from the water spray and end after a period of at least 5 days and $80\%f'_c$ is attained. All exposed surfaces of the precast unit shall be kept wet with a continuous fine spray of water during this period. All surfaces exposed by form removal shall receive water spray curing for the remainder of the curing period.

B. Saturated Cover Curing.

The curing cycle shall begin immediately after the concrete has hardened sufficiently to prevent surface damage from the saturated burlap and end after a period of at least 3 days and $80\%f'_c$ is attained. All exposed concrete surfaces on the precast unit shall be covered with water-saturated burlap during this period. All surfaces exposed by form removal shall be covered with water-saturated burlap for the remainder of the curing period.

C. Curing Covers.

Curing covers shall be Plastic Coated Fiber Blankets or Polyethylene Curing Covers. Proposed curing covers shall be submitted for approval to the Designer of Record with a copy to the MassDOT Research and Materials Section. The curing cycle shall begin immediately after the concrete has hardened sufficiently to prevent surface damage from the curing covers and end after a period of at least 3 days and $80\%f'_c$ is attained. All exposed concrete surfaces on the precast unit shall be covered with curing covers during this period. The Contractor shall ensure that the surface of the concrete remains wet until the covers are placed. If forms are removed, curing covers shall be placed over the exposed concrete. Adjoining covers shall overlap not less than 12 inches. All edges of the covers shall be secured to maintain a moist environment (100% minimum relative humidity). The concrete temperature of the precast unit shall not be less than 50°F until the period of at least 3 days is over and $80\%f'_c$ is attained.

D. Accelerated Curing.

Accelerated Curing shall comply with PCI MNL-116 as modified herein. Accelerated curing shall maintain 100% relative humidity during the curing phases. Curing shall be accomplished in the following phases using steam or radiant heat with moisture. The curing cycle shall begin upon completion of the Preset Period and end upon completion of the Accelerated Temperature Period.

1. Preset Period.

Accelerated curing of the precast unit shall begin after initial set of the concrete. The Fabricator shall determine the time of initial set according to AASHTO T 197 specifications for the full range of concrete temperatures proposed to be used during initial set. The temperature of concrete shall not exceed 104°F during initial set.

2. Ramp-up Period.

Once initial set is complete, the concrete temperature shall rise at a rate not to exceed 36°F per hour.

3. Accelerated Temperature Period.

Once the ramp-up period is complete, the unit shall be cured in a moist environment at a controlled elevated concrete temperature of at least 120°F for no less than 8 hours and no more than 48 hours, and may terminate once a minimum of 8 hours and 80% f'_c is attained. The maximum concrete temperature shall not exceed 158°F at any time.

4. Ramp-down Period.

The concrete temperature shall be reduced at a rate not to exceed 50°F per hour until the concrete temperature is within 40°F of the ambient temperature outside of the curing enclosure.

Stripping Strength.

The contractor shall not strip forms, or handle the precast concrete unit until concrete compression test cylinders indicate that a compression strength of 80% f'_c , or the value indicated on the approved drawings has been achieved

Finishing.

The finish of the precast units shall be as indicated on the plans.

Storage and Handling.

The precast element may be exposed to temperatures below freezing (32°F) when the chosen curing cycle has been completed, provided that the units are protected from precipitation with polyethylene curing covers until they achieve 100% of f'_c . Units shall maintain a minimum internal concrete temperature of 40°F until 100% f'_c is attained.

Precast units damaged during handling and storage will be repaired or replaced at MassDOT's direction at no cost to MassDOT.

Precast units shall be lifted at the designated points by approved lifting devices embedded in the concrete and in accordance with proper lifting and handling procedures.

Storage areas shall be smooth and well compacted to prevent damage due to differential settlement. Precast units shall be supported on the ground by means of continuous blocking in accordance with the approved dunnage plan.

Precast units shall be loaded on a trailer with blocking as described above in accordance with the approved dunnage plan. Shock-absorbing cushioning material shall be used at all bearing points during transportation of the precast units. Blocking shall be provided at all locations of tie-down straps. Precast units stored prior to shipment shall be inspected by the Contractor prior to being delivered to the site to identify damage that would be cause for repair or rejection.

Repairs and Replacement.

In the event defects are identified, they shall be classified in the following categories and a non-conformance report (NCR) shall be filed if required. The NCR shall be submitted to MassDOT for review. Defects in all categories shall be documented by plant Quality Control personnel and made available to MassDOT upon request. Any required repairs shall utilize materials listed on the MassDOT QCML.

Category 1, Surface Defects.

Category 1 defects do not need to be repaired, and an NCR does not need to be filed. Surface defects are defined as the following:

- Surface voids or bug holes that are less than 5/8-inch in diameter and less than ¼-inch deep, except when classified as Category 4
- cracks less than or equal to 0.006" wide
- cracks less than or equal to 0.125" wide on surfaces that will receive a field-cast concrete overlay

Category 2, Minor Defects.

Category 2 defects shall be repaired, but an NCR does not need to be filed. Minor defects are defined as the following:

- Spalls, honeycombing, surface voids that are less than 2 inches deep and have no dimension greater than 12 inches
- Cracks less than or equal to 0.016" that will not receive a concrete overlay
- Broken or spalled corners that will be covered by field-cast concrete

Minor defects shall be repaired according to the Guidelines for Resolution of Non-Conformances in Precast Concrete Bridge Elements, Report Number PCINE-17-RNPCBE. Cracks shall be sealed according to the PCI Repair Procedure #14 in PCINER-17-RNPCBE.

Category 3, Major Defects.

For Category 3 defects, the Fabricator shall prepare an NCR that documents the defect and describes the proposed repair procedure. The NCR shall be submitted to the Engineer for approval prior to performing the repair. Major defects are defined as the following:

- Spalls, honeycombing and surface voids that are deeper than 2 inches or have any dimension greater than 12 inches, when measured along a straight line
- Concentrated area of defects consisting of four or more Category 2 Defects within a 4-square foot area.
- Exposed reinforcing steel
- Cracks greater than 0.016 inch and less than or equal to 0.060" in width
- Bearing area spalls with dimensions not exceeding 3 inches
- Cracks, spalls and honeycombing that will be encased in cast in place concrete need not be repaired, but the limits and location of the defects must be documented with an NCR

Upon Engineer approval, defects and cracks shall be repaired according to the Guidelines for Resolution of Non-Conformances in Precast Concrete Bridge Elements, Report Number PCINE-17-RNPCBE and this specification. All repairs shall be completed at the expense of the Contractor.

Category 4, Rejectable Defects.

Rejectable defects as determined by the Inspector, RMS, and Engineer may be cause for rejection. Fabricator may submit an NCR with a proposed repair procedure, requesting approval. Some rejectable defects are defined as the following:

- Surface defects on more than 5% of the surface area which will be exposed to view after installation
- Minor defects that in total make up more than 5% of the surface area of the unit
- Cracks greater than 0.060" in width except as noted in Category 1.
- Elements fabricated outside of the specified tolerances

- MassDOT compressive strength testing that does not meet the specified Design Strength, f'_c

Delivery.

Units shall be stored for a minimum of 7 days after cast date, and prior to delivery the QC Compressive Strength Results shall reach Design Strength, f'_c . A Certificate of Compliance shall be generated as described under *Quality Control*, above, prior to delivery. Prior to delivery, all NCRs shall be signed off by the Inspector, and the Quality Control Manager. The Inspector and Quality Control Manager shall verify that any required corrective action has been completed.

The Quality Control Inspection Report shall be signed by the Plant Quality Control Manager certifying that the unit(s) have been fabricated in accordance with the specifications and the Plant Quality Manual. The Quality Control Inspection Report shall be provided to the Inspector prior to delivery.

The Certificate of Compliance shall accompany each shipment and shall be presented to the Engineer or designee upon delivery to the site. The Contractor shall inspect precast units upon receipt at the site. Precast units damaged during delivery shall be repaired or replaced at the Engineer's direction at no cost to MassDOT.

CONSTRUCTION METHODS – FIELD CONSTRUCTION**General.**

Precast concrete bridge elements shall be installed to the line and grade shown on the plans in accordance with the Contractor's approved erection procedures and in accordance with relevant provisions of these Standard Specifications. Prior to installation, the Engineer or designee shall confirm that Compressive Strength Results have achieved Design Strength, f'_c . Field construction staff shall verify that the Engineer has accepted all precast concrete bridge products prior to installation.

Assembly and Erection Plans.

Before erecting the precast units, the Contractor shall submit assembly and erection plans for review and approval by the Engineer. At the Contractor's option, assembly and erection plans may be submitted as one plan set.

Assembly Plans:

1. Include a timeline and descriptions of Quality Control activities throughout construction.
2. Include detailed sequence of construction and a timeline for all operations including installation of shims/leveling devices and installation of grout within shear keys.
3. Include leveling bolt assembly details and design calculations, if required.
4. Include methods and procedures for controlling tolerance limits both horizontally and vertically.

Erection Plans:

1. Preparation and submission of the erection procedures, including the information and calculations to be provided, shall be in accordance with the applicable requirements of Section 960.61, D. Erection and the following:
 - A. Follow applicable sections in Chapter 5 of the PCI Design Handbook for handling, erection, and bracing requirements.

Erection.

The Contractor shall supply competent workmen and equipment sufficient to install the precast concrete elements in a safe, accurate, workmanlike manner. Erection shall be performed in accordance with the approved erection procedure, as described in Section 960.61, Erection.

The precast concrete elements shall be lifted only by the lifting hooks, and the utmost care shall be taken to prevent distortion of the elements during handling, transportation or storage. The design of the lifting hooks shall be the responsibility of the Fabricator. The lifting hooks shall be designed to meet the requirements for lifting devices as specified under Section 960.61, Erection.

Filling of Shear Keys

Non-shrink grout, approved by the Engineer, shall be placed as shown on the plans and in strict accordance with the specifications and manufacturer's recommendations and instructions.

As required by the approved shop drawings, joints shall be filled flush to the top with non-shrink grout, and any vertical misalignment between adjacent elements shall be feathered out on a slope of 1 to 12.

Curing of grout or concrete shall be performed in strict accordance with the specifications and manufacturer's recommendations. Filling shall not be completed in cold weather when either the ambient temperature or the precast member's temperature is below the manufacturer's recommendation. No localized heating of either the precast members or of the air surrounding the element will be permitted in an attempt to reach application temperatures.

If the joints or voids are not filled within five days after the precast elements are erected, the Contractor shall cover and protect the openings from weather and debris until they are filled. Fill all lifting and erection anchor recesses with grout.

As a minimum, the joints between the culvert elements must be sealed by placing sections of 1½" diameter preformed mastic in each joint. The joint is then covered with a 9 inch self-adhering strip of rubberized asphalt flashing meeting the culvert manufacturer's minimum specifications.

Backfilling

Backfilling operations shall not begin until the following checks have been made;

1. The joints between exterior box units and wingwall stems are complete as shown on the plans;
2. All joint seals are properly placed.
3. Bituminous Damp-proofing has been applied.

Backfill shall be paid for under separate items. The backfilling procedures shall be in accordance with Sections 120, 150, and 170 of the Standard Specifications and Supplemental Specifications dated July 1, 2015, with the following modifications:

1. Fill shall be placed and compacted in layers not exceeding one foot in depth;
2. Dumping of fill shall not be allowed any nearer to the structure than 3.25 feet from a vertical plane extending from the back of the footing;
3. Backfill shall be placed as symmetrically as possible around the structure with differential depths of backfill on each side of the structure not exceeding 1.5 feet with respect to each other;
4. Compaction shall be achieved using hand compaction equipment for all fill within one foot of the structure;
5. The bare structure shall not be crossed by any equipment heavier than that specified by the frame manufacturer. All damage resulting from equipment damage shall be rectified to the satisfaction of the Engineer at no cost to the Department;
6. Construction equipment will not be permitted atop an uncompleted structure of in contact with the spray applied membrane waterproofing;
7. Construction equipment whose weight exceeds the design capacity shall not be permitted atop the completed structure under any circumstances;
8. The use of vibratory rollers for compaction purposes will not be permitted.

A representative of the manufacturer shall be on site at the commencement of the installation, at no cost to the MassDOT, to assist the Contractor. The representative shall offer advisory assistance only and shall not supplant the Contractor's representative, or the Engineer.

Natural Substrate Bottom

The natural substrate construction material is to be placed within the culvert as depicted on the plans. The intent of this item is to replicate within the culvert area an environment that is similar to the existing environment adjacent to the work area.

The Contractor shall excavate to install the new structures. Any material can be stockpiled and reused for the natural substrate bottom, provided the material is characteristic of the existing material at the work area, or meets the criteria below. Unless indicated otherwise within the contract documents, the elevations and conditions of the existing ground shall be maintained or to the maximum extent practicable.

If the excavated material is not suitable or there is not enough material, the natural substrate material shall be comprised of a fine to coarse sand and topsoil. Large angular stones shall not be used. Crushed stone and gravel borrow will not be accepted. Acceptance of natural substrate material shall be determined by the Engineer. Natural substrate material shall be considered incidental to this Item. No additional compensation shall be provided for procurement or placement of the natural substrate bottom.

BITUMINOUS DAMPROOFING

See 995.01 Special Provision.

Schedule of Basis for Partial Payment

At the time of bid, the Contractor shall submit on his/her proposal form a schedule of unit prices for the major component Sub-Items that make up Item 995.011 as well as his/her total bridge structure Lump Sum cost for Culvert Structure No. C-19-040 (BUK). The bridge structure Lump Sum breakdown quantities provided in the proposal form are estimated and not guaranteed. The total of all partial payments to the Contractor shall equal the Lump Sum contract price regardless of the accuracy of the quantities furnished by the Engineer for the individual bridge components. The cost of labor and materials for any Item not listed but required to complete the work shall be considered incidental to Item 995.011 and no further compensation will be allowed.

The schedule on the proposal form applies only to Bridge Structure No. C-19-040 (BUK). Payment for similar materials and construction at locations other than at this bridge structure shall not be included under this Item. Sub-Item numbering is presented for information only in coordination with MassDOT Standard Nomenclature.

BRIDGE STRUCTURE, BRIDGE NO. C-19-040 (BUK)

Sub-Item	Component	Quantity	Unit	Unit Price	Total
910.	4000 PSI, 1.5 IN., 565 CEMENT CONCRETE	40	CY		
910.1	STEEL REINFORCEMENT FOR STRUCTURES-EPOXY COATED	1600	LB		
915.111	PRECAST CONCRETE BOX CULVERT UNITS	19	EA		
970	BITUMINOUS DAMP-PROOFING	410	SY		

Total Cost of Item 995.011 = _____

ITEM 995.02**BRIDGE STRUCTURE,
BRIDGE NO. C-19-037 (BF4)****LUMP SUM****SCOPE OF WORK**

Work under this Item shall conform to applicable provisions of Section 995 of the Standard Specifications and specific requirements stipulated below for component parts of the subject Item. For those component parts where no specific requirement is stipulated, the Standard Specifications shall apply, except for payment.

Work under this Item shall include all materials, equipment and labor needed to construct the following:

- Concrete abutments, wingwalls, and curtain walls
- Keeper blocks
- Approach slabs
- Steel reinforced elastomeric bearings
- Galvanized and painted rolled steel beams
- Concrete deck slab, end diaphragms, and backwalls
- Timber bridge railing
- Bituminous damp-proofing
- Spray applied membrane waterproofing

The work does not include any items listed separately in the proposal. Payment for materials shown on the Plans as being part of this bridge structure or which may be incidental to its construction and are not specifically included for payment under another Item shall be considered incidental to the work performed under this Item and shall be included in the unit price of the component of which they are a part.

ELASTOMERIC BRIDGE BEARING PAD

See 995.01 Special Provision.

4000 PSI – 1½ IN. – 565 CEMENT CONCRETE**4000 PSI – ¾ IN. – 610 CEMENT CONCRETE****4000 PSI – ¾ IN. – 585 HP CEMENT CONCRETE**

The work to be done under this item shall conform to the relevant provisions of Subsection 901 of the Supplemental Specifications and the following:

4000 PSI, 1½ IN., 565 Cement Concrete shall be used to construct the abutment pile caps and stems, wingwall pile caps and stems, approach slabs, and curtain walls.

4000 PSI, ¾ IN., 610 Cement Concrete shall be used to construct the backwalls and keeper blocks.

4000 PSI, ¾ IN., 585 HP Cement Concrete shall be used to construct the deck slab, end diaphragms, and curbs and those other areas designated by the Engineer, and/or as designated on the Plans. This concrete shall conform to all material requirements contained in Subsection

M4.06.1 of the Supplemental Specifications, with the exception of cementitious content, which shall be limited to a maximum of 585 pounds per cubic yard.

PLACEMENT, FINISHING AND CURING OF CAST IN PLACE CONCRETE DECKS

See 995.01 Special Provision.

STRUCTURAL STEEL - M270 GRADE 50 GALVANIZED AND PAINTED

The work under this heading shall conform to the relevant provisions of Section 960 and shall include the furnishing and installation of galvanized steel beams and diaphragms for Bridge No. C-19-037 (BF4) as shown on the Plans. The Fabricator shall be approved by the Engineer in compliance with the requirements of Section 960.61. The Contractor shall submit the procedure for preparing and galvanizing the steel to the Engineer for approval.

Materials

All structural steel shall be Hot Dipped Galvanized according AASHTO-M111 and Section 960.64. All hardware shall be galvanized according to Section 960.64. The engineer shall inspect all Hot Dipped Galvanized coatings for damage during construction and repairs shall conform to Section 960.64.

MEMBRANE WATERPROOFING FOR BRIDGE DECKS - SPRAY APPLIED

DESCRIPTION OF WORK

The work under this Item shall conform to applicable sections of Section 965 of the Standard Specifications and the following:

The work to be performed shall consist of the furnishing and application of an approved cold liquid spray applied, seamless methyl methacrylate or polyurea membrane system and all concrete surface preparation work necessary to install the membrane system. The membrane system shall consist of the primer, the membrane, aggregated keycoat layer, and polymer modified tack coat.

GENERAL

Membrane waterproofing application shall be in accordance with the manufacturer's instructions. The Manufacturer's representative shall be present during the entire application and shall oversee surface preparation, installation and quality control testing. The handling, mixing, and addition of membrane components shall be performed in a safe manner to achieve the desired results in accordance with the Manufacturer's recommendations. All open flames and spark producing equipment shall be removed from the work area prior to commencement of application in accordance with the Manufacturer's recommendations. No smoking signs shall be posted at the entrances to the work. The Applicator shall be responsible for the protection of equipment and adjacent areas from overspray or other contamination.

Product approval shall require the demonstration, by the Manufacturer, that the membrane system meets the material specifications and that the entire membrane system is designed and tested as waterproofing for use on bridge deck applications. The Contractor and the Applicator shall agree

upon a schedule for coordination between trades working in the areas that are to receive the membrane waterproofing system.

SUBMITTALS

The Contractor shall submit to the Engineer for approval the following documents:

1. Initial submission:
 - a. The membrane system material specifications including product performance data.
 - b. Certified independent test reports demonstrating conformance to Table 965.2-1.
 - i. The independent lab shall be recognized by the National Cooperation for Laboratory Accreditation (NACLA) in Construction Materials Engineering and Testing (CMET) or an equal program approved by the Engineer.
 - All testing shall be performed by one independent lab unless approved by the Engineer.
 - ii. Independent testing reports must be dated within two (2) years from the anticipated start of membrane installation.
 - Samples for all required testing shall be fabricated at the same time. Test reports shall denote the lot of material as well as the sample fabrication and testing dates.
 - c. Safety data sheets (SDS) for all components.
 - d. MassDOT shall perform prequalification testing on the membrane.
 - i. Two (2) 10 inch by 10 inch square samples of the proposed membrane with smooth surfaces (no primer or aggregate in the keycoat) shall be provided to the Engineer. The samples shall be a minimum of 80 mils thick or the thickness used to pass the crack bridging requirement found in table 965.2-1.
2. At the pre-application meeting:
 - a. Manufacturer's written approval of the Applicator's qualifications
 - b. List of personnel performing the installation and the Manufacturer's representative performing the inspection and testing.
 - c. Installation procedure including storage and protection instructions as well as handling and mixing instructions.
 - d. List of application equipment to be used.
 - e. Manufacturer's written approval of the proposed polymer modified tack coat and the application rate that it shall be applied at.
3. A minimum of 48 hours prior to installation:
 - a. A certificate of analysis for the proposed polymer modified tack coat shall be submitted by the supplier of the tack coat to the Engineer for approval.
4. Upon completion of installation:
 - a. All QC installation test results for the tests specified in the materials section, including the name, address and contact person of the laboratory that performed the tests and the date of the tests.
 - b. A Certificate of Compliance certifying that the membrane waterproofing system materials and installation meet the requirements of the Manufacturer and the contract specifications.

MATERIALS

Only products pre-approved by the MassDOT Research and Materials section will be accepted for use. The membrane waterproofing system shall consist of:

- primer
- one or two coat rapid curing cold liquid spray applied seamless methyl methacrylate, polyurea, or polyurethane methyl methacrylate membrane
- aggregated keycoat layer
- polymer modified tack coat

The total minimum base thickness for the membrane shall be 80 mils measured over peaks. The membrane shall easily accommodate the need for day joints and patch repairs. The membrane shall be able to bridge live cracks up to 1/8 inch in width and meet the criteria specified in Table 965.2-1.

The membrane waterproofing system shall be asbestos-free. The primer shall promote adhesion of the membrane to the concrete surface. The chemical composition of the primer, membrane, aggregate keycoat and tack coat that make up the membrane waterproofing system shall conform to the Manufacturer's specifications for the material. All components shall be approved by the Manufacturer as being compatible for use with the specified membrane. Cleaning solvents shall also be approved by the Manufacturer for use with the membrane.

APPLICATOR QUALIFICATION

The waterproofing system shall be applied by an Applicator who is approved by the membrane waterproofing system Manufacturer. The Applicator shall be certified by the membrane waterproofing Manufacturer and have at least 2 years of experience in membrane installation. The Engineer shall receive the Manufacturer's written approval of the Applicator's qualifications at least fourteen (14) days prior to the application of any system component. This approval shall apply only to the named individuals performing the application.

MATERIAL DELIVERY AND STORAGE

All components of the membrane system shall be delivered to the site in the Manufacturer's original packaging, clearly identified with the products type and batch number. The Contractor shall provide the Applicator with a storage area for all components. The area shall be cool, dry, out of direct sunlight, and comply with relevant health and safety regulations. Copies of material safety data sheets for all components shall be kept on site at the Contractor's field office.

PRE-APPLICATION MEETING

A minimum of fourteen (14) days before the anticipated start of membrane application, the Contractor shall schedule and conduct a pre-application meeting at the site to review the approved submittals, and other pertinent matters related to the application including the schedule for coordination between trades. At a minimum, the Contractor, the Applicator, the Manufacturer's field representative and the Engineer shall be present at the meeting.

Table 965.2-1: Spray Applied Waterproofing Membrane Material Properties

PROPERTY	TEST	REQUIREMENTS
Solids Content		100%
Stability	ASTM C836	≥ 6 months
Crack Bridging (Neat Material + Aggregated Keycoat)	ASTM C1305*	Pass, no cracking
Extensibility after Heat Aging	ASTM C1522	For information only
Percent Elongation at Break	ASTM D638	≥ 130%
Tensile Strength	ASTM D638 Type IV @ 2 in/min	> 1,100 psi
Shore Hardness	ASTM D2240	≥ 40 D
Minimum Thickness (Membrane only)	ASTM D6132 or other approved method	≥ 80 mils minimum measured over peaks or ≥ thickness used to pass ASTM C1305 (Whichever thickness is greater)
Membrane Waterproofing System Adhesion to Concrete	ASTM D7234	≥ 100 psi minimum and failure in concrete
Water Vapor Transmission – Permeance	ASTM E96 Water Method Procedure B	≤ 1.0 perms [grains / (hr·ft ² ·in. Hg)]
Notes: * ASTM C1305 shall be modified to 25 cycles at -15°F no failure at 1/8 inch per hour.		

APPLICATION PROCEDURE

The installation procedure shall consist of preparation of the concrete surface and application of primer, membrane, aggregated keycoat layer, and polymer modified tack coat. Special attention shall be paid to the bridge deck surface preparation prior to the membrane waterproofing system application. A representative from the membrane manufacturing company shall be present for the entire duration of the membrane system application and shall have the responsibility to ensure that the membrane system is installed in accordance with the Manufacturer's requirements. The Manufacturer's representative shall be also responsible for the field testing including but not limited to adhesion bond testing, deck moisture content measurement, and all other required documentation and reporting.

The membrane waterproofing system shall not be applied in either wet, damp or foggy weather, or when the ambient temperature is 40°F or below or is forecast to fall below 40°F during the application period. The temperature of the concrete deck surface shall also exceed the dew point by at least 5°F.

The membrane waterproofing on bridge decks shall not be placed until the Contractor is ready to follow within 24 hours with the first layer of hot mix asphalt pavement; a longer period of time will be allowed only with prior written approval from the Engineer.

Where the areas to be waterproofed are bound by a vertical surface including, but not limited to, a curb or a wall, the membrane waterproofing system shall be continued up the vertical as necessary. A neat finish with well-defined boundaries and straight edges shall be provided.

1. CONCRETE SURFACE PREPARATION

Concrete surfaces which are to be waterproofed shall be screeded to the true cross section and sounded. All spalls and depressions shall be repaired prior to the application of the primer. Depressions shall be filled to a smooth flush surface with 1:2 mortar (1 part cement to two parts sand) or an approved rapid setting patching mortar that is compatible with the membrane waterproofing system. Other surfaces shall be trimmed free of rough spots, projections, or other defects which might cause puncture of the membrane so that the surface profile of the prepared concrete surface shall not exceed a ¼ inch amplitude, peak to valley.

The use of resin or wax-based deck curing membranes is not acceptable. Unless otherwise approved by the Engineer the concrete shall be cured for a minimum of seven (7) days and aged a minimum of 28 days including curing time, before application of the membrane waterproofing system. For precast, high early strength, or rapid setting concrete mixtures for closure pours the Engineer may consider a curing period less than 7 days. This consideration will be subject to the approval of the Manufacturer and the Engineer and may require a mockup simulating the anticipated construction schedule. If an expedited schedule is approved then results of moisture testing and adhesion testing performed on the actual bridge deck and closure pours by the Manufacturer's representative in accordance with these specifications must be performed and all results shall be submitted to the Engineer for approval prior to primer placement.

Immediately prior to the application of the primer, the concrete to which the membrane is to be applied shall be cleaned of all existing bond inhibiting materials in accordance with ASTM D4259 or as required by the Manufacturer. Dust or loose particles shall be removed using clean, dry, oil-free compressed air or industrial vacuums. The surface preparation shall produce a clean dry surface and insure that the concrete surface is free of bituminous product, surface laitance, oil staining, soiling, and dust.

Any exposed steel components to receive membrane waterproofing shall be blast cleaned in accordance with SSPC SP6 or as required by the Manufacturer and coated with the membrane waterproofing system within the same work shift.

2. APPLYING PRIMER

The primer shall only be applied when the temperature of the concrete deck surface exceeds the dew point by at least 5°F and when the concrete deck surface has a moisture content of 5% or less as confirmed by a portable electronic surface moisture meter supplied by the Contractor.

The primer shall be applied in a manner to ensure full coverage. The primer shall consist of one coat with an overall coverage rate of 125-175 ft²/gal unless otherwise recommended in the Manufacturer's written instructions. All components shall be measured and mixed in accordance with the Manufacturer's recommendations. The primer shall be spray applied using a single or multiple component spray system approved for use by the Manufacturer. If required by site conditions, brush or roller application shall be allowed. The primer shall be allowed to cure tack-

free for a minimum of 30 minutes or as required by the Manufacturer's instructions, whichever time is greater, prior to application of the first lift of waterproofing membrane.

A second coat of primer shall be required if the first coat is absorbed by the concrete. The membrane shall be applied within the primer re-coat drying time allowed by the Manufacturer but in no case shall it exceed 24 hours. Beyond this period, the surface shall be prepared again and re-primed following the Manufacturer's recommendations prior to membrane application.

3. APPLYING MEMBRANE

The waterproofing membrane shall be applied in a methodical manner. The Applicator shall follow the approved mixing and application procedure. Unless approved by the Engineer, the membrane shall be spray applied, with the mixing of the two components taking place at the nozzle, and shall be applied to the primed deck in accordance with the Manufacturer's instructions. The spray equipment shall be controlled so that the quantities applied may be monitored and shall allow for coverage rates to be checked.

Following the application of the membrane waterproofing system, the cured surface shall be visually inspected. If any defects or pinholes are found, an appropriate quantity of membrane material shall be mixed and repaired in accordance with Section 7 Repairs below. In all cases, the thickness of the repair shall be sufficient to bring the area up to the specified thickness. The thickness of the repair patch shall be a minimum of 80 mils, measured over peaks, or the thickness used to pass the ASTM C1305 Crack Bridging Test.

4. APPLYING AGGREGATED KEYCOAT

Following the membrane application, an additional layer of membrane or resin, compatible with the membrane, shall be spray applied to a thickness of 30 to 40 mils into which an aggregate approved by the membrane Manufacturer shall be broadcast ensuring a minimum coverage of 95%. The coverage rate shall be designated by the Manufacturer. The broadcast aggregate shall be durable and provide the required shear resistant to prevent the hot mix asphalt (HMA) from shoving. Aggregate shall have a minimum Mohs hardness rating of seven (7). Loose aggregate shall be removed with brooms or oil/moisture-free compressed air before applying the tack coat.

5. APPLYING POLYMER MODIFIED TACK COAT

The polymer modified tack coat shall be applied in accordance with the membrane Manufacturer's recommendations after a minimum of three hours from initial membrane application. The tack coat shall consist of either a polymer modified asphalt emulsion or a polymer modified asphalt binder approved for use by the membrane waterproofing Manufacturer and the Engineer. The tack coat shall be allowed to cool for a minimum of 1 hour prior to the application of the hot mix asphalt. The tack coat application rate shall be in accordance with the Manufacturer's recommendation. The application rate shall be monitored by the Quality Control personnel from the paving contractor in accordance with MassDOT approved procedures and shall be verified by the Engineer.

6. PAVING OVER MEMBRANE

Placement of the HMA surface shall be in conformance with Section 450.58 and the contract specifications. During paving, a light soap spray should be applied to the paving equipment wheels to prevent removal of the tack coat.

7. REPAIRS

If an area of membrane requires repair or if the membrane becomes damaged, a patch repair shall be carried out to restore the integrity of the membrane waterproofing system. The damaged area shall be cut back to sound materials and wiped with a solvent up to a width of at least 6 inches beyond the periphery of the damaged area, removing contaminants. The concrete shall be primed as necessary, followed by the application of the membrane. A continuous layer shall be obtained over the concrete with a 6 inch overlap onto the existing membrane. The solvent shall be as approved by the membrane waterproofing manufacturer. Repairs shall comply with the Manufacturer's guidelines for any over-coating times.

Where the membrane is to be joined to existing cured material and at day joints, the new application shall overlap the existing membrane/day joint by at least 4 inches. The existing membrane/day joint shall be cleaned of all contamination including tack coat material or dirt to an edge distance of a least 6 inches and wiped with a solvent as approved by the membrane waterproofing manufacturer.

8. MOCKUP TO VALIDATE BOND STRENGTH

A mockup shall be performed for those projects where the available concrete cure time may adversely affect the required bond strength of the spray applied membrane waterproofing system. A mockup using the approved spray applied waterproofing membrane shall be required before and as close as possible to the intended date of the deck slab waterproofing placement to emulate actual placement conditions. The mockup shall take place offsite and be representative of the specified final bridge placement and shall include placement and surface preparation of the concrete, installation of membrane waterproofing system, and placement of HMA pavement. The intent is to validate the adhesion tensile bond strength in accordance with ASTM D7234 using the membrane Manufacturer's primer and membrane.

Testing shall be performed as directed by the Engineer. Testing shall verify the adhesion bond strength and the moisture content on the deck. The moisture content shall be in accordance with Table 965.2-2. The mockup shall simulate the actual job conditions in all respects including air temperature, transit equipment, travel conditions, admixtures, forming, placement equipment, and personnel. If there are problems, the Engineer may require the Contractor to conduct more trial placements.

If weather conditions change between completion of trial testing and actual placement, adhesion bond testing and deck moisture testing shall be repeated as directed by the Engineer. Removal of the mockup concrete from the job site is the responsibility of the Contractor. In addition to the requirements contained herein, all weather and concrete temperature requirements contained in Subsection 901.64 shall be satisfied.

Acceptance of the mockup shall be the responsibility of the Engineer.

PROTECTION OF EXPOSED SURFACES

The Contractor shall exercise care in the application of the waterproofing materials to prevent surfaces not receiving treatment from being spattered or marred. Particular reference is made to the face of curbs, copings, finished surfaces, substructure exposed surfaces, and outside faces of the bridge. Any material that spatters on these surfaces shall be removed and the surfaces cleaned to the satisfaction of the Engineer.

CONTRACTOR QUALITY CONTROL

The following tests shall be conducted by the Manufacturer's representative and recorded on a test report form to be submitted to the Engineer. All test reports shall be submitted to the Engineer within 72 hours of the test completion. Testing shall be in accordance with Table 965.2-2.

- a. Deck moisture: The concrete deck surface moisture content shall be measured by the Manufacturer's representative. The representative shall determine if the deck moisture is suitable to allow for installation to proceed.
- b. Primer Adhesion: Random tests for adequate tensile bond strength shall be conducted in accordance with ASTM D7234 using the membrane Manufacturer's primer. Minimum bond strength of 100 psi and failure in the concrete will be required for acceptance.

Testing shall be at a frequency of 1 test per 5,000 square feet with a minimum of 3 tests per day. Areas smaller than 5,000 square feet shall receive a minimum of 3 tests.

- c. Film Thickness:
 1. Wet film thickness shall be checked every 300 square feet in accordance with ASTM D4414 using a gauge pin or standard comb type thickness gauge or a magnetic gauge. Film thickness checks shall be carried throughout the application process.
 2. Dry Film Thickness: If the membrane waterproofing system cures too quickly to perform wet film thickness testing, dry film thickness shall be checked every 300 square feet in accordance with ASTM D6132 using magnetic or ultrasonic gauges, or using a destructive method. If a destructive method is used, areas shall be repaired in accordance with Section 10 Repairs.
 3. During the Final Review, the cured membrane film thickness shall be checked by a dial thickness gauge.
- d. Pin Hole/Holidays: The entire surface of the membrane shall be inspected for pin holes and/or holidays by the Manufacturer's representative. All pin hole/holidays shall be located, marked for repair, documented, and repaired in accordance with a repair procedure developed by the Manufacturer and approved by the Engineer.
- e. Membrane Adhesion: Random tests for adequate tensile bond strength shall be conducted in accordance with ASTM D7234 using the membrane Manufacturer's primer and membrane. The portion of the membrane to be tested shall be separated from the rest of the membrane prior to performing the test so that only the portion under the dolly receives the tensile force. A minimum bond strength of 100 psi and failure in the concrete will be required for acceptance.

Testing shall be at a frequency of 1 test per 5,000 square feet with a minimum of 3 tests per day. Areas smaller than 5,000 square feet shall receive a minimum of 3 tests.

- f. Coverage Rates: Rates for all layers shall be monitored by checking quantity of material used against the area covered.
- g. Visual inspections shall be conducted throughout the application process. The Manufacturer's field representative shall take progress photos for incorporation with his final review report to the Engineer.
- h. The Manufacturer's representative shall take a representative sample of the membrane from that day's installation. The samples shall consist of two (2) 10 inch by 10 inch square samples of the membrane with smooth surfaces. The primer and aggregate shall not be incorporated into the sample. The sample shall be sprayed separate from the bridge deck on a non-adhesive surface using the same application techniques used for the deck. These samples shall be provided to the Engineer to be tested by MassDOT Research & Materials.

Table 965.2-2: Installation Quality Control Testing and Inspection Requirements

PROPERTY	TEST	FREQUENCY	REQUIREMENTS
Deck Concrete Moisture	Manufacturer's recommendation	1 per 5,000 ft ² and minimum of 3 tests	Manufacturer's recommendation
Primer Adhesion to Concrete	ASTM D7234	1 per 5,000 ft ² and minimum of 3 tests	≥ 100 psi minimum and failure in concrete
Film Thickness	Wet: ASTM D4414 Dry: ASTM D6132 or other approved method	1 per 300 ft ² and minimum of 3 tests	≥ 80 mils minimum measured over peaks or ≥ thickness used to pass ASTM C1305 (Whichever thickness is greater)
Pin Holes	Visual Inspection	Entire surface	No visible defects
Membrane Adhesion to Concrete	ASTM D7234	1 per 5,000 ft ² and minimum of 3 tests	≥ 100 psi minimum and failure in concrete

MASSDOT ACCEPTANCE

Acceptance of the membrane waterproofing system shall only take place once it is determined by the Engineer that the membrane has been installed in accordance with the special provisions and plans and that all necessary documentation has been submitted.

MassDOT shall perform visual inspection of the application and Quality Control during the installation of the membrane system. The two (2) 10 inch by 10 inch samples taken during installation shall be submitted to the Research & Materials section for verification testing.

Table 965.2-3: MassDOT Verification Testing

PROPERTY	TEST	REQUIREMENTS
Minimum Thickness (Membrane only)	ASTM D6132 or other approved method	≥ 80 mils minimum measured over peaks or \geq thickness used to pass ASTM C1305 (Whichever thickness is greater)
Percent Elongation at Break	ASTM D638	$\geq 130\%$
Tensile Strength	ASTM D638 Type IV @ 2 in/min	$> 1,100$ psi
Shore Hardness	ASTM D2240	≥ 40 D

FINAL REVIEW

The final review and visual inspection shall be conducted jointly by the Applicator, Contractor, Manufacturer's field representative and Engineer. Irregularities or other items that do not meet the requirements of the special provisions and the plans shall be addressed/repared at this time, at no additional cost to the MassDOT.

BITUMINOUS DAMP-PROOFING

See 995.01 Special Provision.

SCHEDULE OF BASIS FOR PARTIAL PAYMENT

At the time of the bid, the Contractor shall submit on his/her proposal form a schedule of unit prices for the major component Sub-Items that make up Item 995.02 as well as his/her total bridge structure Lump Sum cost for Bridge Superstructure, Bridge No. C-19-037 (BF4). The bridge structure Lump Sum breakdown quantities provided in the proposal form are estimated and not guaranteed. The total of all partial payments to the Contractor shall equal the Lump Sum contract price regardless of the accuracy of the quantities furnished by the Engineer of the individual bridge components. The cost of labor and materials for any Item not listed but required to complete the work shall be considered incidental to Item 995.02 and no further compensation will be allowed.

The schedule on the proposal form applies only to Bridge Structure No. C-19-037 (BF4). Payment for similar materials and construction at locations other than at this bridge structure shall not be included under this Item. Sub-Item numbering is presented for information only in coordination with MassDOT Standard Nomenclature.

ITEM 995.02 (Continued)

<i>Sub-Item</i>	<i>Description</i>	<i>Quantity</i>	<i>Unit</i>	<i>Unit Price</i>	<i>Total</i>
655.02	Timber Rail Fence on Bridge	520	FT		
901.	4000 PSI, 1.5 IN., 565 Cement Concrete	200	CY		
904.	4000 PSI, ¾ IN., 610 Cement Concrete	5	CY		
904.4	4000 PSI, ¾ IN., 585 HP Cement Concrete	45	CY		
910.1	Steel Reinforcement for Structures - Epoxy Coated	21,000	LB		
911.1	Shear Connectors	504	EA		
933.	Elastomeric Bridge Bearing Pad	8	EA		
960.1	Structural Steel – Coated Steel	24,500	LB		
965.2	Membrane Waterproofing for Bridge Decks – Spray Applied	1,250	SF		
970.	Bituminous Damp-proofing	160	SY		

Total Cost of Item 995.02 = _____

ITEM 996.31 MECHANICALLY STABILIZED EARTH WALL SQUARE YARD**DESCRIPTION**

The work under this item shall consist of design, fabrication, furnishing, transportation, and erection of a Mechanically Stabilized Earth (MSE) retaining wall system of the required type, including excavation, support of excavation, control of water (as required), backfill and miscellaneous items necessary for a complete installation.

The MSE retaining walls shall consist of reinforcing strips or reinforcing mesh earth wall systems utilizing architectural precast concrete facing panels supported on cast-in-place concrete leveling pads. All reinforcing strips or mesh material shall consist of galvanized steel. The wall structures shall be dimensioned to achieve the design criteria shown in Geotechnical Engineering report, on the Plans and specified herein.

The MSE retaining walls shall be constructed in accordance with these specifications and in conformity with the lines, grades, design criteria, and dimensions shown on the Plans or established by the Engineer.

QUALITY ASSURANCE

Mechanically Stabilized Earth (MSE) retaining walls shall be designed and constructed as specified herein. The design shall be subject to approval by the Engineer. Any additional design, construction or other costs arising as a result of rejection of a retaining wall design by the Engineer shall be borne by the Contractor.

Precast facing panels shall be manufactured in a concrete products plant with MassDOT approved facilities. Before proceeding with production, precast sample units shall be provided for the Project Engineer's acceptance. These samples shall be kept at the plant to be used for comparison purposes during production. All calculations and Shop Drawings shall be signed and stamped by a Professional Engineer Registered in the Commonwealth of Massachusetts and specializing in geotechnical construction.

The contractor installing the MSE retaining walls shall have demonstrated experience constructing MSE walls and shall use personnel having demonstrated experience in the installation procedures recommended by the manufacturers and as specified herein.

Accepted MSE retaining wall systems are:

- Reinforced Earth ® by the Reinforced Earth Company
- Vist-A-Wall MSE Structural System – by Big R Bridge
- Tricon Retained Soil Wall System – by Tricon Precast, Ltd.

Value engineering is not applicable to the work of this item.

ITEM 996.31 (Continued)

The Contractor shall design and build the MSE retaining wall system using only one of the above approved systems. Alternate systems will not be considered.

Requirements for the precast facing panels are different from the standard panels from the approved systems. Appropriate, alternate details shall be prepared by the Contractor.

All MSE walls shall be built in accordance with the Plans and accepted Shop Drawings for the proposed wall systems.

A qualified representative from the wall manufacturer shall be present during construction of the MSE walls as specified in Item 996.33 - MSE Wall Manufacturers Representative.

DESIGN REQUIRMENTS

The MSE retaining walls shall be designed to provide the grade separation shown on the Plans with a service life of not less than 75 years.

In general, the MSE wall system shall be designed in accordance with the manufacturer's requirements, as specified herein and shown on the Plans, and in accordance with the latest AASHTO LRFD Bridge Design Specifications and the 2013 MassDOT LRFD Bridge Manual sections 3.1.6, 3.3.2, and 3.4.6. Where conflicting requirements occur the more stringent shall govern.

The MSE walls shall be dimensioned so that the maximum bearing pressure does not exceed the recommendations presented in the Geotechnical Engineering Report for this project.

The MSE wall design shall follow the general dimensions of the wall envelope shown on the Plans. Base of footing elevation shall be a minimum of 4 feet below the proposed final grade elevation at the front face of wall for frost protection. All wall elements shall be within the right-of-way limits shown on the Plans. The panels shall be placed so as not to interfere with drainage or other utilities, or other potential obstructions.

Facing panels shall have tongue and groove, ship lap or similar approved connections along all joints, both vertical and horizontal.

MSE facing panels shall be installed on cast-in-place concrete leveling pads.

All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, fences, concrete parapet wall or other appurtenances shown on the Plans shall be accounted for in the stability design of the wall.

Walls or wall sections which intersect at an angle of one hundred thirty (130) degrees or less shall include a special corner element to cover the joint formed by the abutting walls or wall sections and to permit relative movement. Corner elements shall not consist of connected standard facing panels.

ITEM 996.31 (Continued)**MATERIALS**

The Contractor shall be responsible for the purchase or manufacture of the precast concrete facing panels, reinforcing mesh or strips, panel/reinforcement connections, bearing pads, joint filler, and all other necessary components. The Contractor shall furnish to the Engineer the appropriate Certificates of Compliance certifying that the applicable wall materials meet the requirements of the project specifications. All materials used in the construction of the MSE retaining walls shall meet the requirements specified in MassDOT Standard Specifications and as specified herein.

Materials not conforming to this section of the specifications or from sources not listed in the contract documents shall not be used without written consent from the Engineer.

Reinforced Concrete Facing Panels

The panels shall be fabricated in accordance with Section M4 and Section 901, with the following exceptions and additions:

- A. The facing panels shall be manufactured of 5000 psi, 3/4 inch, 705, air-entrained cement concrete as follows:
 1. Reinforced Concrete Facing Panels shall nominally measure 5' high by 10' long on the exterior exposed face without additional tabs or interlocking extensions adding to the overall dimension of the panel face. Panel dimensions and layout shall include a minimum design joint width of 3/4" in order to accommodate differential settlement without impairing the appearance of the facing or compromising the structural integrity of individual panels. Panel joints should be maintained at 3/4" throughout the wall.
 2. Inspection and Rejection: The quality of materials, process of manufacture, and finished units shall be subject to inspection by the Engineer prior to shipment. Precast units may be subject to rejection on account of failure to conform to this specification. Individual units may be rejected because of any of the following:
 - a.) Variations in the exposed face that substantially deviate from the approved architectural model as to color, texture, relief and reveals in accordance with precast concrete industry standards.
 - b.) Dimensions not conforming to the following tolerances:
 - Position of panel connection devices within 1", except for coil and loop imbeds which shall be 3/16". All other dimensions within 3/16".
 - Panel squareness as determined by the difference between the two diagonals shall not exceed 1/2".

ITEM 996.31 (Continued)

- Surface defects on smooth-formed surfaces measured over a length of five feet shall not exceed 1/8". Surface defects on textured-finished surfaces measured over a length of 5' shall not exceed 5/16".
 - c.) Defects indicating honeycombed or open texture.
 - d.) Defects which would affect the structural integrity of the unit including cracked or severely chipped panels.
- B. The units shall be fully supported until the concrete reaches a minimum compressive strength of 1,500 psi. The units may be shipped after reaching a minimum compressive strength of 4,400 psi. At the option of the Contractor, the units may be installed after the concrete reaches a minimum compressive strength of 4,400 psi.
- C. Unless otherwise indicated on the plans, the concrete surfaces shall be finished in accordance with Section 901.68 and as modified herein. The panels shall be cast on a flat area. The coil embeds, tie strip guide, and other galvanized devices shall not contact or be attached to the face panel reinforcement steel.
- D. The wall finish shall be a rustic ashlar stone finish. The color of the stones shall be random mix gray and brown colors to match the existing MSE Walls at the Bruce Freeman Rail Trail bridge at the Route 2A intersection in Acton. Form liners shall be manufactured by one of the following approved form liner manufacturers:
1. Greenstreak Form Liners, by Greenstreak, St. Louis, Missouri
 2. Symons Form Liner, by Dayton Superior, Miamisburg, Ohio
 3. Custom Rock Form Liners, by Custom Rock, St. Paul, Minnesota
- E. The date of manufacture, production lot number, and the piece mark shall be clearly scribed on an unexposed face of each panel.
- F. All units shall be handled, stored, and shipped in such a manner as to eliminate the dangers of chipping, discoloration, cracks, fractures, and excessive bending stresses. Panels in storage shall be supported in firm blocking to protect the panel connection devices and the exposed exterior finish.
- G. Reinforcing steel for precast panels shall be plain uncoated reinforcing bars in accordance with Section M8.

ITEM 996.31 (Continued)

H. Quality assurance and testing will be modified by the following:

Compressive Strength - Acceptance of concrete panels with respect to compressive strength will be determined on the basis of production lots. A production lot is defined as a group of panels that will be represented by a single compressive strength sample and will consist of either 40 panels or a single day's production, whichever is less.

During the production of the concrete panels, the manufacturer will randomly sample the concrete in accordance with AASHTO T141 (ASTM C172). A single compressive strength sample, consisting of a minimum of four cylinders, will be randomly selected for every production lot.

Compressive tests shall be made on a standard 6-inch by 12-inch test specimen prepared in accordance with AASHTO T23 (ASTM C31). Compressive strength testing shall be conducted in accordance with AASHTO T22 (ASTM C39).

Air content will be performed in accordance with AASHTO T152 (ASTM C231) or AASHTO T196 (ASTM C173). Air content samples will be taken at the beginning of each day's production and at the same time as compressive samples are taken to insure compliance.

The slump test will be performed in accordance with AASHTO T119 (ASTM C143). The slump will be determined at the beginning of each day's production and at the same time as the compressive samples are taken.

For every compressive strength sample, a minimum of two cylinders shall be cured in accordance with AASHTO T23 (ASTM C31) and tested at 28 days. The average compressive strength of these cylinders, when tested in accordance with AASHTO T22 (ASTM C39) will provide a compressive strength test result which will determine the compressive strength of the production lot.

ITEM 996.31 (Continued)

Acceptance of a production lot will be made if the compressive strength test result is greater than or equal to 5,000 pounds per square inch. If the compressive strength test result is less than 5,000 pounds per square inch, then the acceptance of the production lot will be based on its meeting the following acceptance criteria in their entirety:

1. Ninety percent of the compressive strength test results for the overall production shall exceed 5,150 pounds per square inch.
2. The average of any six consecutive compressive strength test results shall exceed 5,250 pounds per square inch.
3. No individual compressive strength test result shall fall below 4,600 psi.

Soil Reinforcing and Attachment Devices

All reinforcing and attachment devices shall be carefully inspected to insure they are true to size and free from defects that may impair their strength and durability.

- A. Ribbed Reinforcing Strips - Ribbed reinforcing strips shall be hot rolled from bars to the required shape and dimensions. Their physical and mechanical properties shall conform to either AASHTO M183 (ASTM A36) or AASHTO M223 Grade 65 (ASTM A572). Galvanization shall conform to the minimum requirements of AASHTO M111 (ASTM A123).
- B. Reinforcing Mesh-Reinforcing mesh shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M32 (ASTM A82) and shall be welded into the finished mesh fabric in accordance with AASHTO M55 (ASTM A185). Galvanization shall be applied after the mesh is fabricated and conform to the minimum requirements of AASHTO M111 (ASTM A123).
- C. Tie Strips - The tie strips shall be shop fabricated of hot rolled steel conforming to the minimum requirements of ASTM A570, Grade 50 or equivalent. Galvanization shall conform to AASHTO M111 (ASTM A123).
- D. Coil Embeds/Loop Embeds- Shall be fabricated of cold drawn steel wire conforming to ASTM 510, UNS G 10350 or AASHTO M32 (ASTM A82). Loop imbeds shall be welded in accordance with AASHTO M55 (ASTM A185). Both shall be galvanized in accordance with ASTM B633.
- E. Coil Embed Grease - The cavity of each coil embed shall be completely filled with no-oxide type grease.
- F. Coil Bolt - The coil bolts shall have two inches of thread. They shall be cast of 80-55-06 ductile iron conforming to ASTM A536. Galvanization shall conform to ASTM B633.

ITEM 996.31 (Continued)

- G. Fasteners - Fasteners shall consist of hexagonal cap screw bolts and nuts, which are galvanized and conform to the requirements of AASHTO M164 (ASTM A325) or equivalent.
- H. Connector Pins-Connector pins and mat bars shall be fabricated from AASHTO M183 (ASTM A36) steel and welded to the soil reinforcement mats as shown on the Plans. Galvanization shall conform to AASHTO M111 (ASTM A123).

Joint Materials

Installed to the dimensions and thickness in accordance with the Plans or approved shop drawings.

- A. Provide either preformed EPDM rubber pads conforming to ASTM D2000 for 4AA, 812 rubbers or neoprene elastomeric pads having a Durometer Hardness of 55 ±5.
- B. Cover all joints between panels on the back side of the wall with a geotextile fabric. The geotextile fabric shall conform to the requirements of Section M9.50.0, Type II. Slit film and multifilament woven and resin bonded non-woven geotextile fabrics are not allowed for this application. The minimum width of the fabric shall be 12 inches. Lap fabric at least 4 inches where splices are required.

Backfill Material

Backfill materials used in the MSE Walls volume when installed below maximum groundwater elevation shall conform to Crushed Stone M2.01.5 and when installed above maximum groundwater elevation shall conform to Gravel Borrow M1.03.0(b) and the following additional requirements:

- A. Soundness - The material shall be substantially free of shale or other soft, poor durability particles. The materials shall have a magnesium sulfate soundness loss, as determined by AASHTO T104 (ASTM C88), of less than 30 percent after four cycles.
- B. Electrochemical Requirements - The backfill materials shall meet the following criteria, with one test required for every 2000 CY of material provided from the same supplier. If an additional material supplier is used, an additional test for every 2000 CY is required:

<u>Requirements</u>		<u>Test Methods</u>
Resistivity	>3,000 ohm centimeters	AASHTO T288 (ASTM G57)
pH between	5 and 10, inclusive	AASHTO T289 (ASTM G51)
Chlorides	<100 parts per million	AASHTO T291 (ASTM D512)
Sulfates	<200 parts per million	AASHTO T290 (ASTM D516)
Organic Content	< 1%	AASHTO T267-86

ITEM 996.31 (Continued)**Leveling Pad**

The leveling pad shall be constructed of 4000 psi, 1-1/2 inch, 565-pound cement concrete as specified in Section M4. Leveling pad shall have minimum dimensions of 6 inches thickness and 12 inches width and be placed at the design elevation shown on the plans within a 1/8 inch tolerance.

Acceptance of Material

The Contractor shall furnish to the Engineer a Certificate of Compliance certifying that the above materials comply with the applicable contract specifications. A copy of all test results performed by the Contractor necessary to assure contract compliance shall also be furnished to the Engineer. Acceptance will be based on the Certificate of Compliance, accompanying test reports, and visual inspection by the Engineer.

SUBMITTALS

- A. Design computations demonstrating compliance with the criteria specified herein and shown on the Plans, prepared and signed and stamped by a Registered Professional Engineer licensed in the Commonwealth of Massachusetts and specializing in geotechnical engineering.

The design calculations shall include:

1. Statement of all assumptions made and copies of all references used in the calculations.
 2. Analyses demonstrating compliance with all applicable earth, water, surcharges, seismic, or other loads, as specified herein and required by the latest AASHTO LRFD Bridge Design Specifications. The design calculations shall include all applicable references to the LRFD code.
 3. External stability calculations for the MSE wall, including evaluation of sliding, overturning, bearing resistance, settlement, and short-term and long-term slope stability.
 4. Analyses or studies demonstrating durability and corrosion resistance of retaining wall systems for the proposed location and environment. The designers shall provide all corrosion protection devices necessary for the retaining wall to have a minimum service life of 75 years in the proposed location and environment.
- B. A detailed resume of the wall designer listing similar projects and demonstrating necessary experience to perform the MSE retaining wall design, including a brief description of each project that is similar in scope. A reference shall be included for each project listed. As a minimum, the reference shall include an individual's name, address and current phone number.

ITEM 996.31 (Continued)

- C. A detailed listing of MSE walls that the contractor has constructed including a brief description of each project and a listing of personnel who will construct the walls demonstrating their experience in construction of MSE retaining walls. A reference shall be included for each project listed. As a minimum, the reference shall include an individual's name, address and current phone number.
- D. Manufacturer's product data for the MSE wall system, including material, manufacture and erection specifications, all specified erection equipment necessary, details of buried MSE wall elements, special details required of reinforcing layout around drainage structures and sign foundations, structures design properties, type of backfill and details for connections between facing panels.
- E. Concrete mix design in accordance with Section M4.
- F. Shop Drawings showing the configuration and all details, dimensions, quantities and cross-sections necessary to construct the MSE wall, including but not limited to the following:
1. A plan view of the wall which shall include Contract limits, stations and offsets, and the face of wall line shown on the Plans
 2. An elevation view of the wall which shall include the elevation at the top of the wall at all horizontal and vertical break points and at least every 50 feet along the face of the wall, all steps in the leveling pads, the designation as to the type of retaining wall system(s), and an indication of the final ground line and maximum calculated bearing pressures. The face of wall shown on the Plans shall be indicated.
 3. A typical cross section or cross sections showing the elevation relationship between existing ground conditions and proposed grades, and the proposed wall configuration, including details for the proposed methods for connecting to existing conditions. The sections shall also indicate the location of the face of wall shown on the Plans.
 4. General notes pertaining to design criteria and wall construction.
 5. A listing of the summary of material quantities for each wall.
 6. Details of sleeves and pipes and other embedded items to be installed through the walls.
 7. Clearly indicated details for construction of walls or reinforcing elements around drainage, foundations, utilities or any other potential obstructions.
 8. Details of the architectural treatment of facing panels.
 9. Drainage design detail and design scheme.
 10. Location of utilities.
 11. Sequence and schedule of construction, including overall construction schedule.
 12. Methods of excavation and backfill.
 13. Method of maintaining stability of excavated trenches.
 14. Method of monitoring plumbness and deviation of wall.
 15. Excavation support system, if any.
 16. Any acceptance testing and frequency.

ITEM 996.31 (Continued)

17. Details and location of all necessary construction and expansion joints.
18. Connection details at the interface of the wall and any adjacent proposed cast-in-place retaining wall or abutment structure.
19. Details of impermeable membrane connection to facing panels and to runoff collection system.

G. Samples:

1. Precast Reinforced Concrete Facing Panels/Units
 - a. Prior to commencing manufacture of facing panels, the Contractor shall provide samples and mock-ups of the facing panel unit and specified finish. The sample submittal shall consist of a minimum of two 6-inch – 6 inch x 2 inch thick samples indicating the specified finish.
 - b. Upon approval of the sample submittal, two mock-up panels 5 feet x 5 feet shall be cast, one of which shall be made available at the casting plant and the other at the Engineer's office to establish acceptance criteria for the approved finished surface. All sample submittals must be accepted by the Engineer for visual qualities prior to proceeding with the casting of the panels.
 - c. The MSE wall mock-up units shall be maintained and protected throughout the work of this item to serve as criteria for acceptance of this work. The same custom form liner must be used exclusively for all textured architectural finish surfaces on the job. Using form liners from different manufacturers together on the same job will not be permitted.

CONSTRUCTION**Delivery, Storage and Handling**

The Contractor shall check the material upon delivery to assure that the proper material has been received. A product certification should be provided with each shipment.

All wall materials and facing panels shall be stored elevated from the ground and protected to prevent all mud, wet cement, epoxy and like substances which may affix themselves to the panels or materials. The panels shall be supported during storage to prevent excessive bending stress. For storage exceeding 30 days in duration, all materials shall be stored in or beneath a trailer or covered with a colored tarpaulin to prevent long-term exposure.

Wall Excavation

Earth excavations for walls shall be in accordance with the requirements of Section 120 and in close conformity to the limits and construction stages shown on the Plans. Sections 120.80, 120.81, and 120.82 do not apply to the work covered in this section. Payment for excavation and incidentals to complete the excavation are included in the MSE wall item.

ITEM 996.31 (Continued)**Foundation Preparation**

The foundation for the structure shall be graded level for a width equal to the length of reinforcement elements plus 1 foot. Prior to wall construction the foundation shall be compacted with at least 10 passes of a smooth wheel vibratory roller weighing at least 10,000 lbs. Any foundation soils found to be unsuitable shall be removed and replaced with Gravel Borrow for Backfilling Structures and Pipes Material as per Section 140. In areas below the existing groundwater level, backfill shall consist of Crushed Stone for Bridge Foundations as per Section 150. The foundation for the structure shall be approved by the Engineer before erection is started.

Wall Erection

Precast concrete panels shall be placed so that their final position is vertical or battered as shown on the Plans. For erection, panels are handled by means of lifting devices connected to the upper edge of the panel. Panels should be placed in successive horizontal lifts in the sequence shown on the approved Shop Drawings as backfill placement proceeds.

As backfill material is placed behind the panels, the panels shall be maintained in position by means of temporary wedges or bracing according to the wall supplier's recommendations. Concrete facing vertical tolerances and horizontal alignment tolerances shall not exceed 3/4 inch when measured with a ten-foot straight edge. During construction, the maximum allowable offset in any panel joint shall be 3/4 inch. The overall vertical tolerance of the wall (top to bottom) shall not exceed 1/2 inch per ten feet of wall height.

Backfill Placement

Backfill placement shall closely follow erection of each course of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbance of the wall materials or misalignment of the facing panels or reinforcing elements. Any wall materials which become damaged during backfill placement shall be removed and replaced at the Contractor's expense. Any misalignment or distortion of the wall facing panels due to placement of backfill outside the limits of this specification shall be corrected at the Contractor's expense. At each reinforcement level, the backfill shall be placed to the level of the connection. Backfill placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

Backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T-99, Method C or D (with oversize corrections as outlined in Note 7 of that test). For backfills containing more than 30 percent retained on the 3/4 inch sieve, a method of compaction consisting of at least 4 passes by a heavy roller shall be used.

ITEM 996.31 (Continued)

The moisture content of the backfill material prior to and during compaction shall be uniformly distributed throughout each layer. Backfill materials shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniformly acceptable throughout the entire lift.

The maximum lift thickness after compaction shall not exceed 12 inches. The Contractor shall decrease this lift thickness, if necessary, to obtain the specified density. In areas of two-way (overlapping) MSE wall reinforcement, lift thickness shall be limited to the height between the overlapping reinforcement layers. In confined areas, place only 6-inch layers and compact with manually operated, powered vibratory compactor acceptable to the Engineer.

Compaction within 5 feet of walls less than 15-feet high, or within 10 feet of walls greater than 15- feet high should be performed using vibratory walk-behind roller or plate compactor. At the end of each day's operation, the Contractor shall slope the last lift of the backfill away from the wall facing to rapidly direct runoff away from the wall face. In addition, the Contractor shall not allow surface runoff from other areas to enter the wall construction site.

Bending of reinforcements in the horizontal plane that result in a kink in their alignment shall not be allowed. Gradual bending in the vertical direction that does not kink the reinforcements is allowable.

Where soil reinforcements are overlapped, i.e., at 90 degree wall corners, a minimum 6 inch thick granular fill shall be placed between reinforcement layers to prevent reinforcement contacts.

Cutting of reinforcement longitudinal bars shall not be allowed to avoid conflicts with utility obstructions. A structural connection (yoke) from the wall panel to the reinforcement shall be used whenever it is necessary to avoid cutting or excessive skewing of reinforcements due to utility conflicts.

Soil reinforcements shall be placed normal to the face of wall, unless otherwise shown on the plans or as directed by the Engineer. If skewing of the soil reinforcements is required due to obstructions in the reinforced fill, rotatable connections shall be used and the maximum skew angle shall not exceed 15 degrees from the normal position unless specifically addressed in design calculations that justify that the skewed reinforcements are adequate.

ITEM 996.31 (Continued)**Measurement**

MSE walls will be measured in units of vertical square yard of retaining structure installed complete in place, according to lines, grades, and dimensions shown on the Plans. The vertical area of retaining structure is defined as the area, measured at the wall face, bounded by the top of the leveling pad, ends of wall, and top of coping.

Payment

Payment will be at the contract unit price per vertical square yard for design, fabrication, transportation, and erection of MSE retaining walls, including excavation, control of water (as required), backfill, impervious membrane, slot perforated corrugated pipe and miscellaneous items necessary for a complete installation, which price and payment will be full compensation for all labor, tools, equipment, materials and incidental expense necessary to complete this item to the satisfaction of the Engineer.

The unit price for Mechanically Stabilized Earth Wall shall include costs for:

- A. All design work, preparation of written submittals and plans, revision of submittals, sample submittals and any other necessary preliminary work prior to and after acceptance of the retaining wall by the Engineer.
- B. All materials, including transportation, for the MSE walls, including facing panels, MSE reinforcing elements, attachment devices, fasteners, bearing blocks and shims, joint materials, copings, concrete masonry, reinforcing steel, compacted select granular backfill, reinforced stone backfill, geotextile fabric, leveling pads and incidentals.
- C. All labor and equipment required to excavate and prepare the wall foundation, form and cast the leveling pad, erect the MSE wall to the lines and grades shown on the Plans, place and connect attachment devices, install the joint materials, install wall drainage, place and compact backfill, and construct any other items necessary to complete the MSE wall.
- D. All temporary shoring.

Excavation and replacement of any unsuitable materials below the MSE wall limits as shown on the Plans, or as directed by the Engineer, will be measured and paid for as defined in Sections 120, 140, and 150.

ITEM 997.**EXPANDED POLYSTYRENE****CUBIC YARD****GENERAL**

This item shall conform to the requirements of all relevant Sections of the Standard Specifications.

This work includes placement of the Expanded PolyStyrene (EPS), Gasoline Resistant Geomembrane (GRG), Cushion Geotextile (CG), sand layers (below and above) and permeable material. Excavation shall be under Item 140., Bridge Excavation.

The EPS blocks shall be constructed in accordance with these specifications and in conformity with the lines, grades, design criteria, and dimensions shown on the Plans or established by the Engineer.

A pre-production meeting shall be held to verify Project requirements, existing conditions, and details relative to the manufacturing, shipping and placement of the EPS, and Geomembrane. The meeting shall involve the Owner, Contractor, EPS Installer, EPS Manufacturer, and EPS Design Engineer.

A pre-construction meeting is also required between the Manufacturer/Supplier, Contractor, and Owner, to confirm Certifications and Acceptance approval of all materials, construction sampling and testing requirements.

RELATED WORK

Excavation and backfill of the areas shall be in conformance with Sections 120 (Excavation), 140 (Excavation for Structures), 150 (Embankment), and 170 (Grading).

Additional related items specified herein include Item 997.1 – EPS/Geomembrane/Geotextile manufacture's representative.

QUALITY CONTROL AND ACCEPTANCE

Manufacturer Quality Control:

The manufacturer shall have in place a Manufacturing Quality Control (MQC) program and assume responsibilities to provide EPS material meeting the requirements of the specification. The QC program shall be monitored and certified by an independent third-party testing organization, with a laboratory accreditation by AASHTO and/or the Geosynthetic Accreditation Institute (GAI).

All EPS-block geofam shall be manufactured using a vacuum-assisted mold. Written documentation and technical information concerning the mold to be used shall be submitted to the Engineer for Approval. The Owner's Agent shall be allowed to inspect the facilities to be used for producing EPS blocks for the Project upon reasonable advance request and during normal business days and hours. The Owner's Agent shall also be allowed to photograph these facilities during this inspection. This is solely for Project documentation and information, and any photographs will not be made available to anyone not involved in the project without prior written consent of the owner of the facilities.

ITEM 997. (Continued)

A minimum of 20 business days prior to beginning work, the contractor's manufacturer/supplier shall either submit a pre-certification (with acceptable documentation of the certifying agency and the procedures used by that agency for certification) or provide three blocks to the Owner or Owner's Agent for testing where no third-party certification is available.

Quality Control – Construction Stage:

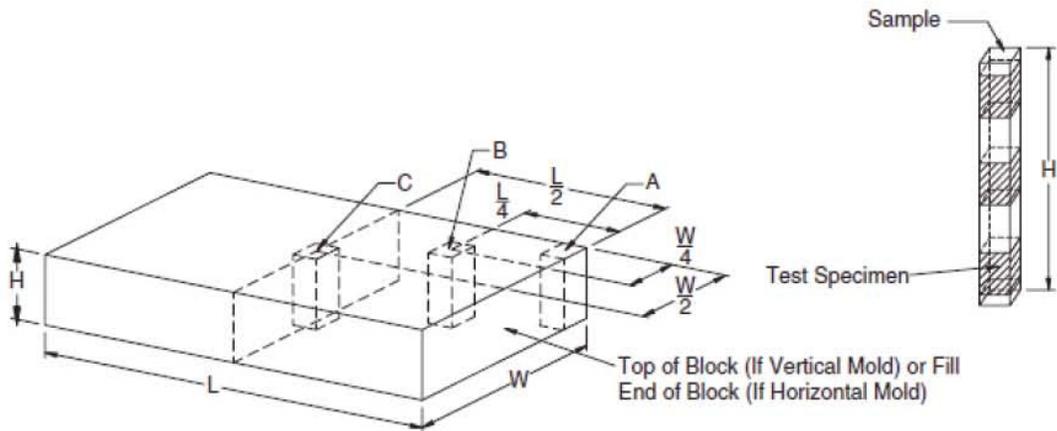
Construction Quality Control (CQC) will be performed by the Contractor. Items covered by CQC include all earthwork and related activities. Items of particular relevance to the placement of EPS-block fill structure are given in this specification.

Acceptance – Construction Stage:

Acceptance will be performed by the Engineer or MassDOT designated representative as the EPS blocks are delivered to the project site. Acceptance will start with an on-site visual inspection of the EPS blocks delivered to the project site to check for damage and to visually verify the labeled information on each block. Any block with damage or not meeting specifications will be rejected on the spot and placed in a separate area, marked "unacceptable", and returned to the supplier.

Acceptance will also consist of on-site verification, by MassDOT's representative, that the EPS block Density and Strength, as well as the physical tolerances meet specifications. The first truckload of EPS blocks must be checked and comply with these specifications. A truckload of EPS-blocks is defined as either a full-length box trailer or a flat-bed trailer of typical dimensions, i.e., approximately 40 feet in length, fully loaded with EPS blocks. The volume of EPS in such a truckload would be on the order of 65 to 130 cubic yards. The EPS Contractor shall supply a scale on site with sufficient capacity and precision for weighing the EPS blocks. This scale shall be recently calibrated, and certification of such calibration shall be kept on site.

Acceptance will consist of sampling the EPS blocks and laboratory testing specimens prepared from field-samples such as Sample A, B and C as shown in the sketch below. Test Specimens from each sample are of approximate square cross-section, as required by the testing specifications, and from locations as shown in the sketch below. Sampling and cutting shall be in conformance with ASTM C390. The laboratory tests will check for compliance with the EPS material properties for Density and Compressive Strength only. Testing will be by or under the direction of the MassDOT's representative. At least one block will be selected for sampling from the first truckload of EPS blocks delivered to the job site. Additional blocks will be selected for sampling during the course of the project at a rate of sampling not to exceed one sample for every 325 cubic yards of EPS delivered.

ITEM 997. (Continued)**DESIGN REQUIREMENTS**

EPS block design shall be based on:

- A. AASHTO LRFD 6th Ed., 2012, except the selection of the grade of EPS is based on ASD.
- B. NCHRP Report 529 – Guideline and Recommended Standard for Geofoam application in Highway Embankments, Washington D.C., 2004.
- C. NCHRP Web Document 65 – Geofoam Application in the Design and Construction of Highway Embankments, 2004.
- D. NCHRP Report – Project No. 21-11 (02) – Guidelines for Geofoam Application in Slope Stability Projects – September 2011.

The EPS wall design shall follow the general dimensions of the wall envelope shown on the plans. Base of wall elevation shall be as shown on the Plans.

All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, fences or other appurtenances shall be as shown on the Plans.

ITEM 997. (Continued)**MATERIALS****Expanded Polystyrene (EPS) blocks**

EPS blocks must be entirely made of Expanded Polystyrene (EPS) consisting of 100% virgin raw material. Previously used or recycled EPS blocks are not allowed. EPS blocks shall be fabricated and trimmed in a standard size measuring approximately 2'x4'x8'. Special-size blocks, custom-cut or field-cut, will be required at the edges of the embankment/ramp section to fill the volume shown on the Plans. The density of the EPS blocks shall be as specified on the plans.

The thickness, width, and length dimensions of an EPS block are defined and measured along a block face. These dimensions of each block shall not deviate from the theoretical dimensions by more than 0.5 percent. The corner or edge formed by any two faces of an EPS block shall be perpendicular, i.e., forming an angle of 90 degrees. Any one face of a block shall not deviate from planarity by more than 0.5 in. when measured using a straightedge with a length of 10 ft.

All EPS-block shall be adequately seasoned prior to shipment to the project site. Seasoning is defined as storage in an area suitable for the intended purpose for a minimum of 72 hours after an EPS block is released from the mold. Seasoning shall be done within a building or other structure, which protects the EPS blocks from moisture as well as ultraviolet (UV) radiation, such that adequate space is allowed between blocks and positive air circulation and venting of the structure are provided so as to foster the out-gassing of blowing agent and trapped condensate from within the blocks. The Engineer shall be allowed to inspect the structure(s) to be used for seasoning upon request and during normal business days and hours.

The Contractor shall prevent damage to the EPS block during delivery, storage, and construction. The EPS blocks shall be protected from petroleum products, ultraviolet light, and/or mechanical damage. Any EPS block with cracks is considered damaged and unacceptable, and shall be rejected and replaced with undamaged equal EPS block. Holes shall not be created in the blocks at any stage to facilitate shipping or handling of the blocks during placement.

Each EPS block shall be labeled to indicate the name of the molder, the date the block was molded, the weight of the entire block (in pounds) as measured after the satisfactory period of seasoning as specified above, the dimensions of the block in inches, and the actual dry density in pounds per cubic foot (pcf). Additional identification markings using alphanumeric characters, colors, and/or symbols shall be used to indicate the location of placement of each block relative to the shop drawing. Any paint used to mark EPS blocks shall be chemically compatible with EPS and not cause any dissolution of the EPS.

ITEM 997. (Continued)

EPS blocks shall be EPS 29 (ASTM D 6817) and have the following properties:

Physical Property	ASTM Designation	Acceptance Value
Density	D 1622	1.80 lb/ft ³ Minimum
Compressive Strength (at 1% deformation)	D 1621	10.9 psi Minimum
Elastic Modulus	D 1621	1090 psi Minimum
Flexural Strength	C 203 (Method I)	50.0 psi Minimum
Tensile Strength	D 1623 Type B Preferred	20.0 psi Minimum
Water Absorption	C 272	2.0% Maximum by Volume
3rd Party Certification	D 6817 and D 7180	Pass

The specimens used for compressive testing shall be 2 inch cubes, tested at a strain rate of 10% per minute. The elastic-limit stress and initial secant Young's modulus shall be determined in the same test used to measure compressive strength. The elastic-limit stress is defined as the measured compressive normal stress at a strain of 1%. The initial secant Young's modulus is defined as the average slope of the compressive stress versus compressive strain curve between 0% and 1% compressive normal strain.

The EPS Geofoam shall contain a flame retardant additive and shall have UL Certification of Classification as to External Fire Exposure and Surface Burning Characteristics so as to comply with Oxygen Index requirements of ASTM C578. EPS Geofoam blocks used below grade shall be treated to prevent insect attack and shall be protected from burrowing animals, with the use of additives. The EPS Geofoam supplier shall present proposed treatment methods to the Engineer for review and approval prior to the first shipment of EPS Geofoam to the site.

Connector plates shall be galvanized 20 gage steel two-sided multi-barbed design. Each connector shall be capable of penetrating the EPS blocks $\frac{3}{4}$ inch, minimum, and have a lateral holding strength of at least 60 lbs. when tested with ASTM D6817 (EPS29), with a safety factor of 2.0. A minimum of two plates for each 4'x8' section of a block is required.

ITEM 997. (Continued)**Gasoline Resistant Geomembrane (GRG)**

The Geomembrane shall consist of textured-surface materials, made of high-density polyethylene (HDPE), tri-polymer membrane manufactured from polyvinyl chloride (PVC), ethylene interpolymer allow (EIA), or a comparable polymer combination. The Geomembrane shall be suitable for the containment of spilled liquid hydrocarbons, including gasoline, diesel fuel, kerosene, hydraulic fluid, methanol, ethanol, mineral spirits, and naphtha.

The geomembrane shall be sufficiently flexible to cover and closely conform to 90-degree edges and corners of EPS blocks, and subgrade material, at ambient temperatures as low as 45[°]F without application of heat. The Geomembrane thickness shall be 30 mils minimum and factory produced seams bonded width shall be 1.25 inch minimum.

Physical Property	ASTM Designation	Acceptance Value
Unleaded Gasoline Permeability (VTR)	D 814	0.4 oz/ft ² Maximum per 24 Hours
Grab Tensile Strength (1" grip, 4" x 8" sample)	D 751	550 lb Minimum in each direction
Elongation at Break	D 751	20% Minimum
Bursting / Puncture Resistance (ball tip)	D 751	750 lb Minimum
Factory Produced Seams, Shear Strength	D 751 Procedure A	550 lb Minimum
Field Produced Seams, Vapor Tight Seal	D 5641	Pass

The Contractor shall submit, to MassDOT's representative, samples and properties of the Geomembrane in accordance with the relative materials specifications for Geomembranes (GM) per the Geosynthetic Research Institute (GRI):

GM1 Seam Evaluation by Ultrasonic Shadow Method.

GM4 Three Dimensional Geomembrane Tension Test (see ASTM D5617).

GM5(a) Notched Constant Tensile Load (NCTL) Test for Polyolefin Geomembranes (ASTM D5397).

GM6 Pressurized Air Channel Test for Dual Seamed Geomembranes.

GM10 The Stress Crack Resistance of HDPE Geomembrane Sheet.

ITEM 997. (Continued)

GM12 Asperity measurement of Textured Geomembranes using a Depth Gage (ASTM D7466).
 GM13 Test Methods, Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

GM15 Determination of Ply Adhesion of Reinforced Geomembranes (see ASTM D6636).

GM 19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

Cushion Geotextile

Cushion Geotextile (CG) must be a nonwoven needle-punched fabric of polypropylene, polyester, or a combination of polymer materials including polyethylene. CG must not contain biodegradable filler materials.

Cushion Geotextile shall conform to the following properties, as documented through testing from an independent third party laboratory:

Physical Property	ASTM Designation	Acceptance Value
Weight	D 5261	10 oz/yd ²
Grab Tensile Strength (1" grip both directions)	D 4632	230 lb
Elongation at Break	D 4632	50%
Trapezoidal Tear Strength	D 4533	95 lb
Puncture (pin) Strength	D 4833	120 lb
Water Flow Rate	D 4491	85 gpm/ft ²
UV Resistance	D 4355	70% Minimum
Biodegradable Filler Materials	E 204	0%

*All are MARV (Minimum Average Roll Value), except UV Resistance.

Permeable Material

Permeable material shall conform with the details shown on the plans, to the provisions of MassDOT Standard Specifications and these special provisions. Permeable material shall be sand borrow conforming to the requirements of Section M1.04.1.

ITEM 997. (Continued)**SUBMITTALS**

- A. A detailed resume of the EPS/Geotextile Installer, which must be a firm with a minimum of 6 years of EPS-block construction experience and with at least one supervisor experienced in the handling and installation of EPS in the same capacity, with a minimum of three (3) EPS roadway fill projects of similar complexity and size. The EPS Contractor shall furnish the Engineer a certified report after installation confirming that the EPS fill system and all appurtenances have been installed in compliance with all project requirements.
- B. Certificate of Compliances for the Expanded PolyStyrene (EPS), Gasoline Resistant Geomembrane (GRG), and Cushion Geotextile (CG) to the Engineer for review and approval.
- C. Shipping plan of the EPS blocks to the construction site, for the Engineer's review. This plans shall include protective measures during shipping to avoid any damage to the blocks, such as crushing to the edges, sides, and corners of blocks.
- D. Shop drawings, to the Engineer for approval, before fabricating the EPS blocks and delivering together with the Geomembrane and Geotextile. Show the layout of all EPS blocks in each layer, and method of temporarily ballasting the blocks to prevent movement during construction, including all accessory items to be used. Match plan details and construction requirements.
- E. Certified Test Reports for each of the materials to be used.

CONSTRUCTION METHODS**EPS Blocks**

Any unsuitable area, as determined by the Geotechnical Engineer, shall be excavated and replaced with suitable compacted backfill. The existing embankment shall be free from deleterious or loose soils.

Granular cover (including asphalt thickness) for EPS blocks shall be 2 feet minimum.

Sand layers and base course shall be placed using light-weight equipment. A thickness of 12" granular material shall cover the EPS blocks before compaction commences. Vibratory equipment (i.e., vibrating drum roller) shall not be used to compact the sand or fill layers.

ITEM 997. (Continued)

If the EPS blocks are to be stockpiled at the project site until installation, a secure storage area shall be provided. The storage area shall be away from any heat source or construction activity that produces heat or flame or would expose the blocks to hydrocarbon fuels (diesel, kerosene, gasoline). In addition, personal tobacco smoking shall not be allowed in the storage area. EPS blocks shall be secured with sandbags and similar “soft” weights to prevent them from being dislodged by wind. The blocks shall not be covered in any manner that might allow the buildup of heat beneath the cover.

EPS blocks shall be placed to the lines and grades shown on the plans and as directed by the Engineer. Surfaces to receive the EPS blocks shall be finished such that there is not more than a 0.5” variation in vertical grade over any 10 foot interval, and are within 2” of the grade shown on the contract plans. All blocks shall fit accurately against adjacent blocks, tight and without voids. EPS blocks shall not be less than 6” in thickness.

No debris of any kind shall be permitted on adjacent or successive surfaces of EPS blocks. This requirement is not limited to the subgrade and must be followed throughout the full height of EPS structure.

EPS blocks cannot be placed on frozen subgrade, and on any surface with standing water or ice. Contractor to provide temporary water control of any runoff water which is collected within the excavation of the proposed EPS blocks. This temporary water control shall be designed by the Contractor and shall remain in place until the approach slab is installed on top of the proposed EPS blocks.

Top fill shall be placed so as not to damage the top layer of EPS blocks.

If irregular shapes are required, the EPS blocks may be trimmed in the field by a method approved by the manufacturer’s representative. A “hot-wire” cutting device (a NiCr wire held between insulated handles and connected to a power source by a rheostat) is recommended. All excess EPS block cuttings and debris shall be contained, collected and hauled offsite for disposal by the Contractor.

Do not operate any vehicle or construction equipment directly on the EPS blocks. In addition, foot traffic by persons shall be kept to a minimum. The amount of time during which EPS blocks can be stored at the construction site shall be limited to 30 calendar days.

Between construction, the EPS blocks shall be protected with the Geomembrane and weighted down with sufficient sand bags to keep the blocks in place. The sacks for sand-bags shall be made of at least 8oz/yd² burlap or an equivalent strength woven getotextile and shall be approximately 10” x 18” measured inside the seams when the sack is laid flat. The capacity of each sack shall be approximately 0.025 cubic yard. The sacks shall be filled with approximately 0.02 cubic yard of sand loosely placed so as to leave room for folding at the top.

ITEM 997. (Continued)

The long axis of the EPS blocks in adjacent layers shall be rotated horizontally 90 degrees and the edges of blocks in adjacent layers shall be offset to minimize continuous joints.

EPS blocks shall be secured along the horizontal planes with connector plates, made of galvanized steel plates with two-sided multi-barbed shape.

Gasoline Resistant Geomembrane

Geomembrane (gasoline resistant) shall be placed directly on the surface of the EPS blocks both between construction and permanently, which shall be clean and free of sharp objects. Encase the top of EPS blocks with the Geomembrane within the limits shown on the Plans. Field seams shall be bonded with and electrically-heated hot-wedge device or other method as recommended by the manufacturer. The temperature of the bonded geomembrane shall not exceed 165°F immediately before contacting the EPS blocks.

Before installation of geomembrane, the Contractor shall demonstrate to the Engineer that the equipment, techniques, and personnel proposed for the bonding of field seams can produce vapor-tight seams under similar weather and work conditions near the job site. The Contractor shall provide a typical “test panel” as a basis for testing acceptance.

Field seams shall be inspected by the Installer and, when ordered by the Engineer, shall be tested by the Installer and shall pass the Vacuum Chamber test.

Construction equipment shall not be operated directly on the geomembrane. Any material damaged by the Contractor’s equipment or operations shall be replaced or repaired to the satisfaction of the Engineer.

Cushion Geotextile

Cushion Geotextile shall be placed directly on the surface of the geomembrane, which shall be clean and free of sharp objects. Joints shall overlap a minimum of 12” construction equipment shall not be operated directly on the geotextile cushion. The geotextile shall be handled and placed in conformance with the manufacturer’s recommendations and shall be aligned and placed in a wrinkle-free manner. Within 72 hours after the geotextile has been placed, the geotextile shall be covered with the planned thickness of overlying material as shown on the plans. Completely encase the Gasoline Resistant Geomembrane with the Cushion Geotextile. Do not operate construction equipment directly on the Geotextile.

Permeable Material

Conform to the Standard Specification for subgrade preparation. No debris of any kind is permitted on the subgrade or on adjacent EPS block surfaces. Remove loose or extraneous materials and sharp protruding objects.

No standing water or ice is permitted on the subgrade or adjacent EPS surfaces during installation.

ITEM 997. (Continued)

Place permeable material on prepared subgrade and finish to a maximum vertical grade differential of +0.05-foot over any 10-foot interval, and to within 0.2-foot of planned grade.

Bench into existing slopes as required to provide a level subgrade to support each layer of EPS blocks. Re-compact subgrade to a minimum of 92 percent of maximum dry density as determined by AASHTO T180 or as accepted by the Engineer.

COMPENSATION

Expanded Polystyrene shall be measured on a cubic yard basis, complete in place, including EPS blocks, backfill, geomembrane, geotextile, and permeable material.

Expanded polystyrene will be paid for at the contract unit price per cubic yard. This price shall include all equipment, tools, labor, and materials incidental thereto. This work includes placement of the Expanded PolyStyrene (EPS), Gasoline Resistant Geomembrane (GRG), Cushion Geotextile (CG), sand layers, and permeable material.

ITEM 997.1

EPS MANUFACTURER'S REPRESENTATIVE

DAY

DESCRIPTION

A qualified civil engineer representing the Manufacturer(s) of the EPS / Geomembrane / Geotextile shall be on site at the start of construction of the EPS blocks to assist the Contractor in methods of construction and to advise the Engineer in methods of ensuring that the EPS blocks are constructed in accordance with the Manufacturers' recommendations. The Engineer shall be notified 48 hours in advance as to which day the representative will be present at the site. Additionally, the representative shall be available on an as-needed basis, as requested by the Engineer at any time during construction. In no case shall changes in the plans or specifications recommended by the Manufacturers' Representative be made unless submitted in writing and approved by the Engineer.

The Contractor shall submit to the Engineer for approval a daily report of the Manufacturers' Representative activities. The report shall be prepared by the Manufacturers' Representative and shall describe all items investigated, inspected and discussed with MassDOT inspectors and personnel on the job site for that day.

METHOD OF MEASUREMENT

Expanded polystyrene manufacturer's representative shall be measured on a daily basis.