

DOCUMENT 00 01 10 - TABLE OF CONTENTS

Document/Section No. and Title	Page Numbers
<u>DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS</u>	
Not Used	
<u>DIVISION 01 – GENERAL REQUIREMENTS</u>	
Section 01 12 16 Phasing of the Work	01 12 16-1 through 2
Section 01 23 00 Alternates	01 23 00-1 through 2
Section 01 33 00 Submittal Procedures	01 33 00-1 through 11
<u>DIVISION 02 - EXISTING CONDITIONS</u>	
Section 02 41 00 Demolition	02 41 00-1 through 8
Section 02 41 13 Site Preparation	02 41 13-1 through 6
Section 02 42 91 Removal and Salvage of Historic Materials	02 42 91-1 through 11
<u>DIVISION 03 - CONCRETE</u>	
Section 03 30 00 Cast-In-Place Concrete	03 30 00-1 through 15
<u>DIVISION 04 - MASONRY</u>	
Section 04 01 10 Masonry Cleaning	04 01 10-1 through 12
Section 04 01 40 Stone Masonry Restoration	04 01 40-1 through 16
Section 04 05 13 Restoration Mortars and Masonry Pointing	04 05 13-1 through 13
<u>DIVISION 05 - METALS</u>	
Section 05 01 70 Conservation and Maintenance of Decorative Metals	05 10 70-1 through 9
Section 05 50 01 Metal Fabrications	05 50 01-1 through 8
<u>DIVISION 06 THROUGH 07</u>	
Section 07 11 13 Bituminous Damproofing	07 11 13-1 through 3
<u>DIVISION 08 - OPENINGS</u>	
Not Used	
<u>DIVISION 09 - FINISHES</u>	
Section 09 91 13 Exterior Painting	09 91 13-1 through 10
<u>DIVISIONS 10 THROUGH 25</u>	
Not Used	
<u>DIVISION 26 - ELECTRICAL</u>	
Section 26 00 00 Electrical	26 00 00-1 through 40
Ray Dunetz Landscape Architecture, Inc.	TABLE OF CONTENTS 00 01 10 - 1

Document/Section No. and Title	Page Numbers

DIVISIONS 27 THROUGH 30

Not Used

DIVISION 31 - EARTHWORK

Section 31 20 00	Earthwork	31 00 00-1 through 26
Section 31 24 00	Erosion and Sedimentation Controls	31 25 00-1 through 8
Section 31 60 00	Ground Improvements	31 60 00-1 through 13

DIVISION 32 - EXTERIOR IMPROVEMENTS

Section 32 12 16	Asphalt Paving	32 12 16-1 through 20
Section 32 12 42	Pervious Concrete	32 12 42-1 through 11
Section 32 13 13	Concrete Paving	32 13 13-1 through 12
Section 32 14 00	Unit Paving	32 12 00-1 through 5
Section 32 14 40	Stone Paving	32 14 40-1 through 7
Section 32 16 14	Curbs and Gutters	32 16 13-1 through 5
Section 32 17 21	Pavement Markings	32 17 23-1 through 4
Section 32 30 00	Site Improvements	32 30 00-1 through 5
Section 32 31 19	Ornamental Metal Fence	32 31 19-1 through 6
Section 32 84 00	Irrigation	32 84 00-1 through 30
Section 32 90 00	Lawns and Planting	32 90 00-1 through 14

DIVISION 33 – SITE UTILITIES

Section 33 05 05	Selective Site Utility Demolition	33 05 05-1 through 3
Section 33 10 00	Water Utilities	33 10 00-1 through 9
Section 33 40 00	Storm Drainage Utilities	33 40 00-1 through 13

DIVISIONS 34 THROUGH 49

Not Used

END OF TABLE OF CONTENTS

SECTION 01 12 16 – PHASING OF THE WORK

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Requirements for phasing of the work include logistics, phasing, and completion of designed phases prior to commencement of subsequent phases.

1.3 RELATED WORK

- A. Section 02 41 00 – DEMOLITION.
- B. Section 02 41 13 – SITE PREPARATION.
- C. Section 02 42 91 – REMOVAL & SALVAGE OF HISTORIC MATERIALS.
- D. Section 31 20 00 – EARTHWORK.

1.4 SUBMITTALS

- A. The Contractor shall submit a Project site logistics plan in accordance with and as required by this Section.

1.5 DEFINITIONS

- A. Contractor: The contractor of record for the Lincoln Square Improvements project as awarded by the City of Worcester, Massachusetts.
- B. Building Contractor: The contractor authorized to perform construction operations to renovate the Worcester Boys Club and build a new building adjacent to the memorial site.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 PHASING OF THE WORK - GENERAL

- A. Project shall be constructed in separate phases, as identified or as described in this Section and/or the Contract Drawings. Phasing will delineate the Work to be completed in each designated phase.
- B. Contractor shall perform all the work described in each Phase to completion during the time indicated within this Section and/or on the Contract Drawings, unless otherwise authorized in writing by the Owner's Representative.

3.2 PHASING OF THE WORK - SPECIFIC

- A. Phase One
 - 1. Phase One shall be complete no later than ninety (90) days of the City issuing the notice to proceed to the Contractor.

2. The Building Contractor will utilize a portion of the memorial site for staging and as a material laydown area.
 3. The Building Contractor will erect a site construction fence and gate around the perimeter of the site according to the Contract Drawings and will provide necessary signage to direct pedestrians around construction operations during this phase.
 4. The Building Contractor will install a construction entrance along Grove Street.
 5. The Building Contractor will allow the Contractor access through the construction entrance to the eastern portion of the memorial site. The Contractor shall coordinate with the Building Contractor for travel through the Building Contractor's laydown area.
 6. The Contractor shall provide construction fencing and a gate in order to erect a laydown area in front of the Worcester Auditorium across Grove Street.
 7. Work shall consist of the site preparation and demolition operations indicated on the Contract Drawings.
 - a. The Building Contractor shall be responsible for all site preparation of their enclosed area.
 - b. The Contractor shall be responsible for all site preparation indicated on the Drawings for their enclosed area.
- B. Phase Two – ADD ALT #1
1. Phase Two shall commence immediately at the conclusion of Phase One and run through March 31, 2026.
 2. The Contractor shall perform the work described in the Contract Drawings and/or this Section, unless otherwise authorized in writing by the Owner's Representative.
- C. Phase Three – ADD ALT #1
1. Phase Three shall begin April 1, 2026 and last through the completion of construction by May 1, 2027.
 2. The Contractor shall be responsible for all the work described in this Section and/or the Contract Drawings.
 3. The Contractor shall complete site preparation by removing the concrete sidewalk adjacent to existing building.
 4. The Contractor shall furnish all pedestrian signage and barriers required to ensure safety of pedestrians. The Contractor shall submit a signage and phasing plan to the Owner's Representative for approval.

END OF SECTION
01 12 16

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. This Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. **ALTERNATE:** An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 RELATED WORK

- A. Section 01 12 16 – Phasing of the Work
- B. Section 02 41 13 – Site Preparation
- C. Section 03 30 00 – Cast-In-Place Concrete
- D. Section 04 01 10 – Masonry Cleaning
- E. Section 05 01 70 – Conservation and Maintenance of Decorative Metals (Partial)
- F. Section 05 50 01 – Metal Fabrications
- G. Section 07 11 10 – Bituminous Dampproofing
- H. Section 09 91 13 – Exterior Painting
- I. Section 26 00 00 – Electrical
- J. Section 31 20 00 – Earthwork (Partial)
- K. Section 31 24 00 – Erosion and Sedimentation Controls
- L. Section 31 60 00 – Ground Improvements
- M. Section 32 12 16 – Asphalt Paving
- N. Section 32 12 42 – Pervious Concrete
- O. Section 32 13 13 – Concrete Paving
- P. Section 32 14 00 – Unit Paving
- Q. Section 32 14 40 – Stone Paving
- R. Section 32 16 13 – Curbs and Gutters
- S. Section 32 17 23 – Pavement Markings
- T. Section 32 30 00 – Site Improvements
- U. Section 32 31 19 – Ornamental Metal Fencing
- V. Section 32 84 00 – Irrigation
- W. Section 32 90 00 – Lawns & Planting
- X. Section 31 00 00 – Water Utilities
- Y. Section 32 40 00 – Storm Drainage Utilities

1.5 PROCEDURES

- A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the alternate into the Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to alternates.
- C. Execute accepted alternates under the same conditions as other work of the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ALTERNATE NO. 1: MEMORIAL RECONSTRUCTION, CONSERVATION, AND NEW SITE IMPROVEMENTS

- A. State the amount to be ADDED to the base bid for the following:
 - 1. Restoration and conservation of all metal work, flagpole, and stone work.
 - 2. Re-installation of metal work, flagpole, and stone memorial including all associated earthwork including, but not limited to, aggregate soil piers, pervious concrete paving, unit paving, stone paving.
 - 3. Construction of all site improvements including all paving, fencing, electrical, utility, and drainage work, and installation of new site furnishings, irrigation system, and plantings, and seeding of new lawns.

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Submittal requirements, standards, and procedures for all products, materials, and goods specified in the Project Manual.

1.3 SUMMARY

- A. Submittal coordination.
- B. Submittal procedures and grading.
- C. Schedule of Submissions.
- D. Shop drawings, product data and samples.
- E. Manufacturer's instructions.
- F. Manufacturer's and Installer's certificates.
- G. Fabricator's certificates.
- H. Emergency addresses.
- I. Erosion and sediment control program.

1.4 SUBMITTAL COORDINATION

- A. General: The Contractor is fully responsible for delay in the delivery of materials, progress of the Work and damages incurred due to Contractor's failure to submit, revise and resubmit submissions in accordance with the requirements herein, and in a coordinated and timely manner.
- B. Make submittals in a proper and timely fashion, allowing for administrative procedures, Owner's Representative's review, corrections to submissions and resubmittal, if necessary, and fabrication of products without delaying the project. Minimum processing times required by the Owner's Representative are as follows:
 - 1. Review for Owner's Representative's Office only: Allow a minimum of 10 working days for review and processing. Some submittals may require additional time.
 - a. Simultaneous submission of a large number of shop drawings and product data may require longer than 10 working days for review. (In particular submittals for Divisions 3, 5, 6, 21, 22, 23, 25 and 26).

- b. Complex Systems (structural, mechanical, electrical) may require longer than 10 working days for review each time shop drawings, layout drawings, and product data are submitted or resubmitted.
- C. Review by Owner's Representative and its consultant(s): Allow 10 working days for review and processing of submittals by Owner's Representative plus an additional 5 working days for review by each consultant as applicable.
- D. Reprocessing of submittals: For submittals requiring resubmittal, re-processing time required shall be the same as first submittal.
- E. No extension of Contract Time will be authorized due to failure to transmit submittals sufficiently in advance of scheduled performance of Work.
- F. Make submittals of similar items, systems, or those specified in a single specification section together.
- G. Make submittals for products which other products are contingent upon, first.
- H. The Contractor is fully responsible for delay in the delivery of materials or progress of work caused by late review of shop drawings due to failure of the Contractor to submit, revise, or resubmit shop drawings in adequate time to allow the Owner's Representative checking and processing of each submission or resubmission.

1.5 REPETITIVE REVIEW

- A. Shop Drawings, Product Data and Samples, Coordination Drawings submitted for each item will be reviewed by the Owner's Representative or Consultants no more than two times at Owner's expense. Submittals failing to comply with Contract requirements will be reviewed at times convenient to the Owner's Representative and its Consultants and at the Contractor's expense, based upon a flat rate of \$200.00 per hour for each subsequent re-submittal. Contractor shall reimburse Owner for such additional submittal reviews monthly, and Owner reserves the right to deduct said reimbursement from Contractor's periodic application for payment and the Contract Sum.

1.6 SCHEDULE OF SUBMISSIONS

- A. Schedule procedure: Immediately after being awarded the Contract, meet with the Owner's Representative to discuss the schedule of submissions and then prepare and submit within 14 calendar days for approval a schedule of submissions for the Work. The schedule of submissions shall be related to the entire Project, and shall contain the following:
 - 1. Shop Drawing Schedule (for shop and setting drawings to be provided by the Contractor).
 - 2. Schedule of Product Data.
 - 3. Schedule of mock-ups to be fabricated in the field.
 - 4. Sample Schedule (for samples to be provided by the Contractor).
 - 5. Schedule of Manufacturer's Instructions.
 - 6. Schedule of Manufacturer's, Installer's, and Fabricator's Certificates
 - 7. With respect to portions of the Work to be performed by subcontractors, such schedule of submissions for the work of each subcontractor shall be submitted for approval within 30 calendar days after execution of a subcontract with such

subcontractor.

- B. List all submissions required of each trade:
1. Include the Specification Section number, name of subcontractor or vendor, submittal type, item, description, type, quantity and size (where applicable) of each submission.
 2. For each submission, provide the following dates, as estimated:
 - a. Scheduled date of submission.
 - b. Required date of approval. (permit time for appropriate review and resubmissions as may be required).
 - c. Estimated date of beginning fabrication or manufacture of product (where applicable).
 - d. Required date of submission of product to testing laboratory.
 - e. Required date of testing laboratory approval.
 - f. Required date for delivery of product to site.
 - g. Required date for beginning of installation of product.
 - h. Required date for completion of installation (and in-place testing).
- C. For each submittal, schedule to allow adequate time for review by the Owner's Representative and its consultants. The Owner's Representative will not be responsible for Work performed in shop or field prior to approval. Long-lead items requiring expedited action must be clearly indicated.
1. The schedule shall be reviewed and resubmitted as necessary to conform to approved modifications to the construction Project Schedule and shall be updated as may be required by the Owner's Representative.
- D. Posting of submittal schedule: Print and distribute the submittal schedule to Owner's Representative, Owner, subcontractors and other parties affected. Post copies in field.
- E. Update schedule throughout progress of the Project, coordinated with scheduling changes in the Work, and redistribute monthly in conjunction with submittal of Application for Payment.
- F. The Contractor shall add or remove required submissions in the Schedule of Submissions requiring review only at the direction of the Owner's Representative.

1.7 SUBMITTAL PROCEDURES AND GRADING

- A. Prepare and submit to the Owner's Representative the following for approval:
1. Construction Schedule.
 2. Schedule of Values.
 3. Schedule of Submissions.
 4. Schedule of Environmental Submissions.
- B. Provide space for Contractor, Owner's Representative and engineering consultant

review stamps, on the front page of each item's submittal copy. Apply Contractor's stamp, signed or initialed certifying that review, verification of products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and the Contract Documents. The Owner's Representative's stamp shall contain the following data (Engineering consultant review stamps may vary in language, but intent of language is similar):

_____APPROVED

_____APPROVED AS NOTED

_____NOT REQUIRED FOR REVIEW

_____RESUBMIT

_____NOT APPROVED

1. The Owner's Representative will insert the date of action taken and an identification of the person taking the action.
 2. Submittal grading:
 - a. APPROVED - No corrections, no marks.
 - b. APPROVED AS NOTED - Minor corrections required are as noted; all items can be fabricated as noted, without further correction and resubmission of original submission; checking is complete and all corrections are deemed obvious without ambiguity.
 - c. NOT REQUIRED FOR REVIEW: Submission received for informational purposes only and no action will be taken by the Owner's Representative.
 - d. RESUBMIT - Resubmission is required; checking may be incomplete; details of items noted by checker are to be clarified further before full review can be given. Correct and resubmit, do not fabricate noted items requiring correction.
 - e. NOT APPROVED- Submittal is rejected as not in accord with the Contract Documents, too many corrections, or other justifiable reasons. When returning submission, Owner's Representative will state reasons for rejection. Correct and resubmit, do not fabricate.
 3. Review/approval neither extends nor alters any contractual obligations of the Owner's Representative, Engineer or Contractor.
- C. Identify all variations from Contract Documents, and product or system limitations which may be detrimental to successful performance of the completed work.
- D. Contractor's review: Review all shop drawings, product data and samples. Include, without limitation, verification of the following:
1. Proper title, original date, drawing number (which shall be changed if resubmitted), revision numbers and dates, designation of subcontractor and/or supplier.
 2. Identification of Shop Drawings, Product Data or Samples by Specification Section and subsection or paragraph where appropriate and identification of Contract Drawings by number and detail.
 3. On each submittal, as a minimum, Contractor shall identify the following:
 - a. Errors, inconsistencies, and omissions discovered in the contract documents and field conditions must be reported at once to the Owner's Representative.

- b. Any variations from code requirements contained in the contract documents must be reported promptly in writing to both the Owner's Representative and Owner.
 - c. Promptly report to the Owner's Representative information that any design, process, or product infringes on a patent.
 - d. Names of subcontractor(s) and supplier(s). Include name(s) of contact person(s), address, telephone and fax number(s).
- E. Revise and resubmit submittals as required, identify all changes made since previous submittal. Distribute copies of reviewed submittals to concerned parties; instruct parties to promptly report any inability to comply with provisions.

1.8 ELECTRONIC DOCUMENT PROCEDURES REQUIREMENTS

A. General:

- 1. All documents including but not limited to shop drawing and product data submittals, Request for Information, Proposal Requests, Proposed Change Orders, reports, etc. shall be transmitted to Owner's Representative and Owners Project Manager in electronic (PDF) format. The Contractor is strongly advised to utilize a web-based service such as Procore Technologies, Submittal Exchange, EBuilder or approved equal designed specifically for transmitting submittals between construction team members. In lieu of a web-based service referenced above, a submittal log in spreadsheet form may be shared via DropBox, Google Docs, or similar file sharing service that allows for common edits to said log.
- 2. The intent of electronic submittals is to expedite the construction process by reducing paperwork, improving information flow, and decreasing turnaround time.
- 3. The electronic document process is not intended for physical color samples, color charts, or material samples.

B. Procedures for Documents and Submittals:

- 1. Document Preparation – Contractor may use any or all of the following options:
 - a. Subcontractors and suppliers may provide electronic (PDF) documents to Contractor via a web-based service.
 - b. Subcontractors and suppliers may provide paper documents to Contractor (subject to approval of the CM) who electronically scans and converts to PDF format.
 - c. Subcontractors and suppliers may provide paper documents to Scanning Service which electronically scans and converts to PDF format.
- 2. Contractor shall review and apply electronic stamp certifying that the submittal complies with the requirements of the Contract Documents including verification of manufacturer / product, dimensions and coordination of information with other parts of the work.
- 3. Contractor shall transmit each submittal or document to Owner's Representative using web based service or email.
- 4. Owner's Representative review comments will be made available on the web based service or email for downloading. Contractor will receive email notice of completed review.

5. Distribution of reviewed submittals to subcontractors and suppliers is the responsibility of the Contractor.
6. Submit paper and electronic copies of reviewed submittals or documents at project closeout for record purposes in accordance with provisions contained in Division 01.

C. Costs:

1. The cost of web based services shall be paid in full by the Contractor.
2. The Contractor shall provide training for web based service for Owner's Representative, OPM and any other entity required to use such service..
3. Internet Service and Equipment Requirements:
 - a. Email address and Internet access at Contractor's main office.
 - b. Adobe Acrobat (www.adobe.com), Bluebeam PDF Revu (www.bluebeam.com), or other similar PDF review software for applying electronic stamps and comments.

1.9 SUBMISSION REQUIREMENTS AND QUANTITIES

- A. Furnish Owner's Representative with electronic files in Adobe Acrobat Portable Document Format (PDF) files for each of the following submittal types:
1. Schedules
 2. Shop drawings.
 3. Product data, manufacturer's instructions and certificates and similar submissions.
 4. Emergency addresses: 1 file to Owner's Representative, and 1 file direct to Owner.
- B. In addition to electronic submittals furnish Owner's Representative with the following quantities of the following physical submittals:
1. All submittals greater than 50 pages shall be provided with an index.
 2. Samples: Sets of 3 identical samples of each submission required.
- C. All submittals and shop drawings shall include a submittal title sheet that lists the following: Product, Specification Section number, article, paragraph and subparagraph reference (i.e. Section 32 30 00, Article 2.2, Paragraph A - Materials, subparagraph 1 – Waste Receptacles, subparagraph a – Recycling Receptacle).
- D. General submission of physical submittals: Deliver to Owner's Representative at the following address:
- Ray Dunetz Landscape Architecture
179 Green Street
Boston, MA 02130
- E. Transmit submittals to Owner's Representative at the above address, with individual transmittal forms, Document 00 62 12 – PRODUCT SUBMITTAL FORM for each submission. Document 00 62 12 is bound into the Project Manual; unbound copies are available from the Owner's Representative.

1. On transmittal form, identify Project, Contractor, subcontractor, installer, or supplier, pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate. Transmittals received by the Owner's Representative from sources other than the Contractor will be returned without any action taken.
 2. Contractor shall number submittals sequentially by Specifications Section prior to submittal. Resubmitted items shall retain number and be noted as resubmitted (example 260000.01 R1).
- F. Contractor shall provide 2 color copies of all approved submittals to the Owner or Owner's Project Manager as directed.

1.10 SHOP DRAWINGS

- A. General: Provide accurately prepared, large scale and detailed shop drawings prepared specifically for this Project. Shop drawings shall include fabrication and installation drawings, setting diagrams, schedules, patterns, templates and similar drawings. Standard information prepared without specific reference to Project are not considered shop drawings.
1. Show adjacent conditions and related work. Show accurate field dimensions where appropriate.
 2. Identify materials and products shown. Note all conditions where require coordination with other trades and special installation procedures.
 3. Show gage and thickness of materials.
 4. Indicate welding details and joint types.
 5. Show every component of fabricated items, notes regarding manufacturing process coatings and finishes, identifying numbers conforming to the Contract Documents (i.e. stair numbers, door numbers and similar items), dimensions, and appropriate trade names.
 6. Show anchorage and fastening details, including type, size and spacing.
 7. Review each submittal for conformity with the Contract requirements prior to submittal, certify such review on each shop drawing with Contractor's stamp, signature and date. Reference on shop drawings to other sections, installers, suppliers, or trade(s) shall designate the appropriate specification sections, and the term "by others" shall not be used.
- B. Size of Format: Not less than 8-1/2 by 11 inches, and no larger than 30 by 42 inches, except for templates, patterns and similar full-size drawings.
- C. The Owner's Representative's comments and corrections will be made on the electronic submission (PDF) and returned to the Contractor. If necessary, the Contractor then shall make the necessary corrections on the original drawings and resubmit the corrected drawings in electronic format (PDF) as specified. Prints of any submittals required for the Owner's Representative's own use, and those of engineering consultants, will be made without cost to the Contractor. The Contractor is responsible to distribute and furnish (at no additional cost to Owner) all shop documents needed for use by the Contractor, subcontractors, installers, vendors and suppliers.
- D. Drawing submittals returned " APPROVED " or " APPROVED AS NOTED " Obtain and

distribute adequate prints for construction, including one print of each for designated Owner's Project Manager, and On-site Representative, and then return the reproducibles to the subcontractor or supplier from whom he originally received them.

- E. Drawing submittals returned " NOT APPROVED " or " RESUBMIT ". Obtain a record print, and then forward originals to source for correction; resubmit new reproducibles and prints as specified herein above.
- F. Each drawing shall have a title block on the right hand side containing the following data:

Name of project -	LINCOLN SQUARE IMPROVEMENTS
Owner's Representative -	Ray Dunetz Landscape Architecture
Contractor -	
Subcontractor/supplier -	
Date of submission -	

- G. Each drawing shall have a clear space on the right hand side for review stamps of both the Owner's Representative and Contractor.
1. The Contractor's Review and Action Stamp: Provide suitable space on label or title block for Contractor's review and action stamp. Stamp and sign each submittal to show Contractor's review and approval prior to transmittal Owner's Representative. Submittals not signed and stamped by Contractor will be returned without action.
 - a. Only submittals received from the Contractor will be considered for review by the Owner's Representative. Contractor shall review each submittal for accuracy and conformance with the requirements of the Contract Documents, and particularly for field measurements and proper fit with adjoining work. Modify submittals as required to show interface with adjacent work and attachment to Building.
 - b. The Contractor's Review and Action Stamp shall contain the following language or similar:

APPROVED FOR CONFORMANCE WITH THE CONTRACT DOCUMENTS.

All dimensions and quantities have been reviewed and are accepted
by _____

Contractor's Name

All dimensions and field conditions have been or will be verified
prior to fabrication of the items described herein.

- c. Submittals received from the Contractor shall be signed and comply with review requirements. Submittals not certified or improperly certified (stamped but not reviewed) will be returned to the Contractor without Owner's Representative's review. Claims due to the return of uncertified, improperly prepared or inadequately reviewed submittals will be rejected.

1.11 PRODUCT DATA

- A. Submit Product data as specified, and as the Owner's Representative may additionally prescribe. Product data includes, but is not limited to:
 - 1. Catalog cuts.
 - 2. Complete specifications.
 - 3. Standard color charts.
 - 4. Performance data.
 - a. Compliance with recognized trade association standards.
 - b. Compliance with recognized testing agency standards, labels and seals.
 - 5. Environmental data including, but not limited to:
 - a. Chemical composition.
 - b. Recycled (pre and post consumer) content.
 - c. Locations of material extraction/harvest and manufacture, with respective distances to site.
 - d. VOC content.
 - e. FSC wood content.
 - f. Material certifications as applicable to product.
 - 6. Certified laboratory test report data.
 - 7. Health and safety precautions.
 - 8. Illustrated capacities, characteristics, wiring diagrams, controls, and other pertinent information for complete product and product use description.
- B. If more than one size or type is shown on any printed sheet, indicate clearly intended item(s).
- C. When accepted or not accepted, the Owner's Representative will retain three copies. Submit sufficient copies for all other parties. No copies stamped RESUBMIT or NOT APPROVED shall be sent to the job site.

1.12 SAMPLES

- A. Submit samples clearly labeled as to its material, type or make, manufacturer, size or gauge, and other pertinent data, accompanied by an appropriate transmittal form. Samples shall show full range of color and texture variation that can be expected.
 - 1. When accepted or not accepted, the Owner's Representative will retain one set of samples and return the other to the Contractor. Samples will not be permitted for use in the project.
 - 2. No final color selections shall be made by the Owner's Representative until all interior samples have been received and reviewed with the Owner.

1.13 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification Sections, submit manufacturer's printed instructions for delivery, handling, storage, assembly, installation, start-up, adjusting, and finishing.

- B. Identify conflicts between manufacturer's instructions and Contract Documents.

1.14 MANUFACTURER'S AND INSTALLER'S CERTIFICATES

- A. When specified in individual specification Sections, submit manufacturer's certificates and installer certificates to Owner's Representative for review.
- B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or product, but must be acceptable to Owner's Representative.

1.15 FABRICATOR'S CERTIFICATES

- A. When specified in individual specification Sections, submit fabricator's certificates and qualifications to Owner's Representative for review.
- B. Certificates shall document that the fabricator meets the standards specified in the respective individual specification Section.

1.16 EMERGENCY ADDRESSES

- A. Within 15 days of Notice to Proceed, submit in writing, the name, addresses and telephone numbers of key members of their organization including Contractor's Superintendent and personnel at the site, to be contacted in the event of emergencies at the project site, which may occur during non-working hours.

1.17 EROSION AND SEDIMENT CONTROL PROGRAM

- A. Unless specified elsewhere as being prepared by the Engineer, submit erosion and sediment control program within 30 days after date of Owner- Contractor Agreement for Owner's Representative's review. Revise and resubmit as required.
- B. Erosion and sediment program shall indicate proposed methods, materials to be employed, and schedule for effecting erosion and siltation control and preventing erosion damage. Provide sufficient information to fully explain the program; the following are the minimum requirements:
 - 1. Proposed methods for actuating erosion and siltation control including 1 inch equals 40 feet (1"=40') scale plans indicating location of erosion control devices and siltation basins.
 - 2. List of proposed materials including manufacturer's product data, in accordance with Division 32 - EARTHWORK and Division 33 - EXTERIOR IMPROVEMENTS.
 - 3. Schedule of and sediment control program indicating specific dates from implementing programs in each major area of Work.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION
01 33 00

This Page Intentionally
Not Used

SECTION 02 41 00 – DEMOLITION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included:
 - 1. Demolition, partial and/or selective demolition, and removal of selected portions of walls, slabs, and other items as required for the completion of the new work. Refer to the Drawings for additional requirements.
 - 2. Demolition and removal of selected site elements and as required for new work. Refer to the Drawings for additional requirements.
 - 3. Salvage of existing items to be reused or turned over to the owner.
 - 4. Removal and legal disposal of demolished materials off site in accordance with Section 02 41 13 – SITE PREPARATION. Except those items specifically designated to be relocated, reused, or turned over to the owner, all existing removed materials, items, trash, and debris shall be completely removed from the site.
 - 5. Demolition and removal work shall properly prepare for alteration work and new construction to be provided under the Contract.
 - 6. Blasting requirements.
 - 7. Scheduling and sequencing operations without interrupting utilities serving occupied areas. If interruption is required, obtain written permission from the utility company and the Engineer. Schedule interruption when the least amount of inconvenience will result.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed as applicable under the designated Sections:
 - 1. Section 02 41 13 – SITE PREPARATION
 - 2. Section 02 42 91 – REMOVAL AND SALVAGE OF HISTORIC MATERIALS
 - 3. Section 04 01 40 – STONE MASONRY RESTORATION
 - 4. Section 33 05 05 – SELECTIVE SITE UTILITY DEMOLITION

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site, unless indicated to be removed and salvaged or removed and reinstalled.

- B. Remove and Salvage: Detach items from existing construction and deliver them to the Owner's representative ready for reuse, at a location designated by the Owner's representative. Protect from weather until accepted by Owner's representative.
- C. Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated. Protect from weather until reinstallation.
- D. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques, antiques, and other items of interest or value to the owner that may be encountered during selective demolition remain property of the Owner as applicable. Carefully remove each item or object in a manner to prevent damage and deliver promptly to a location acceptable to the Owner's representative or Project Manager.

1.5 SUBMITTALS

- A. The Contractor shall prepare and submit to the Engineer for review and approval, a plan indicating his proposed demolition procedures and methods to be used including but not limited to, equipment, tools, devices, crane capacity and location, schedule of operations, methods of utility protection, methods of preventing any debris resulting from demolition, excavation or construction, and any relevant information necessary for the completion of the work. The requirements for equipment and all procedures utilized shall be in conformance with the intent of these specifications and the Massachusetts Building Code. The Contractor's submittal of demolition procedures and methods, including any necessary calculations and drawings, shall be designed and stamped by a Professional Structural Engineer licensed in the Commonwealth of Massachusetts certifying that all existing structural members have sufficient capacity to support the proposed construction loads and are suitably braced and supported throughout the demolition operations. Work under this item may not commence until the Engineer has given written approval. Payment for the Contractor's design and submittal including contractor's engineering services shall be considered incidental to this item and no further compensation will be allowed.
- B. Schedule of Selective Demolition Activities:
 - 1. Detailed sequence of selective demolition and removal work, with early and late starting and finishing dates for each activity. Ensure the owner's on-site operations are uninterrupted if applicable.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
 - 3. Coordination for shutoff, capping, and continuation of utility services.
 - 4. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other occupants affected by selective demolition operations.
 - 5. Coordination of the owner's continuing use or occupancy, or partial use or partial occupancy of portions of existing structures and of owner's partial occupancy of completed Work.
 - 6. Means of protection for items to remain and items in path of waste removal from building.
- C. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged, and turned over to the owner.

- D. Predemolition Videotapes: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by selective demolition operations. Comply with Division 01. Submit before Work begins.
- E. Landfill Records: Provide trip tickets (receipts) indicating receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
 - 1. Comply with submittal requirements in Section 017400 – CLEANING AND WASTE MANAGEMENT.

1.6 QUALITY ASSURANCE

- A. Examination of Existing Conditions: The Contractor shall examine the Contract Drawings for demolition and removal requirements and provisions for new work. Verify all existing conditions and dimensions before commencing work. The Contractor shall visit the site and examine the existing conditions as he finds them and shall inform herself/himself of the character, extent and type of demolition and removal work to be performed. Submit any questions regarding the extent and character of the demolition and removal work in the manner and within the time period established for receipt of such questions during the bidding period.
- B. Removal work in the manner and within the time period established for receipt of such questions during the bidding period.
- C. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.
- D. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- E. Standards: Comply with ANSI A10.6 and NFPA 241.
- F. Predemolition Conference: Conduct conference at Project site to comply with requirements in Section 013100 - PROJECT MANAGEMENT AND COORDINATION. Review methods and procedures related to selective demolition including, but not limited to, the following:
 - 1. Inspect and discuss condition of construction to be selectively demolished.
 - 2. Review structural load limitations of existing structure.
 - 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
 - 5. Review areas where existing construction is to remain and requires protection.

1.7 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

1.8 BLASTING

- A. Blasting shall not be allowed.

PART 2 - PRODUCTS

2.1 TEMPORARY CONSTRUCTION FENCE

- A. Furnish, install, and maintain 600 Linear Feet of new, six-foot height temporary construction fence, including hardware with equal quantities of clamps and bases, as required to protect and secure the limits of the laydown and monument storage area.
- B. Due to the uncertain timing with respect to the reconstruction of the monument, the temporary construction fence shall be purchased, not rented.
- C. The temporary construction fence will become the property of the City at the conclusion of the project. Contractor shall remove and deliver fence to the City as directed.
- D. Temporary fence shall be panelized with 10 foot lengths.
- E. End, gate and corner posts shall be braced to adjacent line posts (more than 30° change in direction constitutes a corner).
- F. Fence panel bases shall be a weighted rubber base such as Start Traffic Fence Anchor or approved equal to minimize panels from topping over in high winds.
- G. Fabric shall be 10 gauge min. wire, woven into approximately 2" diamond mesh.
- H. Steel fabric base metal shall be coated with prime western spelter or approved equal.
- I. Line posts and end or corner posts shall be 1½" O.D.
- J. The contractor is responsible for surface restoration once the fence is removed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Designer.

- E. Engage a professional engineer registered in the Commonwealth of Massachusetts to survey condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective demolition operations.
- F. tive demolition operations.
- G. Survey of Existing Conditions: Record existing conditions by use of preconstruction videotapes.
 - 1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.
- H. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
 - 1. Arrange to shut off indicated utilities with utility companies and Owner.
 - 2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
 - 3. Prior to commencing cutting work in existing surfaces, take all precautionary measures to assure that mechanical and electrical services to the particular area have been made inactive. Coordinate with Fire Protection, Plumbing, HVAC, and Electrical subcontractors. Only licensed tradesmen of that particular trade shall disconnect and cap existing mechanical and electrical items that are to be removed, abandoned and/or relocated.
 - 4. If, during the process of cutting work, existing utility lines are encountered which are not indicated on the Drawings, regardless of their condition, immediately report such items to the Designer. Do not proceed with work in such areas until instructions are issued by the Designer. Continue work in other areas.
 - 5. which are not indicated on the Drawings, regardless of their condition, immediately report such items to the Designer. Do not proceed with work in such areas until instructions are issued by the Designer. Continue work in other areas.

3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Comply with requirements for access and protection specified in Section 015000 - TEMPORARY FACILITIES AND CONTROLS.
 - 2. Maintain adequate passage to and from all exits at all times. Before any work is done which significantly alters access or egress patterns, consult with the Designer and obtain approval of code required egress. Under no condition block or interfere with the free flow of people at legally required exits, or in any way alter the required condition of such exits.

- B. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- C. nt, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
 - 1. Strengthen or add new supports when required during progress of selective demolition.
 - 2. Remove temporary shoring, bracing and structural supports when no longer required.
 - 3. Post warning signs and place barricades as applicable during placement and removal of temporary shoring.
- D. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area(s).
 - 1. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction. Provide temporary barricades as required to limit access to demolition areas.
 - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
- E. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with demolition operations.

3.4 SELECTIVE DEMOLITION, GENERAL

- A. General: Refer to Section 02 42 91 – Removal and Salvage of Historic Materials. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - 2. Neatly saw cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
 - 3. Saw Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during and after flame-cutting operations.
 - 5. Maintain adequate ventilation when using cutting torches.
 - 6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
 - 8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017400 – CLEANING AND WASTE MANAGEMENT.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area designated by the owner's Project Manager.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse. Paint equipment to match new equipment.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Designer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

E. all locations after selective demolition operations are complete.

F. Items for Re-use and Preservation of Existing Surfaces to Remain:

1. Refer to Section 02 42 91 – Removal and Salvage of Historic Materials.

3.5 PROTECTION OF PUBLIC AND PROPERTY

- A. Provide all measures required by federal, state, and municipal laws, regulations, and ordinances for the protection of surrounding property, the public, workmen, and Owner's employees during all demolition and removal operations. Measures are to be taken, but not limited to installation of sidewalks, sheds, barricades, fences, warning lights and signs, trash chutes and temporary lighting.
- B. Protect all walks, roads, streets, curbs, pavements, trees, and plantings, on and off premises, and bear all costs for correcting such damage as directed by the Designer, and to the satisfaction of the owner's Project Manager.
- C. Demolition shall be performed in such a manner that will ensure the safety of adjacent property. Protect adjacent property from damage and protect persons occupying adjacent property from injuries which might occur from falling debris or other cause and so as not to cause interference with the use of other portions of the building, of adjacent buildings or the free access and safe passage to and from the same.
- D. Every precaution shall be taken to protect against movement or settlement of the building, of adjacent buildings, structures, sidewalks, roads, streets, curbs, and pavements. Provide and place at the Contractor's own expense, all necessary bracing and shoring in connection with demolition and removal work.

- E. Remove portions of structures with care by using tools and methods that will not transfer heavy shocks to existing and adjacent building structures, both internal and external of the particular work area.
- F. Provide and maintain in proper condition, suitable fire resistive dust barriers around areas where interior demolition and removal work is in progress. Dust barriers shall prevent the dust migration to adjacent areas. Remove dust barriers upon completion of major demolition and removal in the particular work area.
- G. Protect unaltered portions of existing construction, including finishes, furnishings, and equipment
- H. Provide secure weather protection where demolition has removed a portion of the exterior envelope.

3.6 DISCOVERY OF HAZARDOUS MATERIALS

- A. If hazardous materials, such as chemicals, asbestos-containing materials, or other hazardous materials are discovered during the course of the work, cease work in affected area only and immediately notify the Designer and the Owner's Project Manager of such discovery. Do not proceed with work in such areas until instructions are issued by the Designer. Continue work in other areas.
- B. If unmarked containers are discovered during the course of the work, cease work in the affected area only and immediately notify the Designer and the owner's Project Manager of such discovery. Do not proceed with work in such areas until instructions are issued by the Designer. Take immediate precautions to prohibit endangering the containers integrity. Continue work in other areas.

3.7 CUTTING

- A. Perform all cutting of existing surfaces in a manner which will ensure a minimal difference between the cut area and new materials when patched. Use extreme care when cutting existing surfaces containing concealed utility lines which are indicated to remain and bear full responsibility for repairing or replacement of all such utilities that are accidentally damaged.
- B. Provide a flush saw cut edge where existing concrete foundations will be cut off 12" below finished grade.

3.8 BLASTING

- A. Blasting shall not be allowed.

3.9 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Refer to Section 02 41 13 – SITE PREPARATION.

3.10 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Premises shall be left in a clean condition and ready to accept alteration work and new construction.

END OF SECTION

This Page Intentionally
Not Used

SECTION 02 41 13 – SITE PREPARATION

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Protection of existing paving, lighting, and utilities to remain within and adjacent to the property.
- B. Removal of concrete and metal reinforcing; brick paving; concrete wall; site light fixtures; flagpole light and concrete base; site vegetation; and other miscellaneous items.
- C. Salvage existing historic signs, utility covers, flagpole, memorial plaques and stone markers.
- D. Salvage the following for resetting: monument, granite bench, wall and pier, capstones, steps, pavers, and granite base.
- E. Salvage existing eagle statuary on top of existing flagpole light.
- F. Disposal of all debris legally off site.
- G. Erosion control.
- H. Stump removal.
- I. Construction fencing.
- J. Saw cutting existing pavement.

1.3 RELATED WORK

- A. Section 02 41 00 – DEMOLITION.
- B. Section 02 42 01 – REMOVAL AND SALVAGE OF HISTORIC MATERIALS.
- C. Section 31 20 00 – EARTHWORK.
- D. Section 31 24 00 – EROSION AND SEDIMENTATION CONTROLS.

1.4 SUBMITTALS

- A. The Contractor shall, prior to any removal of rubbish or debris from the site, submit written evidence satisfactory to the Owner's Representative that he has an approved dumping location for debris and/or spoil from his demolition and excavation activities.
- B. Prior to beginning the work of this Contract, the Contractor shall submit a plan indicating stockpile areas and equipment and materials storage areas to the Owner's Representative for review and approval. The Contractor shall provide any security measures necessary to protect his work and equipment at no additional costs to the Owner.

1.5 EXAMINATION OF SITE AND DOCUMENTS

- A. By submitting a bid the Contractor affirms that he has carefully examined the project documents site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period, as no additional compensation will be made for errors or inaccuracies that may be found therein.

1.6 LAWS AND ORDINANCES

- A. Follow all Local, State and Federal laws and ordinances which apply to the work of this Section.

1.7 REFERENCES

- A. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.
- B. Work operations shall meet American National Standards Institute [ANSI] Standard Z-133.1.

1.8 PUBLIC SAFETY

- A. The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site. Provide all necessary signage as required by the jurisdictions having authority for rerouting of pedestrian traffic during construction operations.
- B. All equipment to be used and all work to be performed shall be in full compliance with all OSHA standards including, but not limited to, those regulations concerning noise levels, protective devices and operator safety. Immediately discontinue any obviously hazardous practice.
- C. Contractor shall coordinate for any police details required by the City as a result of the work related to this project. Adhere to all applicable timeframes and requirements of the responsible agency/agencies.

1.9 STORAGE AND HANDLING

- A. Storage of Existing Masonry Materials shall be in accordance with Section 02 42 91 – REMOVAL AND SALVAGE OF HISTORIC MATERIALS.

1.10 DIG SAFE

- A. Contractor is required to contact Dig Safe, tel: 811, a minimum of 3 business days, or 72 hours, prior to start of construction.
- B. Contractor will be given a Dig Safe ticket number as proof of notification. Provide Owner's Representative with number.

1.11 SPECIAL PROTECTION FOR MAINTAINING STREETS AND PUBLIC WAYS

- A. Do not close or obstruct streets or sidewalks within the public right of way without a permit. Do not place or store material in streets or sidewalks.
- B. Conduct operations with minimum interference to the abutting streets.

1.11 PROJECT PHASING

- A. Project phasing, including site preparation operations, shall be in accordance with the Drawings.

1.12 SITE STORAGE AND LAYDOWN AREA

- A. Contractor shall be allowed to store equipment and materials in the area indicated on the drawings in the paved area outside the Worcester Auditorium. Contractor is responsible for any and all damage to the storage area during their use. Contractor shall furnish and supply construction fencing and gates for proper securing of equipment and materials. Construction

fencing shall become the property of the City of Worcester. Contractor is solely responsible for securing equipment and materials contained therein.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. ROOT GROWTH ENHANCER: "Roots Solupaks" as manufactured by Lebanon Seaboard Corporation, 1600 E. Cumberland St., Lebanon, PA 17042, Roots, Inc., or approved equal.
- B. HERBICIDE: "Roundup Pro" as manufactured by Monsanto Company, St. Louis MO or equal approved by the prevailing Public Health Authority.
- C. CONSTRUCTION FENCE: See Section 02 41 00 – DEMOLITION.

2.2 EROSION CONTROL

- A. See Section 31 25 00 – EROSION AND SEDIMENTATION CONTROLS.

2.3 TREE REMOVAL EQUIPMENT AND MATERIALS

- A. Equipment necessary for this Contract shall be properly maintained and in good operating condition to the City's satisfaction. The Contractor shall promptly remove and replace any equipment which the Owner deems to be in unsatisfactory repair or condition or otherwise unsuitable.
- B. At the discretion of the Owner, if equipment failures, breakdowns or other related problems occur that are jeopardizing the meeting of deadlines established in the written schedule provided by the Contractor, the Contract will be terminated.
- C. Vehicles shall display prominently the Contractor's name, address, and telephone number on both doors.
- D. A chipper, meeting all OSHA requirements, shall be used which will process material up to twelve (12) inches in diameter.
- E. A crane or log loader shall be used adjacent to the site to remove logs too large to be chipped.

2.4 ARBORIST PERSONNEL

- A. The Contractor shall submit each employee's name and title prior to the commencement of work. The Contractor shall provide a list of all Massachusetts Certified Arborists who will be working on this contract. This list shall include the names of those individuals and their certification number. The Contractor shall advise the Owner of any changes in the roster assigned to this contract.
 - 1. A crew shall consist of a minimum, one (1) tree trimmer/ climber, and one (1) ground person (one of which shall be a crew foreman and a Massachusetts Certified Arborist in good standing). The crew foreman shall have a minimum of five (5) years climbing and pruning experience.
 - 2. Each worker shall be experienced and highly qualified with necessary tree work skills to successfully complete this contract, including the ability and training to perform aerial rescue. Said skill shall also include worker safety and ability to be in compliance with current OSHA and ANSI Z-133.1 Standards.

2.4 MATERIALS AND TOOLS FOR REMOVAL AND PROTECTION OF SALVAGED MATERIALS

- A. See Section 02 42 91 – REMOVAL AND SALVAGE OF HISTORIC MATERIALS.

PART 3 – EXECUTION

3.1 TEMPORARY PROTECTIVE COVERINGS

- A. Place temporary soil coverings to control erosion and sedimentation on all disturbed or graded areas as required by the construction methods employed and as directed by the Owner. Erosion control matting shall be installed in all areas seeded or planted with slopes of one vertical foot to three-foot horizontal, or steeper, immediately after seeding or planting:
1. The area to receive matting shall have a smooth surface free from stones, clods or depressions.
 2. Install matting according to manufacturer's instructions.

3.2 STAKING OUT PROJECT COMPONENTS

- A. All lines and grades not presently established at the site shall be laid out by the Contractor in accordance with the Drawings. Maintain all established bounds and benchmarks and replace as directed any which are destroyed or disturbed.

3.3 SITE CLEARING - GENERAL

- A. General: Remove trees, shrubs, lawn, improvements, or obstructions, except for those indicated on the Contract Drawings to remain, interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated.
- B. In all areas that are to be cleared, all brush, grass and other vegetation, except trees, shall be cut off flush with or below the original ground surface.

3.5 STRIP EXISTING LAWN

- A. The Contractor shall remove existing lawn turf in proposed areas of regrading and reseeding.
- B. The work shall consist of stripping by mechanical rake or by hand the existing turf vegetation present on all grassed areas within the job site as directed by the Owner. The stripping shall remove turf vegetation only. The Contractor will be responsible for disposal of all stripped material in an off-site location provided by the Contractor.

3.8 TREE REMOVAL PROCEDURES AND QUALITY CONTROL

- A. Trees designated to be removed shall be taken down and all leaves, branches and trunks of trees properly disposed of by chipping or removal from the premises.
- B. Trees are to be felled in such a manner that does not injure trees to be saved or endangers or harms the public and adjacent property.
- C. Removal of all parts of each tree, excluding the stump, shall be completed on the same day that the removal process is started, including the trunk (or butt) of the tree.

- D. Removal shall include digging out tree stumps in their entirety and grubbing roots to at least 30 inches below existing or proposed grades, whichever is deeper, as shown on the Contract Drawings. The area or tree pit is to be left at the finish grade using the specified planting mix that meets the requirements laid out in Section 32 90 00 – LAWNS AND PLANTING. Unless otherwise approved by the Owner, the stump must be removed within ten (10) business days from the date that the above ground portion of the tree is removed.
 - 1. Chips from the stump material shall be removed and disposed of off-site.
 - 2. Backfill all holes from which stumps are removed with material equal to or better than adjacent areas and compact in accordance with Section 31 00 00 - EARTHWORK, of these Specifications. Do not use brush, chips, stumps or other organic debris as fill for these holes.

3.9 SAFETY

- A. All tree removal equipment to be used and all work to be performed must be in full compliance with all standards as promulgated by OSHA at the time of bidding, including, but not limited to those regulations concerning noise levels, protective devices and operator safety.
- B. The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall protect the public and its property from injury or damage that could be caused by the progress of the work. To this end the Contractor shall post all work areas. The Contractor must also provide police details and / or erect and maintain protective devices acceptable to the City Arborist, including but not limited to barricades, lights and warning signs.
- C. Any practice employed by the Contractor that is obviously hazardous, as determined by the City Arborist, shall be immediately discontinued.

3.10 SALVAGE

- A. Salvage existing granite benches, wall and piers, capstones, steps, paving, historic signs, flagpole, monument and granite base, memorial plaques and stone markers.
 - 1. See Section 02 42 91 – REMOVAL OF SALVAGE AND HISTORIC MATERIALS.
- B. Miscellaneous items including signs, utility covers, flagpole, etc. shall be carefully stored in a secure location for the duration of the project, including periods of inactivity. Existing concrete footings shall be removed from post bases prior to re-installation.
- C. See Section 04 01 10, MASONRY CLEANING and Section 04 01 40, STONE MASONRY RESTORATION for cleaning and restoration of masonry elements.
- D. See Section 05 01 70, CONSERVATION AND MAINTENANCE OF DECORATIVE METALS for cleaning and restoration of decorative metal elements.

3.11 REMOVALS AND DISPOSAL OF MATERIALS

- A. Comply with requirements of Section 01 74 00 – CLEANING AND WASTE MANAGEMENT and the following.
- B. Within the construction area, remove all existing obstructions such pavements, footings, and the like, which are to be abandoned to at least 1 foot below final finish grades and to greater depths as required by new construction.

1. The use of explosives will not be permitted.
 2. At the Owner's discretion, certain obstructions may not be removed to full depth if removal, in the Owner's opinion, will negatively affect materials to remain.
 3. Removal of concrete pavement includes the removal of any wire mesh and rebar reinforcing.
 4. Miscellaneous soils and granular base materials not appropriate for reuse shall also be removed.
- B. Materials indicated on the Contract Documents or designated by the Owner in the field to be removed shall be dismantled, removed, and legally disposed of off-site as indicated on the Contract Documents and as specified and performed in this Division 2 Section, SITE PREPARATION.
- E. The Contractor shall be responsible for the methods used in this work including properly protecting against damage to all site improvements, utility lines, trees, etc. Check with the municipality and local utility companies for locations of all existing utilities which may be in use or abandoned. Investigate and ascertain that underground utilities are correctly located and that they have been shut off and/or abandoned before disturbing them.
- F. Legally dispose of all demolished material not to be reused and rubbish off the site. Provide Owner with written affidavits confirming legal disposal. On site burning will not be allowed.
- 3.12 SAWCUTTING PAVEMENT
- A. Sawcut all existing concrete paving with an approved diamond blade concrete saw on a neat, straight line to the dimensions given, or directed. Remove the portion behind the cut with proper tools, keeping noise and disturbance to a minimum.
1. All sawn edges of paving shall be protected from damage until new paving is placed against it. Existing pavement which is damaged, disturbed or settled, shall be cut back by the same method and replaced as directed by the Owner's Representative at no additional cost to the Owner. This Item shall include the removal of all layers of pavement and of gravel or other base or sub-base materials as required beneath pavements removed.

END OF SECTION
02 41 13

SECTION 02 42 91 – REMOVAL AND SALVAGE OF HISTORIC MATERIALS

PART 1 – GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the work of removal and salvage of historic materials as shown on the Drawings, as specified herein, and as may be required by conditions and authorities having jurisdiction, including, but not limited to, the following:
 - 1. Documenting with drawings and photographs keyed to drawings and labeling elements and materials designated for removal and salvage.
 - 2. Providing temporary shoring and bracing as required to ensure stability of building elements and fabric to remain and stability of building elements and materials being removed and salvaged.
 - 3. Providing protection as necessary to protect both elements and materials to be removed and salvaged and elements and materials to remain from damage and deterioration.
 - 4. Removing and disposing of the following elements:
 - a. Sealant and mortar from joints.
 - b. Existing metal elements and anchors.
 - c. Other elements.
 - 5. Removing and salvaging the following elements for restoration and reinstallation:
 - a. All existing granite elements, including benches, walls, piers, capstones, steps, pavers, monument and monument base and eagle sculpture.
 - 6. Delivering items to be restored and reinstalled to locations indicated or designated for restoration and storage.
 - 7. Disposing of elements and materials not to be reinstalled or returned to Owner offsite in a legal manner.

1.3 RELATED WORK

- A. Section 02 41 00 – Demolition
- B. Section 02 41 13 Site Preparation
- C. Section 04 01 10 – Masonry Cleaning
- D. Section 04 05 13 – Restoration Mortars and Masonry Pointing
- E. Section 04 10 40 - Stone Masonry Restoration

1.4 PERFORMANCE REQUIREMENTS

- A. Protection for Elements and Materials To Be Removed and Salvaged: Protection for elements and materials to be removed and salvaged shall comply with the following requirements:
1. Prevent damage and deterioration from abrasion, impact, vibration, water (precipitation, condensation, and humidity level), forces caused by handling and transportation, and other exterior forces.
 2. Prevent soiling, staining, and marking.
 3. Allow application and removal without damaging, deteriorating, or altering existing surfaces and finishes.
 4. Provide optimum support to all portions of elements to prevent cracking, breakage, chipping, and application of undue stress during removal, handling, packing, transportation, and storage.
- B. Protection for Elements and Materials To Remain in Place: Use measures necessary to completely protect in-place elements, materials, and finishes to remain from damage and from deterioration that might result from work of this Section—including, but not limited to, dust, dirt, vibration, water, water vapor, condensation, chemicals, chemical vapors, impact, abrasion, excessive stress, light and ultraviolet rays, temperature extremes, repeated temperature variations, and changes in humidity—without damaging, deteriorating, or otherwise adversely affecting the elements being protected during preparation, application of protection, duration of protection, and removal of protection. All work required to achieve this intent shall be included as work of this Section.
- C. Removal: Removal of elements and materials to be removed and salvaged shall be accomplished without damaging, deteriorating, or altering elements and materials to be removed and without damaging, deteriorating, or altering elements, materials, and finishes to remain in place.
- D. Storage: Storage shall comply with the following conditions:
1. Provide security from theft, loss, vandalism, damage, and deterioration.
 2. Prevent exposure to abrasion, impact, water (precipitation, condensation, and high humidity), excessive heat and cold, substances that might cause soiling or staining, and other deleterious forces.
 3. Prevent damage and deterioration caused by animals, insects, mold, and other organisms.
 4. Provide for inspection of elements and materials at Architect or Restoration Consultant's request.
- E. Utilities: Protect underground plumbing, electric, communications, and data system components from damage and from deterioration resulting from work of this Section. Repair damaged and/or deteriorated underground plumbing, electric, communications, and data system components to condition existing before beginning work of this Section.
1. Cap below grade lines abandoned in place as a part of this Project at the source in approved manner.
 2. Contractor shall remove abandoned below grade utility lines and accessories as necessary to perform work of this Contract.

1.5 QUALITY ASSURANCE

- A. Removal and Salvage Specialist: Award the removal and salvage of historic materials work to a firm or firms regularly engaged in dismantling and salvaging elements and materials of historic

buildings similar to those required to be removed and salvaged as work of this Section that can demonstrate to Owner's satisfaction that, within previous five years, the firm has successfully performed and completed in a timely manner at least three projects similar in scope and type to work required on this Project involving buildings designated as Landmarks by local governmental authorities, buildings listed in the National Register of Historic Places, or buildings listed in a State Register of Historic Places under the direction of preservation authorities.

1. Foreman: Removal and salvage of historic materials shall be directly supervised by a full-time foreman with experience equal to or greater than that required of Removal and Salvage Specialist. Foreman shall read and speak English fluently. Foreman shall be on site daily for duration of work of this Section. Same foreman shall remain on Project throughout work unless Owner deems foreman's performance unacceptable.
 2. Mechanics: Removal and salvage of historic materials shall be carried out by skilled mechanics who are thoroughly experienced in the removal and salvage of materials from historic buildings and have a minimum of three years' experience with work on historic buildings similar to that required by this Section. In acceptance or rejection of work of this Section, no allowance will be made for workers' inattention or lack of skill.
 3. Mechanics for Removing Mortar from Joints in Stonework: Technicians proposed for removing mortar from joints in stonework shall be skilled masons experienced in removal of mortar from joints in stone masonry. Technicians shall be required to successfully complete six linear feet of raking of joints without damaging stone arrises or surfaces. Mechanics who do not complete raking of six linear feet of joint without damaging stone arrises or surfaces shall not be used for work of removal and salvage of stonework on this Project.
- B. Laws, Codes, and Regulations: Work of this Section shall comply with applicable federal, state, and local laws, codes, and regulations.
- C. Referenced Standards: Comply with applicable requirements and recommendations of the latest editions of the referenced standards listed herein, except as modified by more stringent requirements of the Contract Documents and of applicable laws, codes, and regulations. Where these standards make recommendations or suggestions, such recommendations or suggestions shall be considered mandatory for work of this Contract unless specifically indicated otherwise in Contract Documents. Provide a reference copy of each of the following standards at Project site when work of this Section is being performed. In each case in which there is a conflict between requirements of referenced standards; requirements of laws, codes, and regulations; and requirements of this Section, the most stringent or restrictive requirement shall govern.
1. American National Standards Institute (ANSI) A10.6 – *Safety Requirements for Demolition Operations*.
- E. Documentation: Document using drawings and photographs configurations and conditions of elements and materials to be removed and salvaged and of adjacent elements and materials and conditions of elements and materials adjacent to elements and materials that are to be removed. Include detail photographs where configurations and conditions cannot be clearly seen in general photographs. Document conditions that might be misconstrued as damage resulting from work of this Section. Provide drawings identifying the locations depicted in the photographs.
1. Images: Clear, sharp, high-resolution, color images. Unclear images, out-of-focus images, underexposed images, and overexposed images will not be accepted.
 2. Format: One of the following:

- a. Digital Images: High-resolution JPEG (.jpg) or TIFF (.tif) color images (minimum 6 megapixel images with color information yielding files of at least 1 megabyte each) on archival quality CD-R/DVD-Rs made with phthalocyanine dyes with a gold reflective layer. Provide two copies of each CD/DVD. Clearly label CD/DVDs using method that will not cause images to deteriorate and that will not contribute to image deterioration. [Using archival quality is important because typical CD-R/DVD-Rs only have a lifespan of 10 years; archival quality CD-R/DVD-R can last 100 years. The phthalocyanine dye is the most stable dye available and the gold reflective layer does not oxide like the commonly used silver.]
 3. Identification and Keying: Label each photograph with project name, date and time photograph was taken, and location. Key overall photographs to drawings and key detail photographs to overall photographs and to drawings so that area depicted in photograph is easily identifiable.
 - a. Digital Images: Provide identification and keying information, including text description and images of drawings and key photographs, for all photographs on each CD/DVD in text file (Word) or in PDF file on same CD/DVD as images. In addition, submit printed black and white copies of key drawings and key photographs together with the CD/DVDs.
 4. Labeling and Tagging: Label or tag each element to be removed and salvaged using approved method that will identify element until completion of the work and that will not be visible when element is reinstalled in finished work.
- F. Sources of Materials: Obtain each type of material required for work of this Section from a single source to ensure a match in quality, performance, and appearance.
- G. Knowledge of Site and Project Conditions: Before submitting bid, Bidders shall make themselves thoroughly familiar with the Drawings and Specifications, with the scope of this Project, and with conditions at the Project site relating to requirements of this Section and limitations under which the work will be performed and shall determine or verify dimensions and quantities. Submission of a bid shall be considered conclusive evidence that Contractor is thoroughly familiar with Project requirements and site conditions and limitations.
- H. Responsibility for Damage to Historic Material Resulting from Removal and Salvage of Historical Materials Work: Restore and/or replace in kind building elements, materials, and finishes (including elements, materials, and finishes to be removed and salvaged and elements, materials, and finishes to remain) damaged or deteriorated as a result of work of this Section.

1.6 SUBMITTALS

- A. General: Submit the following in compliance with the requirements of the Contract Documents. Revise and resubmit each item as required to obtain Architect or Restoration Consultant's approval.
- B. Qualification Data: Submit qualification data for firm and personnel specified in "Quality Assurance" Article that demonstrates that both firm and personnel have capabilities and experience complying with requirements specified. For firm and foreman, provide a list of at least three completed projects similar in size and scope to work required on this Project. For each project list project name, address, architect, conservator, supervising preservation agency, scope of contractor's work, and other relevant information. Submit this information with the bid.

- C. Documentation Program: Detailed description of methods and equipment proposed for use in documenting existing surfaces and conditions of existing elements and materials to be removed and salvaged and of elements and materials adjacent to those elements and materials indicated to be removed and of elements and materials adjacent to those indicated to be removed and salvaged.
- D. Work Description for Removal and Salvage of Historic Materials: Detailed description of methods and procedures, equipment, tools, and materials proposed for use in removal and salvage of historic materials operations for each element and material to be removed and each element and material to be removed and salvaged, including, but not limited to, the following:
 - 1. Sequence for performing work of this Section.
 - 2. Planned interruption of utility services, if any.
 - 3. Procedures to ensure that removal and salvage of historic materials operations do not transfer unacceptable impacts, vibrations, or stresses to historic building fabric.
 - 4. Procedures for controlling noise and dust.
 - 5. Procedures for releasing or freeing materials and elements from existing construction.
 - 6. Protection for elements to be removed and salvaged.
 - 7. Handling and transporting materials and elements removed.
 - 8. Packaging elements removed and salvaged.
 - 9. Storage locations and provisions for security and protection of salvaged elements to be reinstalled.
 - 10. Disposal locations for elements to be removed and disposed of offsite.
- E. Documentation: Before beginning removal and salvage of historic materials, document characteristics and condition of elements and materials to be removed and salvaged and of elements and materials adjacent to those elements and materials indicated to be removed and of elements and materials adjacent to those indicated to be removed and salvaged with photographs showing overall elements and detail photographs showing all surfaces of elements and materials as required in Paragraph "Documentation" in "Quality Assurance" Article, above.

1.7 MOCK-UPS

- A. General: Before beginning general removal and salvage of historic materials work, prepare mock-ups to provide standards for work of this Section. Do not proceed with removal and salvage of historic materials work until Architect or Restoration Consultant has approved mock-ups.
 - 1. Locate mock-ups as directed by Architect or Restoration Consultant.
 - 2. Notify Architect or Restoration Consultant 48 hours prior to start of each mock-up.
 - 3. Architect or Restoration Consultant will monitor mock-ups.
 - 4. Use crew that will execute the work and follow requirements of this Section.
 - 5. Repeat mock-ups as necessary to obtain Architect or Restoration Consultant's approval.
 - 6. Protect approved mock-ups to ensure that they are without damage, deterioration, or alteration at time of Substantial Completion.
 - 7. Approved mock-ups will represent minimum standards for removal and salvage of historic materials work. Subsequent removal and salvage of historic materials work that does not meet standards of approved mock-ups will be rejected.
- B. Prepare the Following Mock-Ups
 - 1. Removal and Salvage of Exterior Stone Units To Be Reused: Two stone units in each type of stone to be removed, salvaged and relocated.

1.8 PROJECT CONDITIONS

- A. Safety: Protect all persons, whether or not involved in work of this Section, from harm caused by or resulting from work of this Section.
 - 1. Protection from Hazardous Materials: Protect workers and other persons from contact with hazardous materials resulting from work of this Section, including, but not limited to, the following:
 - a. Silica: Use procedures necessary to protect workers and other persons from exposure to respirable crystalline silica. All work should be performed in compliance with applicable OSHA regulations, including but not limited to "Respirable Crystalline Silica Standard" (Title 29, Code of Federal Regulations (CFR) Section 1926.1153) and with other applicable state and local laws and regulations.
 - 2. Protection from Noise: Limit noise generated by work of this Section to an absolute minimum. Prevent all persons, whether or not involved with the work of this Section, from noise that might adversely affect them.
- B. Debris Removal
 - 1. Keep premises clean by removing accumulation of waste materials, rubbish, and debris from site daily. Dispose of waste, rubbish, and debris in a proper manner in accordance with federal, state, and local laws and regulations, to the satisfaction of authorities having jurisdiction, and to the satisfaction of the Architect or Restoration Consultant. Keep site and public rights of way clear.
- C. Security: Secure materials and elements to remain in place and materials and elements to be removed and salvaged from theft, loss, defacement, damage, and deterioration.
- D. Condition of Site: Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical. Owner assumes no responsibility for condition of elements and materials to be demolished, removed, and/or salvaged.
- E. Discrepancies: Notify Architect or Restoration Consultant of discrepancies between existing conditions and Drawings before proceeding with removal and salvage of historic materials.
- F. Disposal: Dispose of items not to be salvaged and reinstalled or salvaged and turned over to Owner offsite in a legal manner. Storage or sale of removed items or materials onsite is not permitted.
- G. Preconstruction Meeting: Convene a preconstruction meeting to discuss removal and salvage of historic materials work and its effect on adjacent elements, materials, and finishes. Attendees shall include Owner's Representatives; Architect and/or Restoration Consultant; Construction Manager; firm(s) that will perform removal and salvage of historic materials work; and other entities that might be affected by removal and salvage of historic materials work.

1.9 WARRANTIES

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during removal and salvage of historic materials work by methods and with materials so as not to void existing warranties.

PART 2 – PRODUCTS

2.1 MATERIALS FOR PROTECTION OF REMOVED ELEMENTS AND MATERIALS

- A. General: Provide materials for packaging and crating elements removed and salvaged suitable for use intended and approved by Architect or Restoration Consultant.
- B. Resilient Materials: Non-staining and non-abrasive materials that will not damage or deteriorate elements and materials to be removed as approved by Architect or Restoration Consultant.

2.3 MATERIALS FOR CRATING REMOVED ELEMENTS AND MATERIALS

- A. General: Provide materials as specified herein, except provide thicker, heavier materials as necessary to ensure sound, secure crates.
- B. Enclosure: Plywood, minimum 1/2-inch CDX. Provide thicker plywood as necessary to ensure sound, secure crate. Reinforce crating materials as necessary to prevent damage from handling and transportation.
 - 1. Provide plywood that does not contain urea formaldehyde resins or binders. Resins and binders shall not be harmful to elements, materials, and/or finishes being protected. Do not provide other types of composite wood board.
- C. Framing and Bracing: Dimensioned lumber, 2-inch nominal dimension by dimension necessary for container. Provide thicker lumber as necessary to ensure sound secure crate that will fully protect stored elements during handling, transportation, and storage.
- D. Fasteners: Screws designed for fastening wood members to wood substrate of gauge and length required to ensure sound, secure crate or pallet.

2.4 TOOLS AND EQUIPMENT

- A. General: Provide tools suitable for use intended that will do the least amount of damage to elements and materials to be removed and salvaged and to elements and materials to remain. Use only tools described in approved Work Description for Removal and Salvage of Historic Materials.
 - 1. Hand Tools: Use small, sharp hand tools designed for cutting and sawing, small pry bars, and other appropriate tools.
 - a. Protect surfaces of elements and materials being removed and salvaged and of elements and materials to remain in place from contact with metal tools used for removal by protecting with wood or other appropriate separation material.
 - 2. Power Tools: Small power tools with rotating blades or small vibrating blades with fine teeth to minimize vibration and width of kerf. Do not use reciprocating saws.
 - 3. Drills: Small rotary power drills with sharp bits or core bits as appropriate for use intended. Do not use hammer drills.
- B. Tools for Removing Mortar from Joints in Stonework: Special knives, special thin cutter blades, hand-operated hacksaw blades, hand-operated abrasive-coated reciprocating saw blades, or other similar blades no thicker than 5/8 times joint width.

- C. Equipment for Handling Stone Units: Suction cups and wood and plastic tools that will not damage or mar surfaces and arrises.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Survey existing conditions and correlate with requirements indicated to determine extent of removal and salvage of historic materials of historic material necessary for execution of the Work.
- B. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect or Restoration Consultant.
- . Perform surveys as the Work progresses to detect hazards resulting from removal activities.

3.2 DOCUMENTATION

- A. General: Before beginning general removal and salvage of historic materials work, document elements and materials to be removed and elements, materials, and finishes adjacent to those to be removed to comply with requirements of Article "Quality Assurance," above.
- B. Documentation Program: Submit proposed "Documentation Program."
- C. Documentation: Following approval of "Documentation Program," document each element and material to be removed and each element, material, and finish adjacent to elements and materials to be removed and submit Documentation.
- D. Identification: Label or tag each element to be removed and salvaged with identification number matching number on drawings. Provide permanent identification on surfaces that will be concealed following reinstallation.

3.3 PREPARATION FOR REMOVAL AND SALVAGE OF HISTORIC MATERIALS

- A. Site Access and Temporary Controls: Conduct removal work and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection necessary to prevent injury to people and damage to adjacent buildings and facilities to remain.
- C. Temporary Shoring and Bracing: Provide and maintain shoring, bracing, reinforcement, structural supports, and enclosures as necessary to maintain existing construction to remain safely and securely in position without movement or displacement and without damage or deterioration during removal and salvage of historic materials work and to prevent unexpected or uncontrolled movement or collapse of construction being removed.
- D. Protection: Provide protection against damage by water and fire, and injury to the public, workers, damage to adjacent property, and damage to portions of existing site not being removed.
 - 1. General: Install protections before beginning general removal and salvage of historic materials work. Protect site, utilities, and equipment, including temporary supports, dust

and other enclosures, barricades, and other elements from damage and from deterioration.

2. Protection of Adjacent Elements, Materials, and Finishes: Protect elements from damage caused by or resulting from removal and salvage of historic materials operations.
 - a. Resilient Cover: Provide resilient, non-abrasive material adjacent to materials and elements to be protected.
 - b. Rigid Protective Cover: Provide rigid cover to prevent impact damage and hold materials and elements in place should they become dislodged by vibrations or other effects of construction work.
 - c. Waterproof Cover: Protect materials and elements from water, water vapor, and condensation that might damage or deteriorate them.

3.4 REMOVAL AND SALVAGE OF HISTORIC MATERIALS, GENERAL

- A. Documentation: Do not begin removal and salvage of historic materials work until documentation has been accepted by Architect or Restoration Consultant.
- B. Support: Provide shoring, bracing, reinforcement, and enclosures necessary to prevent damage and to prevent deterioration prior to beginning removal and salvage of historic materials work.
- C. Protection: Provide protection from dust, noise, and other conditions to be generated by work of this Section.
- D. Hoisting: Use appropriately sized hoisting devices and cribbing for removal, lifting, and lowering.
- E. Removal: Perform removal work systematically in a careful, workmanlike manner using methods required to complete the Work within limitations of governing regulations and as specified herein. Dispose of elements and materials indicated to be removed offsite in a legal manner.
 1. Proceed with removal systematically. Complete operations in one location before proceeding to other locations.
 2. Use hand tools or small power tools designed for sawing or grinding to minimize disturbance of adjacent surfaces.
 3. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage both construction to remain and adjoining construction. Temporarily cover openings to remain.
 4. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 5. Locate removal equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 6. Do not use cutting torches and other devices, including but not limited to heat guns, generating heat.
- F. Salvage: Salvage elements as indicated. Wrap salvaged elements, except for masonry units, to protect them from damage during handling and storage. Crate wrapped elements in crates that will protect elements from damage and from deterioration.
- G. Removed and Salvaged Items To Be Reinstalled
 1. Cleaning and Restoration: Clean and repair items to functional condition for intended reuse and to original appearance as specified in appropriate specification sections.

2. Packaging: Secure to pallet and or crate items for transportation to storage site location until reinstallation. Identify contents of containers.
3. Transporting: Transport items to location designated for storage until time of reinstallation. Protect items from damage, deterioration, loss, theft, and vandalism during transport.
4. Reinstallation: Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment and installation requirements of appropriate specification section for each element and material. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- H. Removed Items To Be Disposed of Offsite: Except for items and materials indicated to be recycled, reused, salvaged, reinstalled, delivered to Owner, or otherwise indicated to remain Owner's property, transport materials removed during work of this Section from Project site and legally dispose of them. Comply with requirements specified in Division 1 Section "Construction Waste Management."

3.5 REMOVAL AND SALVAGE OF STONE UNITS

- A. General: Handle and treat stone units to be removed and salvaged as part of work of this Section in accordance with requirements of this Section and with requirements of Section 04 01 40 – "Stone Masonry Restoration." Repair or replace stones broken and stones deteriorated during removal, handling, and storage as directed by Architect or Restoration Consultant at no additional cost to Owner. Repair procedures shall comply with requirements of Section 04 01 40 – "Stone Masonry Restoration."
- B. Preparing for Removal: Before attempting to remove stone blocks, remove mortar for the full depth of the joints around the entire perimeter of the stone.
1. Use methods for removing mortar as specified in Paragraph "Mortar Removal" of Section 04 05 13 – "Masonry Pointing" that avoid damage to surfaces and arrises of stone blocks.
 2. Use plastic or non-staining wood wedges to temporarily support stone units in place during mortar removal.
 3. Cut anchors and ties encountered in clearing the joints.
- C. Removing Stone Units: Carefully remove stone units. Label stone units using approved identification system in location that will be hidden after units are reinstalled. Clean off remains of mortars and grouts using care to avoid damage to stone surfaces and arrises. Use mallet and chisels, abrasive stones, stiff fiber bristle brushes, and other approved methods.
- D. Handling Stone: Handle stone to prevent chipping, breakage, soiling, and other damage. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials that will not mar stone and will prevent pinch or wrecking bars from damaging stone. Lift with wide belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances that might cause staining. Use wood rollers and provide cushion at end of wood slides as necessary to avoid damaging stone units.
- E. Storing: Store stones in locations as designated by Owner. Store stone on wood skids or pallets. Place blocks on skids to distribute weight evenly and to prevent breakage and cracking of stones. Do not stack skids. Protect stored stone from weather with waterproof, nonstaining covers or enclosures, but allow air to circulate around stones.
- F. Protecting Stone Units: Protect stone against moisture, soiling, staining, physical damage, vandalism, and theft.
- G. Disposal: Dispose of mortar and anchors and accessories not to be reinstalled legally off site.

3.6 CLEANING AND ADJUSTMENT

- A. Cleaning during Progress of Work: Remove debris as work progresses. Maintain premises in neat and clean condition.

END OF SECTION
02 42 91

This Page Intentionally
Not Used

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following applications:
 - a. Memorial footings.
 - b. Memorial pedestals.
 - c. Memorial cores.
 - d. Cylindrical columns, pedestals, and supports for fence and sign posts.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 07 11 13 – BITUMINOUS DAMPPROOFING
 - 2. Section 31 00 00 – EARTHWORK
 - 3. Section 31 23 00 – EXCAVATION AND FILL FOR UTILITIES AND PAVEMENT
 - 4. Section 31 50 00 – SUPPORT AND PROTECTION
 - 5. Section 32 13 13 – CAST-IN-PLACE CONCRETE PAVING

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.
 2. Indicate amount of fly ash in the mix.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
1. Indicate coordination requirements for reinforcement locations with requirements of structural steel, steel joints, and steel deck.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer licensed in the Commonwealth of Massachusetts detailing fabrication, assembly, and support of formwork.
1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- E. Formwork Inspection: Indicate compliance with approved shop drawings.
- F. Anchor Bolt Location: Indicate compliance with approved shop drawings.
- G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates.
- H. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
 2. Admixtures.
 3. Form materials and form-release agents.
 4. Steel reinforcement and accessories.
 5. Waterstops.
 6. Curing compounds.
 7. Floor and slab treatments.
 8. Bonding agents.
 9. Adhesives.
 10. Vapor retarders.
 11. Repair materials.
- I. Floor surface flatness and levelness measurements to determine compliance with specified tolerances and requirements for applied finishes and materials, except as noted for slope to drains.
- J. Field quality-control test and inspection reports.
- K. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, forms and form removal limitations, shoring and reshoring procedures, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: shall be American-made Portland Cement, free from water soluble salts or alkalis which will cause efflorescence on exposed surfaces. Portland Cement shall be Type II, ASTM C150. Use only one brand of cement for each type of cement throughout project. Contractor shall be responsible for whatever steps are necessary to insure that no visual variations in color will result in exposed concrete and shall place on order and secure in advance a sufficient quantity of this (these) cement(s) to complete concrete work specified herein.
 - 1. Fly Ash: ASTM C 618. Fly ash content limited to 15% of total cements for slabs.
 - 2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 - 3. A minimum 25% of total cementitious materials by weight shall be pozzolans.
- B. Normalweight Fine Aggregate: shall be washed, inert, natural sand conforming to ASTM C33 and following additional requirements:

Sieve	Retained Percent
#4	0 - 5
#16	25 - 40
#50	70 - 87
#100	93 - 97
Fineness Modulus	2.80 (Plus/Minus 0.20)
Organic	Plate 2 maximum
Silt	2.0 percent maximum
Mortar Strength	100 percent minimum compression ratio
Soundness	5 percent maximum loss, magnesium sulfate, five cycles

- C. Normalweight Coarse Aggregate: shall be well graded crushed stone or washed gravel conforming to ASTM C33 and the following additional requirements:

Designated Size (inches)	3	2	1-1/2	1	3/4	1/2	3/8
F.M.(+/-0.20)	7.95	7.45	7.20	6.95	6.70	6.10	4.50
Organic	Plate 1 maximum						
Silt	1.0 percent maximum						
Soundness	5 percent maximum loss, magnesium sulfate, five cycles						

Maximum designated sizes for normalweight coarse aggregate to be used in concrete sections shall be as noted below, except that sizes shall also be chosen in conjunction with required clearances.

1. One and one-half inches for sections over ten inches in thickness.
 2. One inch for sections more than eight and up to ten inches in thickness.
 3. Three-quarter inch for sections more than three and up to eight inches in thickness.
- D. Water: shall be from approved source, potable, clean and free from oils, acids, alkali, organic matter, and other deleterious material.
- E. Admixtures:
1. Water-reducing agent confirming to ASTM C494, Type A such as:
 - a. "WRDA Hycol" - W.R. Grace & Co.
 - b. "PDA25" - Protex Industries, Inc.
 - c. "Pozzolith 344H" - Master Builder's Co.
 - d. Note: Water-reducing agent shall be by same manufacturer as air-entraining agent.
 2. Air-entraining agent:
 - a. "DAREX AEA" - W.R. Grace & Co.
 - b. "PROTEX AEA" - Protex Industries
 - c. "MB-VR" or "MB-AE" - Master Builder's Co.
 3. Superplasticizer: High-range water-reducer conforming to ASTM C494, Type F or Type G.
 4. Admixtures retarding setting of cement in concrete shall not be used without written approval of Designer.
 5. Admixtures causing accelerated setting of cement in concrete shall not be used without written approval of Designer.

2.2 CONCRETE MIXTURES

- A. The Contractor shall recommend, on the basis of trial mixes and strength curves specified below, design mixes for each type and strength of concrete. The Testing Agency will verify that the proposed mix designs conform to all specification requirements.
- B. Sufficient materials for concrete mix design shall be furnished by Contractor not less than five weeks before use. Duplicate small samples plainly and neatly labeled with source, where proposed to be used, date, and name of collector shall be provided and presented to Testing Agency for permanent reference.
- C. Mixes shall be designed in accordance with "Method 1" of ACI 301, and the requirements of this Section. All concrete is normalweight unless specifically designated otherwise; air-dry weight not to exceed 150 lbs. per cubic foot.
- D. Limiting values shown below apply for specific strengths of concrete with coarse aggregates less than one and one-half inches unless noted otherwise in TABLE A below.

TABLE A

Minimum Allowable Compressive Strength at 28 day (psi)	Max. Allowable Net Water Content Gallons/Sack*	Minimum Permissible Cement Factor Sacks/Cubic Yard**
4000	5.75	6.00

- * Maximum; decrease if possible. This represents total water in mix at time of mixing, including free water on aggregate.
- ** Minimum; increase as necessary to meet other requirements.
- E. In all slabs and walls exposed to weather, all concrete shall contain the approved air-entraining admixture as per manufacturer's written instructions, to provide entrained air, by volume, in the cured concrete within 4.5 to 6.5 percent.
- F. Water-Reducing Admixture - The approved water-reducing admixture shall be used in all concrete, in accordance with manufacturer's written instructions.
- G. Concrete slabs, including slabs on grade, shall have a maximum water cement ratio of 0.45.
- H. The approved superplasticizer shall be used in all concrete slabs, including slabs on grade.
- I. Water content and cement content of concrete to be used in work shall be based on curve showing relation between water content, cement content, and 7 and 28 day compressive strengths of concrete made using proposed materials. Curves shall be determined by four or more points, each representing an average of at least three test specimens at each age, and shall have range of values sufficient to yield desired data, including all compressive strengths required by Contract Documents, without extrapolation. Design mix of concrete to be used in work, as determined from curve, shall correspond to following test strengths (TABLE B) obtained in laboratory trial mixtures, but in no case shall resulting mix conflict with limiting values as specified in TABLE A.

TABLE B
Minimum Strength of Lab Trial Mixes (psi)

Design Strength	Trial Mix Strength	
	7-days	28-days
4000	3800	5000

- J. Any deviation from approved mix design, which Contractor deems desirable under certain project conditions, will not be allowed without written approval of Designer. Cost of any additional testing by Testing Agency associated therewith shall be paid for by Contractor.

2.3 FORM MATERIALS

- A. Construct formwork to shapes, lines, and dimensions required, plumb and straight, secured and braced sufficiently rigid to prevent deformation under load, and sufficiently tight to prevent leakage, all in conformance with ACI Standard 347, "Recommended Practice for Concrete Formwork".
- B. Formwork for exposed concrete shall be medium-density plastic overlaid plywood, 5/8" minimum thickness; for concealed concrete shall be "Plyform" plywood, 5/8" minimum thickness.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with smooth form finish. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation. Dimensions of form shall be as indicated on the Drawings.

1. Forms shall not impart visible straight or spiral mark on concrete columns.
- D. Chamfer Strips: Half-inch, 45 degree poplar wood strips, nailed six inches on center, and installed in inside corners of all forms, unless otherwise directed by Designer.
- E. Form Ties and Spreaders: Richmond Tyscrus by Richmond Screw Anchor Co.; Superior-ties by Superior Concrete Accessories, Ind.; or Sure-Grip Ties by Dayton Sure-Grip and Shore Co. Wire ties shall not be used. Ties for foundation walls shall be snap-ties or type specified above with removal cones and shall incorporate water seal washer. Ties shall be arranged in a symmetrical manner.
- F. Form Release Agent: Non-staining and non-emulsifiable type, or equal approved by Designer. Form release agent shall be biodegradable and shall not impart any stain to concrete nor interfere with adherence of any material to be applied to concrete surfaces.

2.4 REINFORCEMENT AND ACCESSORIES

- A. Reinforcing Steel Bars: shall be newly rolled billet steel conforming to ASTM A615 Grade 60. Bars shall be bent cold.
- B. All structural steel reinforcement and embedded items shall be hot-dip galvanized after fabrication in accordance with ASTM A123.
- C. All hot-dip galvanized steel shall be inspected for compliance with ASTM A123 and shall be marked with a stamp that indicates the number of ounces of zinc per square foot of steel. After galvanizing, the bars shall be dipped in a 0.2 percent chromic acid solution. A notarized Certificate of Compliance with all of the above shall be required from the galvanizer.
- D. Reinforcement Accessories: shall conform to Product Standard PS7-766, National Bureau of Standards, Department of Commerce, Class C, as produced by Superior Concrete Accessories, Inc.; Dayton Sure-Grip Co.; or R.K.L. Building Specialties Co., Inc. Reinforcement accessories shall include spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening reinforcement. Tie wire shall be galvanized or stainless wire of sufficient strength for intended purpose, but not less than No. 18 gage. Metal supports shall be of such type as not to penetrate surface of formwork and show through surface of concrete. Accessories touching interior formed surfaces exposed to view shall have not less than 1/8 inch of plastic between metal and concrete surface. Plastic tips shall extend not less than 1/2 inch up on metal legs. Individual and continuous slab bolsters and chairs shall be of type to suit various conditions encountered and must be capable of supporting 300 pound load without damage or permanent distortion.

2.5 MISCELLANEOUS MATERIALS

- A. Non-shrink, Non-metallic Grout: Grout shall be easily workable and shall have no drying shrinkage at any age, conforming to ASTM C11007. Compressive strength of grout (2"x2" cubes) shall not be less than 5000 psi at 7 days and 7500 psi at 28 days. Products such as:
 1. "Euco-NS" by Euclid Chemical Co.
 2. "Five Star Grout" by US Grout Corp.
 3. "Masterflow 713" by Master Builders

- B. Membrane Curing Compound: Conform to ASTM C309, Type 1. Product used shall be shown to be compatible with the later application of coatings. Curing compound shall not be used on any floor slab scheduled to receive an adhered floor finish.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine all work prepared by others to receive work of this Section and report any defects affecting installation to the Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.
 - 1. Inspection shall be performed by a structural engineer licensed in the Commonwealth of Massachusetts. Certify compliance with shop drawings.

3.2 HANDLING, STORAGE, AND PROTECTION OF MATERIALS

- A. Handle and store materials separately in such manner as to prevent intrusion of foreign matter, segregation, or deterioration. Do not use foreign materials or those containing ice. Remove improper and rejected materials immediately from point of use. Cover materials, including steel reinforcement and accessories, during construction period. Stockpile concrete constituents properly to assure uniformity throughout project.

3.3 ERECTION OF FORMWORK, SHORING AND RESHORING

- A. Set and maintain formwork to insure complete concrete work within tolerance limits listed in ACI 347 latest edition, "Recommended Practice for Concrete Formwork", and with following additional requirements:
 - 1. Maximum variations from plumb:
 - a. In surfaces of columns and walls:
 - 1) In any 10 feet of length: 1/4 inch
 - 2) Maximum for entire length: 1/2 inch
 - 2. Maximum variations from established position in plan shown on the drawings:
 - a. Column: 1/2 inch
 - b. Walls: 3/4 inch
 - 3. Variations in cross-sectional dimensions of columns and beams and in thickness of slabs and walls.
 - a. Minus: 1/8 inch
 - b. Plus: 1/4 inch
- B. For a minimum of one hour prior to concrete placement, wet forms continuously with water to swell forms in order to prevent leakage of concrete matrix and to minimize absorption of concrete matrix water by form materials. This requirement may be waived for those specific cases where Designer deems it unnecessary or impractical. Care must be exercised to prevent a build-up of water at base of forms.
- C. Before form materials can be re-used, surfaces that will be in contact with freshly cast concrete shall be thoroughly cleaned, damaged areas repaired and projecting nails withdrawn. Re-use of form material shall be subject to approval by Designer.

3.4 PLACING OF REINFORCEMENT

- A. Reinforcement shall be placed in accordance with requirements of CRSI 93, "Recommended Practice for Placing Reinforcing Bars" and CRSI 93, "Recommended Practice for Placing Bar Supports" and with further requirements below.
- B. Reinforcement shall be accurately placed in accordance with Contract Documents and shall be firmly secured in position by wire ties, chairs, spacers, and hangers, each of type approved by Designer.
- C. Bending, welding or cutting reinforcement in field in any manner other than as shown on Drawings, is prohibited, unless specific approval for each case is given by Designer.
- D. Reinforcement shall be continuous through construction joints unless otherwise indicated on Drawings.
- E. Reinforcement shall be spliced only in accordance with requirements of Contract Documents or as otherwise specifically approved by Designer. Splices of reinforcement at points of maximum stress shall generally be avoided. Welded wire fabric shall lap six inches or one space plus two inches whichever is larger, and shall be wired together.
- F. At time concrete is placed, reinforcement shall be free of excessive rust, scale, or other coatings that will destroy or reduce bond requirements. Reinforcement expected to be exposed to weather for a considerable length of time shall be painted with a heavy coat of cement grout. Protect stored materials so as not to end or distort bars in any way. Bars that become damaged will be rejected.
- G. Before concrete is cast, check all reinforcement after it is placed to insure that reinforcement conforms to Contract Documents and approved Shop Drawings. Such checking shall be done only by qualified experienced personnel. In addition, the Designer shall be notified at least 36 hours prior to concrete placement and given opportunity to inspect completed reinforcement and formwork before concrete placement. Prior approval of Shop Drawings shall in no way limit Designer's right to demand modifications or additions to reinforcement or accessories.

3.5 JOINTS

- A. Construction and control joints indicated on Drawings are mandatory and shall not be omitted.
- B. Joints not indicated or specified shall be placed to least impair strength of structure and shall be subject to approval of Designer.

3.6 INSTALLATION OF EMBEDDED ITEMS

- A. Install steel sleeves, embedded wall plates and similar items, furnished by other trades, at locations shown on the drawings.

3.7 MIXING, CONSISTENCY, AND DELIVERY OF CONCRETE

- A. Concrete shall be ready-mixed, produced by plant acceptable to Designer. Hand or site mixing shall not be done. Constituents, including admixtures except certain corrosion inhibitors and

superplasticizers, shall be batched at central batch plant. Admixtures shall be premixed in solution form and dispensed as recommended by manufacturer.

- B. Central plant and rolling stock equipment and methods shall conform with Truck Mixer and Agitator Standard of Truck Mixer Manufacturer's Bureau of National Ready-Mixed Concrete Association, and Contract Documents. Consistency of concrete at time of deposit shall be as follows:

Portion of Structure	Slump	
	Recommended	Max. Range
Walls, columns	4"	3" - 5"
Slabs, beams	3"	2" - 4"

- C. Ready mixed concrete shall be transported to site in watertight agitator or mixer trucks loaded not in excess of rated capacities. Discharge at site shall be within one and one-half hours after cement was first introduced into mix. Discard cement not discharged within one and one-half hours and dispose of legally. Concrete with a temperature greater than 85 degrees F. shall not be placed. Central mixed concrete shall be plant mixed a minimum of five minutes. Agitation shall begin immediately after premixed concrete is placed in truck and shall continue without interruption until discharged. Transit mixed concrete shall be mixed at mixing speed for at least ten minutes immediately after charging truck followed by agitation without interruption until discharged. Concrete shall be furnished by a single plant unless accepted by the Designer in writing.
- D. Retempering of concrete which has partially hardened, that is, mixing with or without additional cement, aggregates, or water, will not be permitted.

3.8 PLACING CONCRETE

- A. Intent of this Specification is that concrete shall not be pumped. Refer to "Submittals and Concrete Constituents" in this Section for requirements should pumping be proposed.
- B. Remove water and foreign matter from forms and excavations and, except in freezing weather or as otherwise directed, thoroughly wet wood forms just prior to placing concrete. Place no concrete on frozen soil and provide adequate protection against frost action during freezing weather.
- C. To secure full bond at construction joints, surfaces of concrete already placed, including vertical and inclined surfaces, shall be thoroughly cleaned of foreign materials and laitance, roughened with suitable tools such as chipping hammers or wire brushes, and recleaned by stream of water or compressed air. Well before new concrete is deposited, joints shall be saturated with water. After free or glistening water disappears joints shall be given thorough coating of neat cement slurry mixed to consistency of very heavy paste. Surface shall receive coating of approximately one-eighth inch thick; this shall be scrubbed in by means of stiff bristle brushes. New concrete shall be deposited before neat cement dries or changes color.
- D. Do not place concrete having slump outside of allowable slump range.
- E. Transport concrete from mixer to place of final deposit as rapidly as practical by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid rehandling. Deposit no partially hardened concrete. When concrete is conveyed by chutes, equipment shall be of such size and U-shaped design as to insure continuous flow in chute. Flat (coal) chutes shall not be employed. Chutes shall be of metal or metal lined and different portions shall have approximately same slope. Slope shall not be less than 25 degrees nor

more than 45 degrees from horizontal and shall be such as to prevent segregation of ingredients. Discharge end of chute shall be provided with baffle plate or spout to prevent segregation. If discharge end of chute is more than five feet above surface of concrete in forms, spout shall be used, and lower and maintained as near surface of deposit as practicable. When operation is intermittent, chute shall discharge into hopper. Chute shall be thoroughly cleaned before and after each run and debris and any water used shall be discharged outside forms. Concrete shall not be allowed to flow horizontally over distances exceeding five feet.

- F. Concrete shall be placed in such manner as to prevent segregation, and accumulations of hardened concrete on forms or reinforcement above mass of concrete being placed. To achieve this end, suitable hoppers, spouts with restricted outlets and tremies shall be used as required.
- G. During and immediately after depositing, concrete shall be thoroughly compacted by means of internal type mechanical vibrators or other tools, or by spading to produce required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on only enough to produce homogeneity and optimum consolidation without permitting segregation of constituents or "pumping" of air. Vibrators used for normalweight concrete shall operate at speed at not less than 7,000 vpm and be of suitable capacity. Do not use vibrators to move concrete. Vibration shall be supplemented by proper wooden spade puddling to remove included bubbles and honeycomb adjacent to visible surfaces. At least one vibrator shall be on hand for every 10 cubic yards of concrete placed per hour, plus one spare. Vibrators shall be operable and on site prior to starting placement.
- H. Vertical lifts shall not exceed 18 inches. Vibrate completely through successive lifts to avoid pour lines. Vibrate first lift thoroughly until top of lift glistens to avoid stone pockets, honeycomb, and segregation.
- I. Concrete shall be deposited continuously, and in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams and planes of weakness within section. If section cannot be placed continuously between planned construction joints, as specified, field joint and additional reinforcement shall be introduced so as to preserve structural continuity. Designer shall be notified in any such case.
- J. Cold joints, particularly in exposed concrete, including "honeycomb", are unacceptable. If they occur in concrete surfaces exposed to view, Designer will require that entire section in which blemish occurs be removed and replaced with new materials at Contractor's expense.
- K. When placing exposed concrete walls or columns, strike corners of forms rapidly and repeatedly from outside along full height while depositing concrete and vibrating.
- L. Chutes, hoppers, spouts, adjacent work, etc. shall be thoroughly cleaned before and after each run and water and debris shall be discharged outside form.

3.9 FINISHING OF UNFORMED CONCRETE SURFACES

- A. Smooth troweled finish: shall be provided where concrete flatwork is to be exposed in the finished work or is to receive resilient flooring materials.
- B. Floated finish: shall be provided where concrete flatwork is to receive waterproofing membranes or setting beds for finished materials.
- C. Floated finish: shall be provided for top surfaces of walls, slabs and beams.

- D. Rough struck surface shall be provided at top of pedestals.
- E. Steel Broom Finish (with smooth edging): shall be provided at exterior concrete walks, pavements and steps.
- F. Contractor, at his own expense, shall level depressed spots and grind high spots in concrete surfaces which are in excess of specified tolerances. Leveling materials proposed for providing proper surface shall be approved by Designer.

3.10 REPAIRING OF UNFORMED CONCRETE SURFACES

- A. Tops of slabs and walls shall be repaired by using either same material as originally cast or by use of dry-pack material, as approved by Designer. Areas affected shall be chipped back square and to depth of one inch minimum. Hole shall then be moistened with water for a minimum of two hours, followed by brush coat of 1/16 inch thick cement paste. Immediately plug hole with concrete, or with dry pack material consisting of 1:1.5 mixture of cement and concrete sand mixed slightly damp to touch. Hammer dry-pack into hole until dense, and excess paste appears on surface. Finish patch flush and to same texture as surrounding concrete. For large repairs employ 1-1-2 mixture of cement, concrete sand and pea gravel at same dry-pack consistency.

3.11 CURING AND PROTECTION

- A. When concrete is placed at or below ambient air temperatures of 40 degrees F. or whenever in opinion of Designer, such or lower temperatures are likely to occur within 48 hours after placement of concrete, cold weather concreting procedures, according to ACI 306 and as specified herein, shall be followed. To this end, entire area affected shall be protected by adequate housing or covering, and heating. No salt, chemicals or other foreign materials shall be used in the mix to lower freezing point of concrete.
- B. Protect concrete work against injury from heat, cold, and defacement of any nature during construction operations.
- C. Concrete shall be treated and protected immediately after concreting or cement finishing is completed, to provide continuous moist curing above 50 degrees F. for at least seven days, regardless of ambient air temperatures.
- D. Curing compounds will not be permitted for slab and beams.
- E. Keep permanent temperature record showing date and outside temperature for concreting operations. Thermometer readings shall be taken at start of work in morning, at noon, and again late in afternoon. Locations of concrete placed during such periods shall likewise be recorded, in such manner as to show any effect temperatures may have had on construction. Copies of temperature record shall be distributed daily to Designer.

3.12 REMOVAL OF FORMWORK, SHORING AND RESHORING

- A. Contractor shall be responsible for proper removal of formwork, shoring, and reshoring.

- B. Forms shall be removed only after concrete has attained sufficient strength to support its shown weight, construction loads to be placed thereon and lateral loads, without damage to structure or excessive deflection.
- C. Forms and supports shall remain in place for not less than minimum periods of time noted below. These periods represent cumulative number of days or fractions thereof, consecutive unless otherwise approved by Designer during which time mean daily air temperature at surfaces of concrete is above 50 degrees F.
 - 1. Vertical Surfaces: concrete shall have reached 100 day-degrees and shall have attained strength of not less than 30 percent of $f'c$. Where such forms also support formwork for slab or beam soffits, removal times for latter shall govern.
 - 2. Horizontal Surfaces: except as noted below, concrete shall have reached 300 day-degrees of curing and attained strength of not less than 60 percent of $f'c$.
 - a. Soffits of beams or girders shall remain supported and in place until concrete has attained 600 day-degrees.
 - b. Forms and supports of floor slabs shall remain in place until concrete has reached 400 day-degrees.
 - c. Definition of day-degrees: Total number of days times mean daily air temperature at surfaces of concrete. For example, five days at temperature of 60 degrees F. equals 300 day degrees. Days or fractions of days in which temperature is below 50 degrees F. shall not be included in calculation of day-degrees.
- D. Form removal shall be so performed that reshores are placed at same time as stripping operations, and that no area larger than one-fourth of a slab panel is unsupported at any time.
- E. Any test cylinders required to verify the specified minimum strengths for form removal shall be field cured under the same conditions as the concrete they represent. Such cylinders and testing shall be at the Contractor's expense.

3.13 REPAIRING AND FINISHING OF FORMED AND ARCHITECTURAL CONCRETE SURFACES

- A. In accordance with the provisions of ACI 301, Chapter 10, all concrete shall have "smooth form finish".
- B. Intent of this Specification is to require forms, mixtures of concrete, and workmanship so that concrete surfaces will require no patching, except for plugging of tie holes. However, where patching is acceptable to Designer, procedure described below shall be followed.
- C. Defective concrete and honeycombed areas shall not be patched unless examined and approval is given by Designer. If such approval is received by Contractor, areas involved shall be chipped down square and at least one inch deep to sound concrete by means of cold chisels or pneumatic chipping hammers. If honeycomb exists around reinforcement, chip to provide clear space at least three-quarter inch wide all around steel to afford proper ultimate bond thereto. For areas less than one and one-half inches deep, patch shall be made in same manner as described above for filling unformed concrete surfaces, care being exercised to use crumbly-dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs shall require build-up in successive days, each layer being applied as described. To aid strength and bonding of multiple layer repairs, non-shrink, non-metallic aggregate shall be used as an additive as follows:

Materials	Volumes	Weights
Cement	1.0	1.0

Non-Metallic Aggregate	0.15	0.25
Sand	1.5	1.55

For very heavy (generally, formed) patches, pea gravel may be added to mixture and proportions modified as follows:

Materials	Volumes	Weights
Cement	1.0	1.0
Non-Metallic Aggregate	0.2	0.33
Sand	1.0	1.0
Pea Gravel	1.5	1.55

After hardening, rub lightly as described above for form tie holes.

1. Mortar for patching shall be same mix as above except aggregate shall pass a No. 14 sieve.
 2. For all concrete to receive "smooth" finish, remove formwork fins and clean entire surface of grease, form oil, laitance, dust, and other foreign matter.
 3. "Smooth" finish shall consist of having all fins removed, joint marks smoothed off, blemishes removed, and surfaces left smooth and unmarred.
 4. Begin finishing operations as soon as practicable after removal of forms, continue with curing operations after finishing is completed. After concrete has been well cured, carefully inspect surfaces. Remove any fins, rough spots, streaks, hardened mortar or grout and other foreign material. Patch defects with finishing mortar as specified above, to satisfaction of Designer.
- D. Patches which become crazed, cracked, or sound hollow upon tapping shall be removed and replaced with new material at Contractor's expense.

3.14 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by the Owner for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
1. Notify the Architect and Testing Laboratory at least 48 hours prior to start of placement of concrete.
 2. All testing specified in this section, including preparation of samples, shall be done by Testing Laboratory retained by the Owner.
 3. The Testing Laboratory shall have free access to all places where concrete materials are stored, proportioned, or mixed and all materials, equipment and methods used shall be subject to this inspection and test. Provide assistance as needed by the testing laboratory.
 4. As a minimum, all testing and inspection as per the requirements of the International Building Code, latest edition.
 5. Before any concrete is poured on any particular portion of the building, the reinforced steel and form dimensions will be inspected by the Owner's testing laboratory, including placement of welded wire fabric and rebar in slab on deck. Inspect anchorage of rebar and welded wire fabric to avoid displacement during concrete pour. Any errors or discrepancies shall be corrected before concrete is placed.
- B. Cooperate with field quality control personnel. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.

- C. Additional inspections and retesting of materials which fail to comply with specified material and installation requirements shall be performed at Contractor's expense.
- D. Sampling and Field Tests:
 - 1. Take a sample from each 50 cubic yards of each grade of concrete or fraction of thereof, or from each 2000 square feet of surface area for slabs or walks placed each day. No less than one sample to be taken for any one days operations. Each sample shall consist of:
 - a. Five identical test cylinders made and stored in accordance with ASTM C-31.
 - b. Slump test in accordance with ASTM C143 at point concrete is discharged into forms.
 - c. Air entrainment test ASTM C 173 or ASTM C231.
 - d. Temperature of concrete and air.
 - e. Water content in accordance with AASHTO TP23.
 - 2. In addition to the normal samples make a slump test a 2-hour interval during concrete placement.
 - 3. When shrinkage limit is specified take a shrinkage sample at the first pour of the mix design.
- E. Testing:
 - 1. Specimens to be cured in the laboratory in accordance with ASTM C 192 and tested in accordance with ASTM C 39.
 - 2. Test two cylinders of each sample at 7 days for information and two cylinders at 28 days for acceptance. Keep the additional cylinder for later testing.
 - 3. The strength level of the concrete will be acceptable if the averages of all sets of three consecutive 28 day strength test results equal or exceed the specified strength, and no individual strength test result fall below the specified strength by more than 500 psi.
 - 4. Test shrinkage in accordance with ASTM C-157.
- F. Periodically inspect batch plant operations during production of concrete.
- G. Notify Architect and Testing Laboratory when reinforcing steel or threaded rods are to be installed in grouted holes so the Testing Laboratory can observe work and proof test bars. A minimum of 25 percent of the bars or rods to be proofs tested to 100 percent of specified yield.

3.15 CLEANING

- A. Concrete surfaces shall be cleaned of objectionable stains as determined by the Designer. Materials containing acid in any form or methods which will damage "skin" of concrete surfaces shall not be employed, except where otherwise specified.

END OF SECTION

This Page Intentionally
Not Used

SECTION 04 01 10 – MASONRY CLEANING

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the work of masonry cleaning as shown on the Drawings, as specified herein, and as may be required by conditions and authorities having jurisdiction, including, but not limited to, the following:

1. Cleaning general soiling and heavy soiling from masonry using chemical cleaners and pressurized water rinsing.
2. Removing rust stains from masonry using chemical removers and water rinsing. Note: approximately 25% of granite will require some level of rust stain removal.
3. Removing bronze stains from masonry using chemical removers and water rinsing.
4. Cleaning biological growth from masonry using biocide and water rinsing.
5. Removing efflorescence from masonry using poultices and water rinsing.
6. Removing adhesive from masonry using mechanical methods followed by chemical strippers and water rinsing.
7. Removing paint from masonry using chemical strippers and water rinsing.

NOTE: MASONRY CLEANING TO BE PERFORMED FOLLOWING STONE DISASSEMBLY AND PRIOR TO STONE REASSEMBLY

1.3 RELATED WORK

- A. Section 04 01 40 – Stone Masonry Restoration
- B. Section 04 05 13 – Restoration Mortars and Masonry Pointing
- C. Section 05 01 70 – Conservation and Maintenance of Decorative Metals

1.4 QUALITY ASSURANCE

- A. Masonry Cleaning Specialist: Award masonry cleaning work to a firm regularly engaged in cleaning masonry on historic structures that can demonstrate to Owner's satisfaction that, within previous ten years, the firm has successfully completed at least five projects similar in scope and type to work required on this Project involving structures designated as Landmarks by local governmental authorities, structures listed in the National Register of Historic Places, or structures listed in a State Register of Historic Places under the direction of preservation authorities.
 1. Foreman: Masonry cleaning shall be directly supervised by a full-time foreman with experience equal to or greater than that required of Masonry Cleaning Specialist. Foreman shall be on site daily for duration of work of this Section. Same foreman shall remain on Project throughout work unless Owner deems foreman's performance unacceptable.
 2. Mechanics: Masonry cleaning shall be carried out by a steady crew of skilled mechanics who are thoroughly experienced with materials and methods specified and have a minimum of three years' experience cleaning masonry on historic structures similar to the work

required by this Section. In acceptance or rejection of work of this Section, no allowance will be made for workers' inattention or lack of skill.

- B. Laws, Codes, and Regulations: Work of this Section shall comply with applicable federal, state, and local laws, codes, and regulations.
- C. Referenced Standards: Comply with applicable requirements and recommendations of the latest editions of the referenced standards listed herein, except as modified by more stringent requirements of the Contract Documents and of applicable laws, codes, and regulations. Where these standards make recommendations or suggestions, such recommendations or suggestions shall be considered mandatory for work of this Contract unless specifically indicated otherwise in Contract Documents. Provide a reference copy of each of the following standards at shop and at Project site during all periods when work of this Section is being performed in each location. In each case in which there is conflict between requirements of referenced standards; requirements of laws, codes, and regulations; and requirements of this Section, the most stringent or restrictive requirement shall govern.
 - 1. American Institute for Conservation of Historic & Artistic Works (AIC), *Code of Ethics and Guidelines for Practice*.
 - 2. United States Secretary of the Interior, *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*.
- D. Alternate Masonry Cleaning Methods: If Contractor proposes use of cleaning procedures and products other than those specified and Architect or Restoration Consultant gives preliminary approval following required submittals, Contractor shall perform tests and create mock-ups demonstrating ability of proposed products and procedures to produce specified cleaning results and for comparison with specified mock-ups at no additional cost. No alternate method shall be permitted until Architect or Restoration Consultant has approved it in writing.
- E. Daily Log: Contractor shall keep onsite and available for inspection a daily log describing masonry cleaning operations. Log shall record temperature at beginning and ending of work, weather conditions, whether masonry was wet or dry prior to beginning work, personnel on site, areas cleaned and procedures used, areas inspected and accepted, and other relevant information.
- F. Access for Observation and Approvals: Provide Architect or Restoration Consultant access on a continuing basis to locations on which mock-ups are being carried out, on which work is ongoing, and where work has been completed to allow for observation and approvals. Provide access complying with laws and regulations regarding safety and acceptable to Architect or Restoration Consultant. Provide manpower and equipment to facilitate observation and approvals.
- G. Measurements of Existing Conditions: Measure and record conditions at Project site to allow assessment of conditions during masonry cleaning work.
 - 1. Temperature Measurement: Measure temperature before beginning and during progress of work of this Section as required to ensure compliance with all specified conditions and manufacturer's recommendations for masonry cleaning.
 - 2. pH Measurement: Measure pH of masonry surfaces following chemical cleaning using non-staining litmus paper or litmus strips with appropriate range to ensure that each surface has been properly neutralized.
- H. Prohibited Materials and Methods: The following methods are strictly prohibited and shall not be used for work of this Contract: sandblasting, steam (except as specifically indicated herein

and approved by Architect or Restoration Consultant), and use of nonproprietary acids, alkalis, and other products not formulated specifically as products for masonry cleaning.

- I. Knowledge of Site and Project Conditions: Before submitting bid, Bidders shall make themselves thoroughly familiar with the Drawings and Specifications, with the scope of this Project, and with conditions at the Project site relating to requirements of this Section and limitations under which the work will be performed and shall determine or verify dimensions and quantities. Submission of a bid shall be considered conclusive evidence that Contractor is thoroughly familiar with Project requirements and site conditions and limitations.

1.5 SUBMITTALS

- A. General: Submit the following in compliance with the requirements of the Contract Documents. Revise and resubmit each item as required to obtain Architect or Restoration Consultant's approval.
- B. Qualification Data: Qualification data for firm and personnel specified in "Quality Assurance" Article that demonstrates that both firm and personnel have capabilities and experience complying with requirements specified. For firm and foreman, provide a list of at least five completed projects similar in size, scope, and character to the work required on this Project. For each project list project name, address, architect, conservator, supervising preservation agency, scope of contractor's work, and other relevant information. Submit this information with the bid.
- C. Work Description: Prior to any masonry cleaning work on site, submit detailed description of proposed materials and procedures for each substrate and condition requiring masonry cleaning. Submit new written descriptive information. Photocopies of Contract Documents, excerpts from Contract Documents, and/or duplication of text in Contract Documents will not be accepted for Work Description. Do not begin work on site until work description has been approved in writing. Description for each condition shall include, but not be limited to:
 1. Cleaning: Materials, methods, tools, and equipment for each type of masonry cleaning specified herein.
 2. Protection: Description, including drawings, of proposed materials and methods of protection for preventing harm, damage, and deterioration caused by work of this Section to persons (whether involved in the Work or not); structure elements, materials, and finishes; surrounding plants, landscape, and site; and the environment (including air and water).
 3. Alternate Masonry Cleaning Methods and Materials (If Any): Contractor proposed alternate methods and materials (if any) to those specified for any phase of masonry cleaning. Provide evidence of successful use on comparable projects and demonstrate effectiveness for use on this Project.
- D. Product Data: Submit manufacturer's published technical data for each product to be used in work of this Section including material description, chemical composition (ingredients and proportions), physical properties, recommendations for application and use, test reports and certificates verifying that product complies with specified requirements, and Material Safety Data Sheets (MSDS).
- E. Schedule of Masonry Cleaning: Prior to commencing masonry cleaning operations, submit a complete detailed schedule for testing and mock-ups and for completion of masonry cleaning.
 1. Provide schedule in visual form and in 8-1/2 by 11 inch format or foldout therefrom.
 2. After masonry cleaning operations commence, submit updated schedule on a weekly basis.

- F. Waste Disposal Program: Prior to commencing masonry cleaning operations, submit a written description of proposed materials and methods for collection, treatment, and disposal of wastes resulting from masonry cleaning operations.
- G. Daily Log: Submit copy of daily log to Architect or Restoration Consultant each week.
- H. Testing and Mock-Ups: Prepare test panels and mock-ups as described in Articles "Testing" and "Mock-Ups," below.

1.6 MOCK-UPS

- A. General: Following completion of testing and before beginning general masonry cleaning work, prepare mock-ups to provide standards for work of this Section. Do not proceed with masonry cleaning until Architect or Restoration Consultant has approved mock-ups.
 - 1. Locate mock-ups as directed by Architect or Restoration Consultant.
 - 2. Notify Architect or Restoration Consultant 48 hours prior to start of each mock-up.
 - 3. Architect or Restoration Consultant will monitor mock-ups.
 - 4. Use crew that will perform the work and follow requirements of this Section.
 - 5. Repeat mock-ups as necessary to obtain Architect or Restoration Consultant's approval.
 - 6. Allow mock-ups to dry for one week to allow natural color to return and problems to appear. Notify Architect or Restoration Consultant when mock-ups are ready for inspection.
 - 7. Protect approved mock-ups to ensure that they are without damage, deterioration, or alteration at time of Substantial Completion.
 - 8. Approved mock-ups in undamaged condition at time of Substantial Completion may be incorporated into the Work.
 - 9. Approved mock-ups will represent minimum standards for masonry cleaning. Subsequent masonry cleaning work that does not meet standards of approved mock-ups will be rejected.
- B. Prepare the Following Mock-Ups
 - 1. Cleaning General Soiling from Granite Masonry: One panel, 1 sq. ft.
 - 2. Cleaning Heavy Soiling from Granite Masonry: One panel, 1 sq. ft. or size of heavy soiling, whichever is less, for each type of heavy soiling.
 - 3. Removing Rust Stains from Masonry: One panel, 1 sq. ft. or size of iron stain, whichever is less, on each type of masonry from which iron stains are to be removed.
 - 4. Removing Bronze Stains from Masonry: One panel, 1 sq. ft. or size of copper stain, whichever is less, on each type of masonry from which copper stains are to be removed.
 - 5. Cleaning Biological Growth from Masonry: One panel 1 sq. ft. or size of biological growth, whichever is less, on each type of masonry from which biological growth is to be removed.
 - 6. Removing Adhesive from Masonry: One panel, 1 sq. ft. or size of asphalt or adhesive, whichever is less, for each type of asphalt or adhesive to be removed from each type of masonry from which it is to be removed.
 - 7. Removing Paint from Masonry: One panel 1 sq. ft. for each type of paint on each type of masonry from which paint is to be removed.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in manufacturer's original containers with labels identifying manufacturer, product, ingredients, instructions for use, and safety precautions. Do not deliver products until MSDS sheets for products are available on site.

- B. Deliver, store, and handle products and materials to prevent damage, deterioration, degradation, and intrusion of foreign material.
- C. Discard and remove from site deteriorated materials, contaminated materials, and products that have exceeded their expiration dates. Replace with fresh materials.

1.8 PROJECT CONDITIONS

- A. Safety: Protect persons, whether involved with work of this Section or not, from harm caused by work of this Section.
 - 1. Provide protection to prevent persons, except properly protected masonry cleaning personnel, from coming in contact with masonry cleaning materials and waste from masonry cleaning process.
 - 2. Provide workers all means of protection necessary to prevent harm caused by work of this Section.
- B. Protection of Monument: Protect monument elements and finishes from damage and from deterioration caused by masonry cleaning work. Repair damage to materials and damage to finishes resulting from work of this Section to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.
 - 1. Adjacent Materials: Protect adjacent materials, including but not limited to masonry, metals, and sealants, from masonry cleaning solutions and abrasives that might adversely affect such materials.
 - 2. Spread of Masonry Cleaning Solutions: Do not clean masonry during winds of sufficient force to spread masonry cleaning solutions to unprotected surfaces. Cease masonry-cleaning operations when winds may carry chemicals, rinse water, or run-off from chemical cleaning to unprotected areas.
- C. Protection of Surroundings: Protect adjacent structures, site, landscape features, public rights of way, motor vehicles, and other surrounding elements from damage and from deterioration resulting from masonry cleaning work.
 - 1. Collect and dispose of runoff and residue from masonry cleaning operations by legal means and in manner that prevents soil erosion, undermining of paving and foundations, damage to sidewalks, water penetration into building interiors, and harm to buildings, landscape elements, and natural bodies of water and water table.
- D. Surfaces To Receive Work: The Drawings are two-dimensional representations of three-dimensional objects and do not show all surfaces of monument components on which work is to be performed, including surfaces concealed from view behind objects shown; surfaces of projections, reveals, returns, and other elements perpendicular to or at an oblique angle to surfaces shown; concealed surfaces of profiled members and of ornament; and surfaces of profiled members and of ornament not drawn in detail. Perform work on surfaces of projections, reveals, returns, profiled members, and ornaments associated with surfaces indicated to receive work and on surfaces of building components concealed behind building components shown. It is the specific intent of the Contract Documents to include work on all surfaces within Project area, whether or not shown on the Drawings, except as specifically indicated otherwise.
- E. Coordination
 - 1. Sequence: Clean masonry before beginning masonry restoration as specified in Section 04 01 40 – "Stone Masonry Restoration," except as specifically indicated otherwise.

2. Staging: Schedule and stage masonry cleaning so that no runoff from masonry cleaning operations comes in contact with previously cleaned masonry.

- F. Preconstruction Meeting: Convene a preconstruction meeting to discuss masonry cleaning and its effect on adjacent elements, materials, and finishes. Attendees shall include Owner's Representatives, Architect, Restoration Consultant, Construction Manager, firm(s) that will perform masonry cleaning, and other entities that might be affected by masonry cleaning work.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Use of Water: Do not perform masonry cleaning work that will wet masonry materials or cause them to be wet when ambient temperature is below 40 deg F or when temperature of air or masonry is expected to drop below 40 deg F within 72 hours as predicted for Worcester, MA by the National Weather Service. Do not begin work when any part of wall or any materials are frozen or subject to freezing.

1.10 COLLECTION AND DISPOSAL OF WASTE PRODUCTS

- A. General: Collect, contain, test, and dispose of solid and liquid wastes in accordance with applicable federal, state, and local laws and regulations
- B. Collection: Provide gutters and troughs to collect runoff from masonry cleaning operations for pretreatment prior to disposal. Do not allow waste materials from masonry cleaning operations to flow or drop onto adjacent roofs; setbacks; sidewalks; trees, shrubs, plants, grass, and other plantings; soil; or structures. Direct waste materials to collection vessels for treatment.
- C. Neutralizing: Neutralize masonry cleaning waste products to a pH of between 5.0 and 9.5. Propose specific methods and materials for neutralization in Waste Disposal Program submission.
- D. Disposal: Dispose of masonry cleaning run-off by legal means that prevent: erosion, undermining, damage to plant material, and water penetration into building.
 1. Install protection and waste collection systems before beginning masonry cleaning work.
 2. Test drains and other water removal systems to ensure that they are functioning properly before masonry cleaning operations begin. Notify Architect or Restoration Consultant at once if drains or systems are stopped or blocked. Do not begin work of this Section until drains are in good working order.
 3. Filter masonry cleaning runoff to prevent suspended solids such as masonry residue from entering drains and drain lines. Clean out drains and drain lines that become blocked or filled with sand or other solids as a result of masonry cleaning work at no additional cost to Owner.
 4. Dispose of waste products at frequent, regular intervals. Do not allow waste products to accumulate on site.

PART 2 – PRODUCTS

2.1 MANUFACTURERS AND SUPPLIERS

- A. General: Provide products by the following manufacturers or approved equals.

- B. Cathedral Stone Products, Inc., 7266 Park Circle Drive, Hanover, MD 21076 (800-684-0901).
- C. Chemique, Inc., 315 North Washington Avenue, Moorestown, NJ 08057 (800-225-4161).
- D. Hydrochemical Techniques, Inc. 253 Locust Street, Hartford, CT 06114 (800-278-7681).
- E. ProSoCo, Inc., 3741 Greenway Circle, Lawrence, KS 66046 (800-255-4255).

2.2 CLEANING MATERIALS FOR WATER, DETERGENT AND CHEMICAL CLEANING

- A. General: Provide the following products for use in testing for cleaning substrates and conditions indicated. Test using dilutions as specified by Architect or Restoration Consultant. Provide products selected during testing for use in mock-ups and for use in cleaning building and at dilutions as selected and approved by Architect or Restoration Consultant in each case at no additional cost to Owner.
- B. Cleaners for Testing for Removing General Soiling and Heavy Soiling from Granite Masonry. Test each of the following or approved equal:
 - 1. Enviro Klean 2010 All Surface Cleaner, manufactured by ProSoCo, Inc.
 - 2. Enviro Klean Restoration Cleaner, manufactured by ProSoCo, Inc.
 - 3. MasonRE G Heavy Duty Cleaner (sandstone, granite, terra cotta, brick), available from Cathedral Stone Products.
 - 4. Hydroclean HT-626 Brick, Granite, Sandstone & Terra Cotta Cleaner, manufactured by Hydrochemical Techniques, Inc.
- C. Cleaners for Testing for Removing Biological Growth from Masonry. Test each of the following or approved equal:
 - 1. Enviro Klean BioWash, as manufactured by ProSoCo., Inc.
 - 2. D/2 Biological Solution, available from Limeworks.US.
- D. Strippers for Testing for Removing Adhesive from Masonry Substrates: Test each of the following, or approved equal:
 - 1. HT-80 Adhesive Remover, as manufactured by Hydrochemical Techniques, Inc.
 - 2. MasonRE S-303 Paint Stripper, as available from Cathedral Stone Products.
- F. Strippers for Testing for Removing Paint from Masonry Substrates: Test each of the following, or approved equal:
 - 1. Sure Klean, Fast Acting Stripper, manufactured by ProSoCo., Inc.
 - 2. MasonRE S-301 Paint Stripper, available from Cathedral Stone Products, Inc.
 - 3. MasonRE S-303 Architectural Paint Stripper, available from Cathedral Stone Products, Inc.
- H. Removers for Testing for Removing Rust Stains from Masonry Substrates: Test each of the following, or approved equal:
 - 1. Artisan Light Duty Rust Remover, as manufactured by Chemique, Inc.
 - 2. Sure Klean Ferrous Stain Remover, manufactured by ProSoCo, Inc.
- I. Removers for Testing for Removing Bronze Stains from Masonry Substrates: Test each of the following or approved equal:

1. Sure Klean T-515 Copper Stain Remover Parts A & B (clay powder and chemical additive), manufactured by ProSoCo, Inc.
2. ShoreBest 2380 Copper Stain Remover, manufactured by Shore Chemical Company.

J. Water for Water Misting, Chemical Cleaning, Low Pressure Hot Water (Steam) Cleaning, Pressure Rinsing, and Other Work of this Section: Clean, potable, free of oils, acids, alkalis, salts, organic matter, soluble and insoluble iron, and other substances detrimental to surfaces being cleaned and non-staining.

1. Source: Subject to requirements specified, water may be obtained from city water supply.
2. Distribution: Pump water to locations where work of this Section is being performed at pressure and flow rate required for optimum cleaning using each process.

2.3 EQUIPMENT FOR WATER RINSING

- A. General: Provide all equipment and accessories to distribute water at pressures and flow rates required for masonry cleaning.
- B. Pressure Pumps: Pressure pumps capable of producing water flow at a rate of 6 gallons per minute at a pressure of 800 psi at nozzle on end of hose. Pumps, or a combination of pumps plus pressure reducing valves, shall have capability of providing water at a steady pressure and flow rate at all pressures from 100 psi to 800 psi. Pumps shall have working pressure gauges. Pumps found to be without working pressure gauges shall be removed from site, and work shall cease until pumps have been replaced with pumps having working pressure gauges. Pumps shall have no ferrous elements in contact with liquid stream.
- C. Particulate Filter: Provide a 5-micron particulate filter in line with water supply. All water used for masonry cleaning shall be filtered.
1. Replace particulate filter as required to provide filtered water with no particles greater than 5 microns at pressure and flow rate specified.
- D. In-line Pressure Gauges: Each water line used for pressure rinsing shall have a working pressure gauge within 15 feet of nozzle used for rinsing.
- E. Spray Nozzles for Pressure Rinsing: Nozzles shall be of nonferrous metal and shall have a minimum 25-degree fan tip.

2.4 MISCELLANEOUS MATERIALS

- A. Sealant: Manufacturer's standard one part acrylic latex sealant. Use exclusively for temporary sealing of cracks and joints around penetrations during masonry cleaning work.
1. Do not use sealant containing silicone or other elastomeric product.
- B. Backer Rod: Closed cell expanded polyethylene rod, sized 25 percent greater than joint to be sealed.
- C. Protection Materials: Provide materials recommended by cleaner manufacturers for products to be used that will protect from damage caused by chemicals without causing damage to materials to be protected.
1. Glass and Metal Protection: "Strippable Acid Stop" manufactured by ProSoCo, Inc., or approved equal.

2. Plastic Sheetting: Polyethylene sheetting, 6 mils thick minimum.

D. Brushes: Natural fiber bristle or synthetic fiber bristle only. No metal bristle brushes are permitted.

E. pH Indicator: Nonstaining litmus paper or strips with appropriate range approved by Architect or Restoration Consultant. Furnish pH strips on site during all work of this Section.

2.5 MIXING CHEMICAL CLEANING SOLUTIONS

A. General: Dilute chemical cleaning materials as determined following results obtained through test panels. Manufacturer's recommended dilutions may be modified to reflect results of test panels and approved mock-ups.

1. Supply all dilutions of chemical cleaners at no additional cost.

B. Create test panels using a minimum of two dilutions for each product where dilution is recommended by manufacturer or requested by Architect or Restoration Consultant.

PART 3 – EXECUTION

3.1 GENERAL STONE MASONRY CLEANING REQUIREMENTS

A. General: These requirements apply to all work of this Section.

B. Areas To Be Cleaned: Locations of materials to be cleaned are designated on Drawings.

C. Stone Masonry Cleaning Progress: Clean masonry systematically in full-height, top-to-bottom sections of areas to be cleaned.

1. Stone Masonry Cleaning with Water: Begin stone masonry cleaning using water at top of section to be cleaned and proceed to bottom of section before moving to adjacent section except where otherwise noted by product manufacturer.

D. Timing: Control timing of stone masonry cleaning operations (including dwell times of cleaners and misting times) to ensure that specified times are maintained. Do not allow chemicals to remain on surfaces longer than dwell times determined during testing and confirmed during mock-ups. Do not allow surfaces to be water misted longer than times determined by testing and confirmed during mock-ups.

E. Water Pressure and Flow Rate: Limit water pressure and flow rates to maximum pressures specified herein and to lower pressures as required to avoid damaging masonry, metals, sealants, and other materials and finishes.

1. Pressure: 800 psi or less as required to avoid damage to materials being cleaned.
2. Flow Rate: 6 gallons per minute.
3. Distance from Masonry Surface: Hold nozzle at a uniform distance from masonry surface as determined by testing and confirmed by mock-up to provide optimum cleaning without damaging masonry surface but at least 12 inches from stone surface.
4. Adjustments: If any building material is damaged or deteriorated by water rinsing, immediately cease work. Do not begin pressure rinsing again until water pressure and flow rate have been adjusted to avoid damage to building materials.

F. Uniform Cleaning: Clean masonry to achieve uniform results so that flat surfaces, edges,

corners, crevices, profiles, and recessed areas are uniformly clean.

- G. Pressure of Low-Pressure Micro-Abrasive Cleaning: Limit pressure of low-pressure micro-abrasive cleaning to pressure selected during testing and approved by Architect or Restoration Consultant. Stop stone masonry cleaning immediately if cleaning procedure damages masonry. Do not begin cleaning until pressures and procedures have been altered to avoid damage.
- H. Alteration: Stone masonry cleaning procedures, including cleaning chemical, chemical dilution, and dwell time may be altered by Architect or Restoration Consultant based on site conditions.
- I. Completion of Stone Masonry Cleaning: Cleaned masonry shall match approved mock-ups. Areas are subject to additional cleaning as directed by Architect or Restoration Consultant in order to match mock-ups. Work of stone masonry cleaning on each surface shall not be considered complete until Architect or Restoration Consultant has inspected surface and so notified Contractor in writing.

3.2 MOCK-UPS

- A. General: Provide mock-ups under direction of Architect or Restoration Consultant's following requirements of "Mock-Ups" Article, above, to confirm products and procedures selected during testing and to provide standards for evaluation of the stone masonry cleaning work.

3.3 CLEANING GENERAL SOILING FROM MASONRY USING LOW-PRESSURE, MICRO ABRASIVE CLEANING SYSTEM

- A. General: Clean masonry free of general soiling using micro abrasive cleaning system to match approved mock-up.
- B. Cleaning: Carefully clean masonry surface using minimum pressure to achieve desired cleaning without damage to stone. Hold nozzle a consistent distance from masonry surface as determined during testing. Overlap passes slightly to ensure surfaces are thoroughly cleaned.
- C. Rinsing: Rinse surfaces thoroughly using water at a pressure of 750 psi and flow rate of 6 gpm, overlapping passes slightly.
- D. Additional Cleaning: Repeat above procedure as necessary to achieve uniformly clean masonry to provide surface matching standard of approved mock-up.

3.4 CLEANING GENERAL SOILING FROM MASONRY USING WATER MISTING AND PRESSURIZED WATER RINSING

- A. General: Clean masonry free of general soiling using water misting and pressurized water rinsing to match approved mock-up.
- B. Misting: Mist surfaces for period determined during testing and confirmed during mock-ups. Carefully control misting procedures and misting time so that surfaces are uniformly misted.
- C. Rinsing: Carefully rinse masonry surface using water at a pressure of 750 psi and flow rate of 6 gpm. Hold nozzle a consistent distance from masonry surface as determined during testing. Overlap passes slightly to ensure surfaces are thoroughly rinsed. Rinse surfaces at least twice, first with vertical passes and then with horizontal passes to ensure complete coverage.
- D. Additional Cleaning: Repeat above procedure as necessary to achieve uniformly clean masonry to provide surface matching standard of approved mock-up.

3.5 CLEANING SOILING FROM MASONRY USING CHEMICAL REMOVER AND PRESSURIZED WATER RINSING

- A. General: Clean masonry free of soiling using cleaning chemical selected during testing followed by pressurized water rinsing. Cleaned masonry shall match approved mock-up to Architect or Restoration Consultant's satisfaction.
- B. Cleaner Application and Removal: Apply and remove cleaner following method of application and dwell times determined during testing and confirmed during mock-ups. Scrub surface gently with fiber bristle brushes. Rinse surface thoroughly using water at a maximum pressure of 750 psi and flow rate of 6 gpm.
- C. Additional Cleaning: Repeat above procedure as necessary to achieve uniformly clean masonry to provide surface matching standard of approved mock-up.

3.6 CLEANING BIOLOGICAL GROWTH FROM MASONRY USING BIOCIDES AND WATER RINSING

- A. General: Clean masonry free of biological growth using biocide selected during testing followed by pressurized water rinsing. Cleaned masonry shall match approved mock-up to Architect or Restoration Consultant's satisfaction.
- B. Biocide Application and Removal: Apply biocide following method of application and dwell time determined during testing and confirmed during mock-ups. Scrub surface with fiber-bristle brushes. Rinse surface thoroughly using water at a maximum pressure of 750 psi and flow rate of 6 gpm.
 - 1. Apply neutralizer if required and rinse surface thoroughly using water at a maximum pressure of 750 psi and flow rate of 6 gpm. Test surface with pH strips and repeat rinsing until masonry surface pH is between 6 and 8.
- C. Additional Cleaning: Repeat above procedure as necessary to achieve uniformly clean masonry free of biological growth to provide surface matching standard of approved mock-up.

3.7 REMOVING ADHESIVE FROM MASONRY USING CHEMICAL REMOVERS AND WATER RINSING

- A. General: Remove adhesive and adhesive residue from masonry using chemical removers and water rinsing. Cleaned masonry shall match approved mock-ups to Architect or Restoration Consultant's satisfaction.
- B. Stripping Adhesive and Adhesive Residue: Remove adhesive and adhesive residue from masonry surfaces using remover and procedure selected during testing and confirmed during mock-ups. Do not spread dissolved adhesive over masonry surfaces or allow adhesive residue to be absorbed into masonry units. Wipe repeatedly using appropriate solvent and clean white cloths to remove adhesive residue.
- C. Additional Cleaning: Repeat removal as specified above as required to achieve uniformly clean masonry without evidence of adhesive residue matching approved mock-up.

3.8 REMOVING PAINT FROM MASONRY USING CHEMICAL STRIPPERS AND PRESSURIZED WATER RINSING

- A. General: Remove paint from masonry using strippers and form of stripper (liquid, gel, and/or

poultice) selected during testing and confirmed during mock-up to achieve masonry surface free of paint matching approved mock-up to Architect or Restoration Consultant's satisfaction.

- B. Stripper Application and Removal: Apply stripper following method of application and dwell time determined during testing and confirmed during mock-ups. Remove stripper and paint following manufacturer's directions. Rinse surface thoroughly using water at a pressure of 750 psi and flow rate of 6 gpm, overlapping passes slightly.
- C. Additional Removal: Repeat above procedure as necessary to achieve uniformly clean masonry free of paint with surface matching standard of approved mock-up.

3.9 REMOVING IRON STAINS FROM MASONRY USING CHEMICAL STAIN REMOVERS AND WATER RINSING

- A. General: Remove iron stains from masonry using chemical stain remover and form of stain remover (liquid, gel, and/or poultice) selected during testing and confirmed during mock-up to achieve masonry surface free of iron stains matching approved mock-up to Architect or Restoration Consultant's satisfaction.
- B. Remover Application and Removal: Apply remover following method of application and dwell time determined during testing and confirmed during mock-ups. Remove chemical following manufacturer's directions. Rinse surface thoroughly using water at a pressure of 750 psi and flow rate of 6 gpm, overlapping passes slightly.
- C. Additional Removal: Repeat above procedure as necessary to achieve uniformly clean masonry free of iron stains with surface matching standard of approved mock-up.

3.10 REMOVING COPPER ALLOY STAINS FROM MASONRY USING CHEMICAL STAIN REMOVERS AND WATER RINSING

- A. General: Remove copper and copper alloy stains from masonry using chemical stain remover and form of stain remover (liquid, gel, and/or poultice) selected during testing and confirmed during mock-up to achieve masonry surface free of copper stains matching approved mock-up to Architect or Restoration Consultant's satisfaction.
- B. Remover Application and Removal: Apply remover following method of application and dwell time determined during testing and confirmed during mock-ups. Remove chemical following manufacturer's directions. Rinse surface thoroughly using water at a pressure of 750 psi and flow rate of 6 gpm, overlapping passes slightly.
- C. Additional Removal: Repeat above procedure as necessary to achieve uniformly clean masonry free of copper stains with surface matching standard of approved mock-up.

3.11 ADJUSTMENT AND PROTECTION

- A. Reclean surfaces that do not have a uniform clean appearance matching approved mock-ups to achieve uniformly clean surfaces matching approved mock-ups.
- B. Protect cleaned surfaces from dirt and soiling from other than normal atmospheric pollution until Project completion. Reclean surfaces that become soiled to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.

END OF SECTION
04 01 10

SECTION 04 01 40 – STONE MASONRY RESTORATION

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. The Work of this Section includes all labor, materials, equipment, and services necessary to complete the work of stone masonry restoration as shown on the Drawings and/or as specified herein and as may be required by conditions and authorities having jurisdiction, including, but not necessarily limited to, the following:
 - 1. Reinstalling stone units.
 - 2. Patching holes and losses in stone units using stone dutchmen and stone dutchman plugs matching adjacent existing stone.
 - 3. Preparing and grouting cracks in stone units.
 - 4. Repairing cracked stone units by inserting stainless steel rods in epoxy adhesive to secure portions of stone units and providing composite patching mortar crack repairs.
 - 5. Preparing and pointing joints in stone masonry.
- B. RELATED WORK
 - 1. Section 02 41 91 - Selective Removal and Salvage of Historic Materials
 - 2. Section 04 01 10 - Masonry Cleaning
 - 3. Section 04 05 13 – Restoration Mortars and Masonry Pointing

1.3 DEFINITIONS

- A. “Dutchman” as used herein refers to a portion of new or salvaged stone fitted into an existing stone to produce an intact contiguous surface.
- B. “Stone-to-Stone” repairs refer to conditions where the original stone piece still exists and can be pinned directly back into its original location or to its mated portion.
- C. “Plug” as used here refers to a circular dutchman cored out of stone matching stone to be repaired.
- D. “Cold Weather Stone Masonry Restoration” as used herein refers to work of this Section when temperature is below 40 deg F or predicted to go below 40 deg F within 48 hours of use of mortar by the National Weather Service.
- E. “Hot Weather Stone Masonry Restoration” as used herein refers to work of this Section when temperature is above 100 deg F or when temperature is above 90 deg F and wind is above 8 mph or when either of these conditions is predicted within 48 hours of use of mortar.

1.4 QUALITY ASSURANCE

- A. Masonry Restoration Specialist: Award stone masonry restoration to a firm regularly engaged in restoration of stone masonry on historic buildings that can demonstrate to Owner's satisfaction that, within previous ten years, it has successfully completed at least three projects similar in scope and type to work required on this Project involving buildings designated as Landmarks by

local governmental authorities, buildings listed in the National Register of Historic Places, or buildings listed in a State Register of Historic Places under the direction of preservation authorities.

1. Foreman: Stone masonry restoration shall be directly supervised by a full-time foreman with experience equal to or greater than that required of Masonry Restoration Specialist. Foreman shall read and speak English fluently. Foreman shall be on site daily for duration of work of this Section. Same foreman shall remain on Project throughout work unless his performance is deemed unacceptable.
 2. Mechanics: Stone masonry restoration shall be carried out by a steady crew of skilled stone masons who are thoroughly experienced with restoration of historic stone masonry using materials and methods specified and have a minimum of three years' experience with work on historic buildings similar to that required by this Section. In acceptance or rejection of work of this Section, no allowance will be made for workers' inattention or lack of skill.
- B. Testing of Workers: Technicians proposed for raking and cutting joints in historic stone masonry of this Project shall be required to successfully complete six linear feet of raking and cutting mortar joints in presence of Architect or Restoration Consultant prior to working on Project. One one-quarter-inch chip of masonry per linear yard will be standard of acceptable skill. Unsuccessful performance in this test area will be grounds for rejection of this technician for joint preparation and pointing work on this Project.
- C. Laws, Codes, and Regulations: Work of this Section shall comply with applicable federal, state, and local laws, codes, and regulations.
- D. Referenced Standards: Comply with applicable requirements and recommendations of the latest editions of the referenced standards listed herein, except as modified by more stringent requirements of the Contract Documents and of applicable laws, codes, and regulations. Where these standards make recommendations or suggestions, such recommendations or suggestions shall be considered mandatory for work of this Contract unless specifically indicated otherwise in Contract Documents. Provide a reference copy of each of the following standards at shop and at Project site during periods when work of this Section is being performed in each location. In each case in which there is conflict between requirements of referenced standards; requirements of laws, codes, and regulations; and requirements of this Section, the most stringent or restrictive requirement shall govern.
1. ASTM International (ASTM)
 - a. ASTM C 144, *Standard Specification for Aggregate for Masonry Mortar*.
 - b. ASTM C 150, *Standard Specification for Portland Cement*.
 - c. ASTM C 207, *Standard Specification for Hydrated Lime for Masonry Purposes*.
 - d. ASTM C 270, *Standard Specification for Mortar for Unit Masonry*.
 - e. ASTM C 615, *Standard Specification for Granite Dimension Stone*.
 - f. ASTM C 1713, *Standard Specification for Mortars for the Repair of Historic Masonry*.
 2. National Building Granite Quarries Association (NBGQA), *Specifications for Building Granite*.
- E. Documentation of Existing Conditions: Refer to Specification Section 02 42 91 "Removal and Salvage of Historic Materials"
- F. Shoring and Bracing: Contractor shall at his sole expense retain the services of a Professional Engineer registered in the Commonwealth of Massachusetts to design and provide documents for the provision of temporary shoring, bracing, and other supports necessary to ensure that stone units to be removed and salvaged are not damaged or deteriorated during removal and that building elements and materials to remain are not damaged, deteriorated, displaced, subjected to undue stress, or otherwise adversely affected as a result of the removal of stone units.

1. Drawings and calculations prepared by the Professional Engineer shall bear the engineer's original signature and seal indicating the engineer's Commonwealth of Massachusetts Registration. Duplicate copies of drawings and calculations shall be forwarded to the Owner prior to commencing any of the temporary work represented in those documents.
 2. The Professional Engineer shall furnish additional details and/or calculations that may be required by authorities having jurisdiction.
- G. Preparation of Mortar under Controlled Conditions: Mortars and grouts shall be batched and packaged in factory or shop under controlled conditions that ensure consistency of ingredients, proportions, and mixing of dry ingredients as described in approved Work Description. Mortars and grouts shall be delivered packaged to Project site ready for mixing with water. No mortar or grout mixes shall be proportioned on site.
- H. Sources of Materials: Obtain each type of material for stone masonry restoration from a single source to ensure a match in quality, performance, and appearance.
- I. Access for Observation and Approvals: Provide Architect or Restoration Consultant access on a continuing basis to locations on which mock-ups are being carried out, on which work is ongoing, and where work has been completed to allow for observation and approvals. Provide pipe scaffolding and manpower to move and reconfigure scaffolding and planking, personnel lift and manpower to operate lift, or other means of access complying with laws and regulations regarding safety and acceptable to Architect or Restoration Consultant. Provide manpower and equipment to facilitate observation and approvals.
1. Extent of Access: Provide Architect or Restoration Consultant with hands-on access to each and every area of stone masonry that has been restored. No approval of stone masonry restoration will be given before Architect or Restoration Consultant is provided hands-on access to all stone masonry surfaces that have been restored. Provide access for reinspection of areas where stone masonry restoration work was not approved on first or subsequent inspections until Architect or Restoration Consultant approves work.
 2. Relocation of Means of Access: If Contractor moves scaffolding, lift, or other means of access before providing Architect or Restoration Consultant with hands-on access to each and every location in which stone masonry has been restored and to each and every location in which stone masonry has been restored after previous stone masonry restoration work was rejected, Contractor shall coordinate reinstallation of means of access to provide for close-up inspection by Architect or Restoration Consultant at no additional cost to Owner.
- J. Manufacturers' Technical Representatives: Technical representatives of manufacturers whose products have been selected for use shall visit site at request of Contractor, Architect or Restoration Consultant, or other Owner's Representative to advise on proper use and installation of products at no additional cost to Owner.
- K. Knowledge of Site and Project Conditions: Before submitting bid, Bidders shall make themselves thoroughly familiar with the Drawings and Specifications, with the scope of this Project, and with conditions at the Project site relating to requirements of this Section and limitations under which the work will be performed and shall determine or verify dimensions and quantities. Submission of a bid shall be considered conclusive evidence that Contractor is thoroughly familiar with Project requirements and site conditions and limitations.
- L. Restoration of Damaged Masonry: Repair or replace broken, lost, and damaged masonry resulting from work of this Section to configuration and condition existing before work began to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.

1.5 SUBMITTALS

- A. General: Submit the following in compliance with the requirements of the Contract Documents. Revise and resubmit each item as required to obtain Architect or Restoration Consultant's approval.
- B. Qualification Data: Qualification data for firm and personnel specified in "Quality Assurance" Article that demonstrates that both firm and personnel have capabilities and experience complying with requirements specified. For firm and foreman, provide a list of at least three completed projects similar in size and scope to the work required on this Project. For each project list project name, address, architect, conservator, supervising preservation agency, scope of contractor's work, and other relevant information. Submit this information with the bid.
- C. Work Description: Detailed description for each type of stone masonry restoration work to be performed. Do not begin work on site until Architect or Restoration Consultant has approved Work Description in writing. Submit new written descriptive information. Photocopies of Contract Documents, excerpts from Contract Documents, and/or duplication of text in Contract Documents will not be accepted for Work Description. Description for each type of restoration on each material shall include, but not be limited to:
 - 1. Materials and Procedures: Materials, methods, tools, and equipment to be used for each phase and task of stone masonry restoration work.
 - 2. Protection: Description, including drawings and diagrams, of proposed materials and methods of protection for preventing harm, damage, and deterioration caused by work of this Section to persons (whether involved in the Work or not); building elements, materials, and finishes; surrounding landscape and site; and the environment (including air and water).
 - a. Include procedures for controlling noise and dust.
 - 3. Alternate Methods and Materials (If Any): Proposed alternate methods and materials (if any) to those specified for stone masonry restoration work. Provide evidence of successful use on comparable projects and demonstrate effectiveness for use on this Project.
- D. Documentation of Existing Conditions: Documentation as required by Paragraph "Documentation of Existing Conditions" in "Quality Assurance" Article, above.
- E. Designs for Shoring and Bracing: Drawings and calculations by Professional Engineer retained by Contractor indicating design of temporary bracing, shoring, and other provisions necessary to ensure support and stability for existing construction and support and stability for elements being removed as specified in "Quality Assurance" Article, above.
 - 1. Drawings and calculations shall bear the Engineer's original signature and seal indicating the Engineer's Massachusetts's Registration.
- F. Product Data: Manufacturer's published technical data for each product to be used in work of this Section including material description, chemical composition (ingredients and proportions), physical properties, recommendations for application and use, test reports and certificates verifying that product complies with specified requirements, and Material Safety Data Sheets (MSDS).
- G. Shop Drawings: Dimensioned detailed scale drawings at appropriate scales to clearly describe stone masonry restoration; details of anchors and fasteners, 3-inches equals 1-foot scale, minimum. Submit newly prepared drawings showing site-verified conditions and materials. Photocopies of Contract Documents and/or electronic scans of Contract Documents will not be accepted for Shop Drawing submittals.

1. Reinstalling Stone Units: Each unit. Show location of cramps and anchors.
2. Pinning and Patching Cracked Stone Units: Each unit to be pinned. Show locations of pins and type of crack repair.
3. Dutchman Repairs: Each dutchman. Show anchors.

H. Samples

1. Granite to Match Existing Granite: 12-inch x 12-inch x 1-inch pieces, finished to match existing.
2. Anchors, Fasteners, Pins, and Accessories: Each configuration and size specified and/or proposed for use.
3. Mortar for Pointing
 - a. Mortar for pointing granite.
4. Mortar for Installing Dutchmen
 - a. Mortar for dutchmen in granite.

- I. Prepare mock-ups following requirements of Article "Mock-ups," below.

1.6 MOCK-UPS

- A. General: Before beginning general stone masonry restoration work, prepare mock-ups to provide standards for work of this Section. Do not proceed with stone masonry restoration until Architect or Restoration Consultant has approved mock-ups.

1. Locate mock-ups as directed by Architect or Restoration Consultant.
2. Notify Architect or Restoration Consultant 48 hours prior to start of each mock-up.
3. Architect or Restoration Consultant will monitor mock-ups.
4. Use crew that will execute the work and follow requirements of this Section.
5. Allow mock-ups with mortar, composite patching mortar, cementitious grout, and other products containing cements and/or limes to dry for five days to allow material to reach final color and allow potential problems to appear. Notify Architect or Restoration Consultant when mock-ups are ready for review.
6. Repeat mock-ups as necessary to obtain Architect or Restoration Consultant's approval.
7. Protect approved mock-ups to ensure that they are without damage, deterioration, or alteration at time of Substantial Completion.
8. Approved mock-ups in undamaged condition at time of Substantial Completion may be incorporated into the Work.
9. Approved mock-ups will represent minimum standards for stone masonry restoration. Subsequent stone masonry restoration work that does not meet standards of approved mock-ups will be rejected.

- B. Prepare the Following Mock-Ups

1. Removing, Salvaging, and Reinstalling Granite Units: One location for each type.
2. Repairing Cracked Stone Units by Inserting Stainless Steel Rods in Epoxy Adhesive to Secure Portions of Stone Units: One stone unit.
3. Patching Holes and Losses in Stone Units Using Stone Dutchmen: Three dutchman repairs.
4. Preparing and Grouting Cracks in Stone Units: Three units.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products and materials to prevent damage, deterioration, degradation, and intrusion of foreign material.
- B. Discard and remove from site deteriorated materials, contaminated materials, and products that

have exceeded their expiration dates. Replace with fresh materials.

- C. Handling Stone: Handle stone to prevent chipping, breakage, soiling, and other damage.
 - 1. Handle cut stone using competent craftspeople and methods that guard against damage and deterioration.
 - 2. Do not use pinch or wrecking bars without protecting edges of stone with wood or other rigid materials.
 - 3. Lifting and Placing
 - a. Slings: Lift with wide belt type slings wherever possible; do not use wire rope or ropes containing tar or other substances that might cause staining.
 - b. Lifting Clamps and Pins: Obtain lifting clamps and lewis pins from stone fabricator or use clamps or pins recommended by stone fabricator for handling stone units weighing over 100 pounds.
 - 4. Use wood rollers and provide cushion at end of wood slides as necessary to avoid damaging stone units.
 - 5. Keep surfaces free from dirt, soot, grime, grease, and other discoloring matter.

1.8 PROJECT CONDITIONS

- A. Safety: Protect all persons, whether or not involved in work of this Section, from harm caused by or resulting from work of this Section.
 - 1. Protection from Hazardous Materials: Protect workers and other persons from contact with hazardous materials resulting from work of this Section.
 - a. Silica: Use procedures necessary to protect workers and other persons from exposure to respirable crystalline silica. All work should be performed in compliance with applicable OSHA regulations, including but not limited to "Respirable Crystalline Silica Standard" (Title 29, Code of Federal Regulations (CFR) Section 1926.1153) and with other applicable state and local laws and regulations.
 - 2. Protection from Noise: Limit noise generated by work of this Section to an absolute minimum. Prevent all persons, whether or not involved with the work of this Section, from noise that might adversely affect them
- B. Protection of Building: Protect building elements and finishes from damage and from deterioration caused by work of this Section. Repair materials and finishes damaged as a result of work of this Section to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.
 - 1. Exclusion of Water: Cover open joints and areas from which sections of masonry, masonry units, and/or portions of units have been removed during periods when work is suspended to ensure materials and finishes are not damaged by water penetration.
 - 2. Prevention of Staining: Prevent grout, mortar, and adhesives from staining face of masonry to be left exposed. Protect sills, ledges, and projections from mortar droppings. Immediately remove grout, mortar, and adhesive in contact with masonry. Protect base of walls from rain splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.
 - 3. Protection from Fire: Take precautions necessary to prevent fire and spread of fire.
 - a. Covers: Membranes, insulation blankets, and other materials used to cover masonry shall be flame retardant and fire resistant.
 - b. Warming Devices: Heating blankets, infrared heaters, and other warming devices shall be UL approved and inspected for damage before use.

- c. Open Flame Heaters: No open flame heaters shall be used to protect finished masonry. Heaters used to warm water or sand for mortar or grout shall be well away from building and from flammable substances.
- C. Support: Provide shoring, bracing, reinforcement, and enclosures necessary to prevent damage or deterioration prior to removing stone units.
- D. Hoisting and Lowering: Use appropriately sized hoisting devices and cribbing, to accomplish lifting and lowering to ensure that items being moved are under control at all times.
- E. Surfaces To Receive Work: The Drawings are two-dimensional representations of three-dimensional objects and do not show all surfaces of building components on which work is to be performed, including surfaces concealed from view behind objects shown; surfaces of projections, reveals, returns, and other elements perpendicular to or at an oblique angle to surfaces shown; concealed surfaces of profiled members and of ornament; and surfaces of profiled members and of ornament not drawn in detail. Perform work on surfaces of projections, reveals, returns, profiled members, and ornaments associated with surfaces indicated to receive work and on surfaces of building components concealed behind building components shown. It is the specific intent of the Contract Documents to include work on all surfaces within Project area, whether or not shown on the Drawings, except as specifically indicated otherwise.
- F. Responsibility for Dimensions: Dimensions of existing elements and conditions in Contract Documents, whether numerical, tabular, or graphic, are provided for bidding purposes and for Contractor's information and are not guaranteed. Contractor shall measure existing elements and conditions in field and in shop before preparing shop drawings, ordering materials, or starting construction and shall certify on shop drawings that dimensions have been field verified. Contractor is responsible for verifying dimensions of existing construction and for preparation of new work and replacement work fitting into and aligning with existing construction.
- G. Dust: Use procedures necessary to generate as little dust as possible in the execution of work of this Section and to minimize dissemination of dust generated during work of this Section to greatest extent possible.
 - 1. Contractor shall hold Owner, Architect, and their consultants harmless from claims relating to dust resulting from work of this Section.
- H. Debris Removal
 - 1. Do not drop or throw materials from any height. Remove debris using suitable containers or conveyances. Lower materials to ground in containers. Use methods that keep dust and impact to absolute minimum.
 - 2. Keep premises clean by removing accumulation of waste materials, rubbish, and debris from site daily. Dispose of waste, rubbish, and debris in a proper manner in accordance with federal, state, and local laws and regulations, to the satisfaction of authorities having jurisdiction, and to the satisfaction of the Architect or Restoration Consultant. Keep site and public rights of way clear.
 - 3. Do not store or permit excess debris to accumulate on site.
- I. Coordination: Coordinate work of this Section with work of other sections as necessary to ensure optimum performance of work of this Contract.
 - 1. Clean stone masonry as specified in Section 04 01 10 – "Masonry Cleaning" before beginning stone masonry restoration and reinstallation.
- J. Preconstruction Meeting: Convene a preconstruction meeting to discuss stone masonry restoration and its effect on adjacent elements, materials, and finishes. Attendees shall include

Owner's Representatives, Architect or Restoration Consultant, Construction Manager, firm(s) that will perform stone masonry restoration, and other entities that might be affected by stone masonry restoration work.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General

1. Manufacturer's Recommendations: Perform work only when temperature of products being used, temperatures of existing and new materials and surfaces, and temperature and humidity of air at Project site comply with manufacturer's requirements and recommendations.
2. Requirements of Referenced Standard: Perform work of this Section in compliance with the requirements and recommendations of Brick Industry Association Technical (BIA) Notes 1, *Cold and Hot Weather Construction*, June, 2018.
3. Conflicting Requirements: In each case in which there is a conflict between manufacturer's recommendations, recommendations of referenced standards, and other requirements specified in this Section, the most stringent and restrictive requirement shall govern.

B. Cold Weather Stone Masonry Restoration: Cold weather stone masonry restoration shall adhere to following requirements for work, performed in ambient temperatures indicated. Work shall not be permitted when temperature of air or wall is below 40 deg F or when temperature of air or wall is predicted to be below 40 deg F in Project location within 48 hours of work by AccuWeather the National Weather Service without's prior written approval. No work shall begin when any part of wall or materials in use are frozen or subject to freezing temperatures.

1. Temperature Range 40 deg F to 32 deg F: Heat mixing water or sand to produce mortar between 40 deg F and 120 deg F and maintain above 40 deg F until placed at that temperature.
2. Temperature Range 32 deg F to 20 deg F
 - a. Heat mixing water and sand to produce mortar between 40 deg F and 120 deg F. Heat grout materials so grout is maintained and placed at a temperature between 40 deg F and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
 - b. For work between 25 deg F and 20 deg F, heat and maintain masonry units above 40 deg F, if grouting.
3. Temperature 20 deg F and Below: Heat mixing water and sand to produce mortar between 40 deg F and 120 deg F. Heat grout materials so grout is placed at a temperature between 40 deg F and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F. Provide enclosure to heat and maintain temperatures above freezing within enclosure.

C. Cold Weather Protection of Completed Stone Masonry Restoration Work: Protect completed stone masonry in the following manner. Temperature ranges indicated apply to anticipated minimum night temperatures.

1. Temperature Range 40 deg F to 32 deg F: Protect masonry from rain and snow for at least 24 hours by covering with weather-resistive membrane.
2. Temperature Range 32 deg F to 20 deg F: Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.
3. Temperature 20 deg F and Below: Except as otherwise indicated, maintain masonry temperature above 32 deg F for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps, or other methods proven to be satisfactory. For

grouted masonry maintain heated enclosure to 40 deg F for 48 hours.

- D. Hot Weather Stone Masonry Restoration: Protect fresh mortar from premature drying when temperature, humidity, and wind conditions result in rapid drying of mortar. Provide and maintain tarps against wind and direct sun. Protect masonry for 72 hours after using mortar by one of the following procedures:
1. Water-Soaked Cover: Provide and maintain damp burlap or other damp cloths over masonry to protect mortars from pre-mature drying. Install, maintain, and remove coverings using materials and methods that do not damage or alter masonry.
 2. Fog Spray: Fog spray newly constructed masonry until damp at least three times a day using water without iron or other contaminants that might adversely affect masonry. Do not use water stream or pressure that might wash binder from surface of mortar or cause rundown on masonry.
- E. Proprietary Mortars and Epoxy Adhesives and Fillers: Perform work of this Section requiring proprietary composite patching materials and epoxy adhesives and fillers only when surface and air temperatures are between 50 deg F and 85 deg F.
- F. Damage from Work in Cold Weather or in Hot Weather: Remove work of this Section damaged by freezing during cold weather masonry work and/or damaged by premature or too-rapid drying during hot weather masonry work and replace with new masonry work complying with the requirements of this Section at no additional cost to Owner.

PART 2 – PRODUCTS

2.1 STONE

A. Granite

1. Salvaged Granite: Salvaged sound stone cleaned free of mortar, grout, dirt, and other contaminants and matching existing cleaned granite in physical and chemical properties and in color, texture, and other surface characteristics.
2. New Granite: New sound stone complying with ASTM C 615 and matching existing cleaned granite in physical and chemical properties and in color, texture, and other surface characteristics for each type of granite to be replaced.

2.2 MORTAR AND PATCHING MATERIALS

- A. Refer to Specification Section 04 05 13 – Restoration Mortars and Masonry Pointing.

2.3 ANCHORS AND FASTENERS

- A. General: Provide anchors, dowels, attachments, and fasteners as shown on approved shop drawings and of size and configuration suitable for use intended to secure sound, secure anchorage.
1. Material
 - a. Anchors and Fasteners Not Being Welded: Stainless steel complying with ASTM A 276 or ASTM A 666 Type 302, 304, 304L, 316, or 316L.
 - b. Anchors and Fasteners Being Welded: Stainless steel complying with ASTM A 276 or ASTM A 666 Type 316L.
 2. Prohibited Types of Anchors and Fasteners: Expansion bolts, cinch bolts, and plugs are not

acceptable.

B. Anchors and Fasteners for Securing Stone Dutchmen

1. Small Veneers: 1/8-inch-diameter stainless steel wire with turned up ends.
2. Direct Pinning: 1/4-inch- or 3/8-inch-diameter threaded stainless steel rod.
3. Drop Dowels: 3/8-inch- or 1/2-inch-diameter threaded stainless steel rod.

C. Anchors and Fasteners for Pinning and Securing Loose and Cracked Units

1. Pins: 1/4-inch-, 3/8-inch-, or 1/2-inch-diameter threaded stainless steel rod.
2. Micro-Pins: Orthopedic surgical bone screws of ASTM A 276 or ASTM A 666 Type 316 stainless steel or titanium (grade 2), 4 mm diameter, head no larger than 6 mm diameter with a recessed hex mortise, available from Diverse Surgical Supply, 7033 N. Fresno Street, Fresno, CA 93720 (866-800-9414), or approved equal.

D. Anchors for Setting Stone Units in Rebuilt Locations:

1. Concealed Anchors: Split anchor specifically designed to secure individual masonry units inserted into existing masonry with plates and sleeves of Type 304 stainless steel complying with ASTM A 666 and dowels of Type 304 stainless steel complying with ASTM A 580. Provide Type HB C3 anchors by Hohmann & Barnard, Inc., 30 Rasons Court, Hauppauge, NY 11788 (631-234-0600), or approved equal.

2.4 EQUIPMENT AND TOOLS FOR CLEANING ANCHOR HOLES, CRACKS AND LOSSES

- A. Brushes for Cleaning Anchor Holes: Stiff wire bristle or nylon bristle brushes of diameter to ensure full cleaning of dust and debris from masonry substrate at sides and bottom of hole. Furnish brushes specifically manufactured for cleaning anchor holes in masonry substrates as available from Hilti, Inc., PO Box 21148, Tulsa, OK 74121 (800-879-8000), Powers Fasteners, Inc., 2 Powers Lane, Brewster, NY 10509 (914-235-6300), Simpson Strong-Tie, 26 International Street, Columbus, OH 43228 (614-876-8060), or approved equal. Brushes shall be sized appropriately for holes in which they are to be used so that they firmly contact entire circumference of hole at the same time. Use sizes recommended by anchor manufacturer and approved by Architect or Restoration Consultant.
- B. Brushes for Cleaning Cracks and Losses: Stiff nylon bristle brushes of shape and dimension to provide optimum removal of contaminants from stone surface and approved by Architect or Restoration Consultant.

2.5 TOOLS FOR JOINT REMOVAL AND PREPARATION

- A. Hand Tools: Chisels, hammers, and mallets.
1. Thickness of Chisels: Maximum thickness of 5/8 times joint width extending from tip at least three times depth at which chisel will be inserted into joint.
- B. Power Tools: Standard tools and equipment, modified tools and equipment, and custom designed and fabricated tools and equipment as necessary to remove mortar from narrow joints without damaging masonry units. Use power tools only under conditions described in Part 3, below, and only if specifically approved by Architect or Restoration Consultant.

1. Electric Grinders: Small, hand-held electric grinders with blades no greater than 1/16 inch thick and a maximum of 4-1/2-inch diameter.
 2. Pneumatic Grinders: Specially modified pneumatic die grinders with thin diamond abrasive blades (0.060 inch thick). Subject to compliance with requirements, provide wafer blades as manufactured by CDP Diamond Products, Inc., 11919 Globe, Livonia, MI 48150 (800-521-0638), or approved equal.
 3. Custom Pneumatic Head and Chisels Designed for Mortar Removal: Pneumatic head and thin carbide-tipped chisels specifically designed for removal of mortar from joints in historic masonry with air compressor and accessories to provide complete mortar removal system. Pneumatic head shall not have a retainer to hold chisels in place. Provide pneumatic head and chisels by Trow and Holden, 45 South Main St., Barre, VT 05641 (800-451-4349), or approved equal.
 - a. Chisels for Use in Narrow Joints: Use custom ground thin carbide-tipped chisels for mortar removal from narrow joints.
 4. Reciprocating Brick and Mortar Saw: Custom saw designed for removing mortar from joints in masonry with paired blades that have an orbiting movement providing both hammering and cutting action and that are designed for making plunge cuts and cutting square corners in masonry joints without overcutting. Provide Arbortech AS160 Brick and Mortar Saw, available from Quikpoint, Inc., 23 B Bradford Street, Concord, MA 01742 (800-368-2292), or approved equal.
 5. Hand-Held Multipurpose Oscillating Tool with Diamond Blade: Multipurpose oscillating tool with thin diamond blade not exceeding 3/4 times width of joints designed for removal of grout and mortar. Provide Fein MultiMaster, manufactured by Fein Power Tools, Inc., 1030 Alcon Street, Pittsburgh, PA 15220 (877-771-0088), Dremel Multi-Max, manufactured by Dremel, 4915 21st St., Racine, WI 53406 (800-437-3635), or approved equal, with appropriate diamond blades.
- C. Tools for Preparation of Joints Containing Sealant: Small wire bristle brushes, metal scrapers, small grinders, low-pressure, airborne, micro-abrasive blasting equipment, or other tools and equipment for removing remains of sealant and sealant residue from joint as described in approved Work Description.
- D. Brushes for Removing Dust and Dirt from Joints: Stiff, natural- or synthetic-fiber bristle brushes. No metal bristle brushes are acceptable.
- 2.6 MISCELLANEOUS MATERIALS AND EQUIPMENT
- A. Detergent: Non-ionic detergent. Provide Surfonic JL-80X, available from Conservation Support Systems, P.O. Box 91746, Santa Barbara, CA 93190 (800-482-6299); Tergitol 15-S-5, available from Sigma-Aldrich Corporation, 3050 Spruce Street, St. Louis, MO 63103 (314-771-5765); or approved equal.
- B. Solvent for Removing Adhesives: Acetone or other solvent approved by Architect or Restoration Consultant.
- C. Tape for Protecting Masonry Surfaces: Masking tape or other approved tape that will protect masonry surface from contact with repair materials being used and that can be applied to and removed completely from masonry surface without damaging, deteriorating, or altering the appearance of the masonry surface.
- 2.7 MORTAR AND GROUT MIXES
- A. Refer to Specification Section 04 05 13 – Restoration Mortars and Masonry Repointing.

PART 3 – EXECUTION

3.1 DOCUMENTATION OF STONE MASONRY TO BE RESTORED

- A. General: Document areas of stone masonry to be restored as specified in “Quality Assurance” Article, above and Specification Section 02 42 91 – Removal and Salvage of Historic Materials.

3.2 REMOVING AND SALVAGING STONE UNITS

- A. General: Removal and salvage of stone units is specified in Section 02 42 91 – Removal and Salvage of Historic Materials.

3.3 REBUILDING STONE MASONRY

- A. General: Ensure sound substrates and provide stone masonry using salvaged stone units and new stone units as indicated on Drawings. Do not damage stone units. Repair and replace stone units damaged during work of this Section as directed by Architect or Restoration Consultant's satisfaction at no additional cost to Owner.
- B. Cleaning Stone: Clean stone before setting. Remove old mortar from salvaged stone and scrub stone with detergent and water using natural or synthetic fiber bristle brushes. Thoroughly rinse salvaged stone and new stone with clean water.
- C. Anchor Holes: Where indicated on Drawings, necessitated by conditions at site, and as shown on approved shop drawings, drill new holes to receive anchors, cramps, dowels, and other anchors and fasteners. Use methods that do not damage stone.
- D. Setting: Set salvaged and replacement stone units accurately with new stainless steel anchors and fresh mortar to match condition of original masonry. Set true to line and level and fill joints and anchor holes completely with mortar.
 - 1. Joint Widths: Set stonework with joints of uniform width not exceeding width of existing joints, unless otherwise specified.
 - 2. Wedges: Use nylon wedges to secure proper setting of stone. Pack bed joints tightly with mortar. Clean wedges before using them and remove wedges before mortar has set hard. Fill resulting holes with mortar.
- E. Defects: Patching of defects in stone blocks shall not be permitted. Chips and stains on faces shall be redressed or cleaned. No acid-leaching agent shall be permitted.
- F. Preparation for Pointing: Upon completion of setting stonework, rake joints to prepare them for pointing in compliance with Specification Section 04 05 13 – Masonry Pointing.

3.4 PATCHING STONE UNITS USING DUTCHMEN

- A. General: Remove existing damaged and deteriorated stone from stone units. Prepare holes and provide stone dutchmen matching adjacent stone to restore unit to original configuration and appearance as indicated on Drawings.
 - 1. In locations indicated on Drawings, remove existing dutchman, prepare substrate, and provide new dutchman.
- B. Anchors
 - 1. Secure each dutchman using at least two metal attachments with one additional attachment for every two additional square feet of configuration and location as shown on

- approved shop drawings.
- 2. Attach anchors using epoxy adhesive and mechanical fastening.

C. General Method for Dutchman Repair

1. Stone Preparation: Cut away portions of deteriorated or damaged stone and edges of losses in stone to sound stone. Cut sides of area to receive dutchman parallel to edges of stone block. Cut sides perpendicular to stone face. Do not weaken stone.
2. Attachment: Fasten dutchman with stainless steel wire, pins, and anchors as necessary to provide mechanical locking and to prevent possible slippage of stone and as shown on approved shop drawings. Position metal anchors without weakening stone in any way.
3. Dutchman Preparation: Dress stone dutchman on all sides and carefully fit to opening in stone, with an allowance of not more than 1/16-inch-wide buttered joints at face. Dress surface of dutchman to match appearance, tooling, and texture of adjacent stone using an approved method. Complete surface dressing of dutchman before installing dutchman.
4. Cleaning Anchor Holes and Substrate: Use stiff bristle brushes to thoroughly remove dust and debris from anchor holes and from stone surfaces to receive mortar.
5. Wetting Stone Surfaces: Wet surfaces to receive mortar to ensure that surfaces are damp but free of standing water at time of mortar application (saturated, surface dry) unless specifically instructed otherwise by mortar admixture manufacturer.
6. Installation: Install dutchman using specified mortar matching adjacent stone. Install anchors with specified adhesive.
7. Joint Surfaces: Finish joints between new and old work to match color and texture of stone.
8. Protection: Protect adjacent surfaces during dutchman repair. Wipe and rinse mortar accidentally splashed onto adjacent surfaces immediately. Remove uncured epoxy adhesive immediately with acetone.
 - a. Repair damage to stone and damage to other materials to remain resulting from adhesive and mortar spills to Architect or Restoration Consultant's satisfaction at no additional cost.
9. Cleaning: Clean faces of patched stone units following completion of dutchman installation. Clean mortar splashes, smears, etc. with wood scrapers or by vigorously brushing with stiff fiber bristle brushes and clean, potable water. If necessary to remove mortar, add clean white sand to water.

3.5 ROUTING AND FILLING CRACKS

- A. General: In locations indicated, rout out cracks at surface and fill with custom patching mortar to match color and texture of adjacent stone surface.
- B. Preparation for Patching Crack: Rout out cracks to a depth of 5/8 inch and a width of 1/8 inch. Do not damage adjacent stone surface.
 1. Removing Previous Repairs: Where previous crack repair is to be replaced, rout out crack to width and depth of previous repair to remove previous patching material and expose stone substrate.
- C. Cleaning: Clean stone at sides and rear of routed cracks thoroughly using fine, stiff, fiber-bristle brush to remove particles and dust.
- D. Wetting: Thoroughly rinse surfaces to ensure that substrate will not rapidly absorb water from patching mortar.
- E. Application: Brush crack with a mortar slurry coat and fill with specified composite patching mortar matching color of adjacent cleaned stone.

- F. Finishing: Strike surface of filled crack flush with face of adjacent stone. Finish surface of patching material to match texture and finish of adjacent cleaned stone.
- G. Curing: Protect installed patching mortar from too rapid drying and from contact with water that might wash binder from surface.

3.6 REMOVING ANCHORS AND PATCHING HOLES WITH DUTCHMEN PLUGS

- A. General: Remove abandoned anchors and anchors from elements being removed from stone units and patch holes with dutchman plugs to match adjacent stone.
 - 1. If anchor and/or patch extends across a joint between masonry units, do not patch across joint. Provide plugs on masonry units on each side of joint separately. Point joint as specified in Section 04 05 13 – “Restoration Mortars and Masonry Pointing.”
- B. Removing Anchors: Carefully remove anchors by drilling with a rotary drill using a sharp masonry bit or masonry core bit 1/8 inch larger in diameter than existing hole. Do not chip edges of drill hole or otherwise damage adjacent masonry. Do not use hammer drill or percussive power tools.
- C. Preparing for Dutchmen Plugs
 - 1. Cleaning: Clean surfaces of area to be plugged free from dust, dirt, oils, grease, and other contaminants and coatings that might adversely affect mortar adhesion. Brush surfaces with stiff fiber-bristle brushes and remove dust and loose particles.
 - 2. Protection: Protect surrounding surfaces as necessary to keep them free from mortar.
 - 3. Wetting Stone Surfaces: Wet surfaces of prepared stone with clean water to ensure that at time of plug installation it is damp but free of standing water (saturated, surface dry).
- D. Patching Using Dutchman Plugs: Fill holes with dutchman plugs matching planes and profiles of adjacent stone and color and texture of adjacent stone surface.
 - 1. Dutchman Plug: Shape dutchman plug to match size of hole in stone block, allowing for a maximum 1/16-inch buttered joint between dutchman and stone unit into which it is to be inserted. Dress face of dutchman to match appearance, tooling, and texture of adjacent stone surface using an approved method. Complete surface dressing of dutchman before installing dutchman.
 - 2. Installation: Wet surface of dutchman and allow to dry slightly. Install dutchman using specified mortar matching adjacent stone.
 - 3. Joint Surfaces: Finish joint between dutchman plug and stone block to match color and texture of stone.
 - 4. Cleaning Mortar Spills: Wipe off and rinse away mortar accidentally splashed onto adjacent surfaces immediately.
 - a. Repair damage to stone resulting from mortar spills to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.
- E. Cleaning: Clean faces of patched stone units following completion of dutchman installations. Clean mortar splashes, smears, and other contaminants with wood scrapers or by vigorously brushing with stiff fiber bristle brush and potable water. If necessary to remove mortar stains, add clean white sand to water.
- F. Corrective Measures: Should Architect or Restoration Consultant determine that a dutchman plug does not equal or exceed the minimum standard established by approved mock-ups, Contractor shall remove plug, properly prepare substrate, and provide new dutchman plug following requirements of this Section to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.

3.7 BLIND PINNING STONE-TO-STONE REPAIRS AND PATCHING CRACKS

- A. General: Repair broken stones with stone-to-stone repairs using structural adhesive and threaded stainless steel rods.
- B. Preparation: Drill holes into the mating surface of each of the two pieces of stone to be united, aligning the holes. Each hole shall be at least 1/4 inch deeper than portion of dowel to extend into hole. Dry fit the pieces with the stainless steel dowels in place to ensure that the holes are aligned. Protect stone surfaces to be exposed in finished work and stone surfaces to be in contact with mortar from contact with adhesive using masking tape or other approved method.
- C. Bonding: Set the dowels in anchor adhesive in the larger stone piece and allow adhesive to cure. Apply adhesive to the mating faces of the stone pieces. Fill the holes in the smaller fragment halfway with anchor adhesive. Attach smaller piece of stone to larger piece of stone. Adjust to ensure that planes and arrises are in line. Remove adhesive that squeezes out of joint.
- D. Repairing Cracks: After adhesive joining pieces of stone has cured, perform a standard crack repair over the adhesive-filled joint by routing surface of crack and filling with cementitious patching mortar as specified in Article "Routing and Filling Cracks".

3.8 PINNING STONE UNITS USING THREADED RODS SET IN EPOXY ADHESIVE AND PATCHING CRACKS USING CEMENTITIOUS PATCHING MORTAR

- A. General: Pin broken pieces of stone to sound pieces of stone and pin loose stone units to sound units or to sound backup masonry as indicated on Drawings.
 - 1. Attach broken pieces of stone less than 24 cu. in. with epoxy adhesive only, when approved in writing by Architect or Restoration Consultant.
- B. Drilling: Drill holes in loose stone units and in cracked stone units indicated to be pinned using rotary drill with sharp masonry bit. Do not use hammer drill or other percussive tools. Extend holes at least 3 inches into solid masonry backup or into solid and securely anchored adjacent portion of stone unit.
- C. Cleaning Holes: Use specified stiff bristle brushes through specially designed nozzles to thoroughly remove dust and debris from holes to receive pins.
- D. Protection of Substrate to Be Patched: Protect outer portions of stone surface within holes to receive composite patching mortar patches using masking tape or other means to prevent contact with adhesive.
- E. Pinning: Inject epoxy adhesive and insert threaded dowels, pushing until dowel ends are below stone surface to extent shown on Drawings but not less than 1/2 inch to allow for composite patching mortar patches.
- F. Patching Holes: Patch holes in exposed surfaces using composite patching mortar following requirements of Article "Patching Stone Units Using Composite Patching Mortar," below. Patches shall match color, texture, and surface of adjacent stone. Cure patches to comply with composite patching mortar manufacturer's recommendations to ensure optimum performance of patching mortar.
- G. Filling Cracks: Rout out and fill cracks with composite patching mortar as specified in Article "Routing and Filling Cracks," below.

3.9 PINNING STONE UNITS USING THREADED RODS SET IN EPOXY ADHESIVE AND
INJECTING CRACKS WITH EPOXY ADHESIVE

- A. General: Pin broken pieces of stone to sound pieces of stone and pin loose stone units to sound stone units or to sound backup masonry as indicated on Drawings and inject cracks with epoxy adhesive.
- B. Drilling: Drill holes in loose stone units and in cracked stone units indicated to be pinned using rotary drill with sharp masonry bit. Do not use hammer drill or other percussive tools. Extend holes at least 3 inches into solid masonry backup or into solid and securely anchored adjacent portion of stone unit.
- C. Cleaning Holes: Use specified stiff bristle brushes to thoroughly remove dust and debris from holes to receive pins.
- D. Protection of Substrate to Be Patched: Protect outer portions of stone surface within holes to receive composite patches using masking tape or other means to prevent contact with adhesive.
- E. Pinning: Inject epoxy adhesive and insert threaded dowels, pushing until dowel ends are below stone surface to extent shown on Drawings but not less than 1/2 inch.
- F. Patching Holes: Patch holes in exposed surfaces using composite patching mortar following requirements of Article "Patching Stone Units Using Composite Patching Mortar," below. Patches shall match color, texture, and surface of adjacent stone. Cure patches to comply with composite patching mortar manufacturer's recommendations to ensure optimum performance of patching mortar.

3.10 ADJUSTMENT AND CLEANING

- A. Adjustment: Correct work of this Section that does not meet requirements of this Specification to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.
- B. Cleaning Restored Stone Masonry: Clean stone masonry affected by work of this Section to remove mortar, grout, adhesive, and other contaminants using approved methods to provide clean surfaces matching the condition of the surfaces cleaned to comply with requirements of Section 04 01 10 – "Masonry Cleaning" before work of this Section was begun.
- C. Site Cleaning: At completion of stone masonry restoration work, remove debris and left over materials from site and leave site broom clean.

END OF SECTION

04 01 40

SECTION 04 05 13 – RESTORATION MORTARS AND MASONRY POINTING

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Work of this Section includes all labor, materials, equipment, and services necessary to complete the work of masonry pointing as shown on the Drawings, as specified herein, and as may be required by conditions and authorities having jurisdiction, including, but not limited to, the following:

1. Setting granite masonry.
2. Pointing joints in granite masonry.

1.3 RELATED WORK

- A. Section 04 01 10 – Masonry Cleaning
- B. Section 04 01 40 – Stone Masonry Restoration

1.4 QUALITY ASSURANCE

- A. Masonry Restoration Specialist: Award masonry pointing to a firm regularly engaged in pointing masonry on historic structures that can demonstrate to Owner's satisfaction that, within previous ten years, it has successfully performed and completed in a timely manner at least five projects similar in scope and type to work required on this Project involving buildings designated as Landmarks by other local governmental authorities, buildings listed in the National Register of Historic Places, or buildings listed in a State Register of Historic Places under the direction of preservation authorities.
 1. Foreman: Masonry pointing shall be directly supervised by a full-time foreman with experience equal to or greater than that required of Masonry Restoration Specialist. Foreman shall be on site daily for duration of work of this Section. Same foreman shall remain on Project throughout work unless Owner deems foreman's performance unacceptable.
 2. Mechanics: Masonry pointing shall be carried out by a steady crew of skilled masons who are thoroughly experienced with materials and methods specified and have a minimum of three years' experience preparing and pointing joints in historic masonry similar to the work required by this Section. In acceptance or rejection of work of this Section, no allowance will be made for workers' inattention or lack of skill.
- B. Testing of Workers: Technicians proposed for raking and cutting joints in historic masonry of this Project shall be required to successfully complete six linear feet of raking and cutting mortar joints in presence of Architect or Restoration Consultant prior to working on Project. One one-quarter-inch chip of masonry per linear yard will be standard of acceptable skill. Unsuccessful performance in this test area will be grounds for rejection of this technician for joint preparation and pointing work on this Project.

- C. Laws, Codes, and Regulations: Work of this Section shall comply with applicable federal, state, and local laws, codes, and regulations.
- D. Referenced Standards: Comply with applicable requirements and recommendations of the latest editions of the referenced standards listed herein, except as modified by more stringent requirements of the Contract Documents and of applicable laws, codes, and regulations. Where these standards make recommendations or suggestions, such recommendations or suggestions shall be considered mandatory for work of this Contract unless specifically indicated otherwise in Contract Documents. Provide a reference copy of each of the following standards at shop and at Project site when work of this Section is being performed in each location. In each case in which there is conflict between requirements of referenced standards; requirements of laws, codes, and regulations; and requirements of this Section, the most stringent or restrictive requirement shall govern.
1. Brick Industry Association (BIA). Technical Notes 1, *Cold and Hot Weather Construction*, June, 2006.
 2. ASTM International (ASTM)
 - a. ASTM C 144, *Standard Specification for Aggregate for Masonry Mortar*.
 - b. ASTM C 150, *Standard Specification for Portland Cement*.
 - c. ASTM C 270, *Standard Specification for Mortar for Unit Masonry*.
 - d. ASTM C 1713, *Standard Specification for Mortars for the Repair of Historic Masonry*.
 3. British Standard (European Standard). BS EN 459-1, Building lime. Definitions, specifications and conformity criteria.
- E. Sources of Materials: Obtain each type of material required for restoration mortars from a single source to ensure a match in quality, performance, and appearance.
- F. Knowledge of Site and Project Conditions: Before submitting bid, Bidders shall make themselves thoroughly familiar with the Drawings and Specifications, with the scope of this Project, and with conditions at the Project site relating to requirements of this Section and limitations under which the work will be performed and shall determine or verify dimensions and quantities. Submission of a bid shall be considered conclusive evidence that Contractor is thoroughly familiar with Project requirements and site conditions and limitations.
- G. Access for Observation and Approvals: Provide Architect or Restoration Consultant access on a continuing basis to locations on which mock-ups are being carried out, on which work is ongoing, and where work has been completed to allow for observation and approvals. Provide pipe scaffolding and manpower to move and reconfigure scaffolding and planking, personnel lift and manpower to operate lift, or other means of access complying with laws and regulations regarding safety and acceptable to Architect or Restoration Consultant. Provide manpower and equipment to facilitate observation and approvals.
- H. Restoration of Damaged Masonry Units: Repair or replace masonry units damaged during masonry pointing work to Architect or Restoration Consultant's satisfaction at no additional cost to Owner.
- 1.5 SUBMITTALS
- A. General: Submit the following in compliance with the requirements of the Contract Documents. Revise and resubmit each item as required to obtain Architect or Restoration Consultant's approval.

- B. Qualification Data: Qualification data for firm and personnel specified in "Quality Assurance" Article that demonstrates that both firm and personnel have capabilities and experience complying with requirements specified. For firm and foreman, provide a list of at least five completed projects similar in size and scope to the work required on this Project. For each project list project name, address, architect, conservator, supervising preservation agency, scope of contractor's work, and other relevant information. Submit this information with the bid.
- C. Product Data: Manufacturer's published technical data for each product to be used in work of this Section including material description, chemical composition (ingredients and proportions), physical properties, recommendations for application and use, test reports and certificates verifying that product complies with specified requirements, and Material Safety Data Sheets (MSDS).
- D. Work Description: Detailed description for joint preparation and pointing of each masonry material and condition. Do not begin work on site until Work Description has been approved in writing. Submit new written descriptive information. Photocopies of Contract Documents, excerpts from Contract Documents, and/or duplication of text in Contract Documents will not be accepted for Work Description. Description for each condition shall include, but not be limited to:
1. Materials and Procedure: Materials, methods, tools, and equipment to be used.
 2. Environmental Conditions: Proposed procedures for ensuring uniform conditions for proportioning and mixing mortars and grouts in factory or shop.
 3. Quality Control Procedures: Proposed procedures to ensure that mortar and grout mixes for each use are consistent throughout the length of the Project. Include proposed procedures for ensuring that each type and formulation of mortar is used in specified locations and only in those locations.
 4. Types of Packaging: Proposed packaging for delivery of mortar and grout mixes.
 5. Storage: Proposed locations and conditions for storage of delivered mortar and grout mixes prior to use to avoid contamination and deterioration.
 6. Testing Procedures: Proposed procedures for testing mortars to ensure compliance with requirements.
 7. Protection: Description, including drawings and diagrams, of proposed materials and methods of protection for preventing harm, damage, and deterioration caused by work of this Section to persons (whether involved in the Work or not), building elements, materials, and finishes, surrounding landscape and site, and the environment (including air and water).
 8. Alternate Methods and Materials (If Any): Proposed alternate methods and materials (if any) to those specified for masonry pointing work. Provide evidence of successful use on comparable projects and demonstrate effectiveness for use on this Project.
- E. Samples
1. Pointing Mortar: Cured mortar samples set in 1/2-inch by 6-inch plastic or aluminum channels for approval of color and texture. Samples shall match existing mortar in color, texture and composition. Provide the following:
 - a. Mortar for setting stone masonry.
 - b. Mortar for pointing stone masonry.
 3. Sand for Setting and Pointing Mortars: Five-pound sample of each type of sand proposed for use in pointing mortars. Include sieve analysis (ASTM C 144) for each type of sand.
 4. Custom Patching Mortar for Filling Cracks in Stone: 4-inch x 4-inch x 1-inch cured samples of each type and color of mortar required for approval of color and texture.

Samples shall match existing stone units in color, texture, surface reflectance, and other properties.

- F. Prepare mock-ups as specified in Article "Mock-Ups," below.

1.6 MOCK-UPS

- A. General: Before beginning general masonry pointing, prepare mock-ups to provide standards for work of this Section. Do not proceed with masonry pointing until Architect or Restoration Consultant has approved mock-ups.
1. Locate mock-ups as directed by Architect or Restoration Consultant.
 2. Notify Architect or Restoration Consultant 48 hours prior to start of each mock-up.
 3. Architect or Restoration Consultant will monitor mock-ups.
 4. Use crew that will execute the work and follow requirements of this Section.
 5. Allow mock-ups using mortar to dry for seven days to allow mortar to reach final color and allow potential problems to appear. Notify Architect or Restoration Consultant when mock-ups are ready for review.
 6. Repeat mock-ups as necessary to obtain Architect or Restoration Consultant's approval.
 7. Protect approved mock-ups to ensure that they are without damage, deterioration, or alteration at time of Substantial Completion.
 8. Approved mock-ups in undamaged condition at time of Substantial Completion may be incorporated into the Work.
 9. Approved mock-ups will represent minimum standards for masonry pointing. Subsequent masonry pointing work that does not meet standards of approved mock-ups will be rejected.
- B. Prepare the Following Mock-Ups
1. Preparing Joints in Granite Masonry: One panel, including at least 16 linear feet of joint.
 2. Pointing Joints in Granite Masonry: One panel including at least 8 linear feet of joint.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original containers and packaging clearly labeled with manufacturer's name, address, and product identification.
- B. Deliver, store, and handle products and materials to prevent damage, deterioration, degradation, and intrusion of foreign material.
- C. Discard and remove from site deteriorated materials, contaminated materials, and products that have exceeded their expiration dates. Replace with fresh materials.

1.8 PROJECT CONDITIONS

- A. Safety: Use all means necessary to protect persons, whether or not involved in the work of this Section, from harm caused by or resulting from work of this Section.
1. Protection from Hazardous Materials: Protect workers and other persons from contact with hazardous materials resulting from work of this Section.
 - a. Silica: Overexposure to respirable crystalline silica may lead to silicosis, which is a disabling, nonreversible, and sometimes fatal lung disease. Provide protections necessary to prevent workers from exposure to respirable crystalline silica. Comply with applicable federal, state, and local laws and regulations.

- b. Lead-Containing Material: Perform work with materials containing lead in compliance with applicable OSHA regulations, including but not limited to, Lead in Construction and Hazard Communication Standard (Title 29, Sections 1926.62 and 1910.1200, respectively, Code of Federal Regulations, OSHA, US Department of Labor) and with other applicable federal, state, and local laws and regulations.

B. Protection of Monument and Property

- 1. Protect adjacent elements and materials from damage and from deterioration during work of this Section. Provide all necessary protection and procedures to protect masonry not being pointed and all other elements and materials.
- 2. Repair damage to elements and materials caused by masonry pointing work, using mechanics experienced in the respective type of work, to Architect or Restoration Consultant's satisfaction at no additional cost.
- 3. Protect components of storm drainage systems against damage and blockage caused or accelerated by work of this Section. Clean out drains and other drainage elements that become clogged as a result of work of this Section.

C. Protection from Fire: Take precautions necessary to prevent fire and spread of fire.

D. Dust: Minimize dissemination of dust to greatest extent possible.

- 1. Contractor shall hold Owner, Architect, Restoration Consultant, and their consultants harmless from claims relating to dust resulting from work of this Section.

E. Protection of Masonry Being Pointed: Protect existing masonry from damage during work of this Section. Take special care in removing existing mortar to ensure that no arrises are damaged, chipped, or broken. Contractor shall replace or repair masonry units damaged by work of this Section as directed by and to complete satisfaction of the Architect or Restoration Consultant at no additional cost.

F. Protection from Staining: Prevent grout and mortar from staining face of masonry to be left exposed. Protect sills, ledges, and projections from mortar droppings. Immediately remove grout or mortar in contact with masonry. Protect base of walls from rain splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

G. Protection from Rain: Protect pointed joints with heavy waterproof sheeting from direct attack by rain or other precipitation for at least 24 hours after mortar has been applied. Do not anchor sheeting to masonry. Restore masonry damaged by installation or removal of sheeting.

H. Surfaces To Receive Work: The Drawings are two-dimensional representations of three-dimensional objects and do not show all surfaces of building components on which work is to be performed, including surfaces concealed from view behind objects shown; surfaces of projections, reveals, returns, and other elements perpendicular to or at an oblique angle to surfaces shown; concealed surfaces of profiled members and of ornament; and surfaces of profiled members and of ornament not drawn in detail. Perform work on surfaces of projections, reveals, returns, profiled members, and ornaments associated with surfaces indicated to receive work and on surfaces of building components concealed behind building components shown. It is the specific intent of the Contract Documents to include work on all surfaces within Project area, whether or not shown on the Drawings, except as specifically indicated otherwise.

I. Preconstruction Meeting: Convene a preconstruction meeting to discuss masonry pointing and its effect on adjacent elements, materials, and finishes. Attendees shall include Owner's Representatives, Architect, Restoration Consultant, Construction Manager, firm(s) that will perform masonry pointing work, and other entities that might be affected by masonry pointing

work.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. General: Perform work only when temperature of products being used and air temperature and humidity comply with manufacturer's requirements and requirements of this Section. In case of conflict, the most stringent requirements shall govern.
- B. Temperature Requirements for Use of Proprietary Materials: Do not use proprietary patching mortars and adhesives unless temperatures are between 50 deg F and 80 deg F and will remain within that range for at least 48 hours after work has been completed unless work at other temperatures is specifically approved by manufacturer and Architect or Restoration Consultant.
- C. Cold Weather Limitations on Use of Mortars: Do not mix or use mortars when air or masonry temperature is below 40 deg F or when it is forecast to drop below 40 deg F within 72 hours of mortar application unless Architect or Restoration Consultant has approved both Contractor's work proposal for cold- and hot-weather masonry work and also specific masonry work to be done in each instance.
- D. Hot Weather Requirements: Do not mix or use mortars when temperature is above 100 deg F or when temperature is above 90 deg F and wind is above 8 mph, or when either of these conditions is forecast to occur within 72 hours of mortar application unless Architect or Restoration Consultant has approved both Contractor's work proposal for cold- and hot-weather masonry work and also specific masonry work to be done in each instance.
- E. Damage from Work in Cold Weather or in Hot Weather: Remove work of this Section damaged by freezing during cold weather and/or damaged by premature or too-rapid drying during hot weather, properly prepare joint substrates, and provide new masonry work complying with the requirements of this Section at no additional cost to Owner.

PART 2 – PRODUCTS

2.1 MORTAR AND GROUT MATERIALS, GENERAL

- A. Grade and Quality: Materials shall conform to requirements of this Section and shall be new, free from defects, and of recent manufacture.
- B. Manufacturer's Instructions: Comply with material manufacturer's instructions for use of products (including surface preparation, mixing, applying, drying, etc.). In case of conflict with requirements of this Section, the more stringent requirements shall govern.
- C. Prohibited Materials: The following materials are strictly prohibited in mortar and grout:
 - 1. Masonry cements, masonry mortars, and other components that include ingredients other than Portland cement, lime, and approved aggregates.
 - 2. Additives and admixtures other than those specified and approved in writing by Architect or Restoration Consultant.

2.2 MORTAR AND GROUT INGREDIENTS

- A. White Portland Cement: ASTM C 150, Type I or Type II, nonstaining.
- B. Portland Cement: ASTM C 150, Type I or Type II. Do not use masonry cement.

- C. Hydrated Lime: ASTM C 207, Type S.
- D. Sand: Clean sharp sand, free of loam, silt, soluble salts, organic matter, and other substances that might adversely affect mortar, masonry units, or embedded elements and graded in compliance with ASTM C 144. Where mortar is to match existing original mortar, select sand or other aggregate to provide mortar matching color and texture of original mortar (with minimum addition of pigment). Sieve and mix sand and aggregates from individual sources and from more than one source to provide mortar matching original mortar.
- E. Pigments: Natural and/or synthetic, milled, blended mineral oxide pigments in dry powder form complying with ASTM C 979 and shown through previous use and exposure to produce uniform and consistent color and to be permanent, inert, stable to atmospheric conditions, sunfast, weather resistant, alkali resistant, water insoluble, lime proof, nonbleeding and free of fillers, extenders, and admixtures. Provide pigments as required to provide color of mortar to match original mortar as approved by Architect or Restoration Consultant. Provide one of the following or approved equal:
 - 1. SGS Concentrated Mortar Colors by Solomon Colors, Inc., 4050 Color Plant Road, Springfield, IL 62702 (800-624-0261).
 - 2. Lanxess Bayferrox Iron Oxide Pigments by Lanxess Corporation, Business Unit Inorganic Pigments, 111 RIDC Park West Drive, Pittsburgh, PA 15275 (412-809-1000).
 - 3. Davis Colors by Davis Colors, 3700 East Olympic Blvd., Los Angeles, CA 90023 (800-356-4848).
- F. Water: Clean and free of substances that might adversely affect mortar, masonry, and embedded elements.
- G. Admixtures for Mortar for Installing Stone Dutchmen: Additives by Laticrete International, Inc., 91 Amity Rd., Bethany, CT 06524 (800-243-4788), or approved equal, to provide mortars as follows:
 - 1. Mortar Bed Less Than 3/8-Inch Thick: Laticrete 4237 Latex Additive for "thin-set" mortars.
 - 2. Mortar Bed 3/8-Inch or Greater in Thickness: Laticrete 3701 Mortar Admix for "thick-set" mortars.

2.3 PREFORMULATED MORTARS AND GROUTS

- A. Composite Patching Mortar for Granite
 - 1. Single-component, cementitious, mineral-based mortar specifically manufactured for the restoration of natural stone. Provide Jahn M160 Granite and Bluestone Repair Mortar, available from Cathedral Stone Products, Inc., 7266 Park Circle Dr., Hanover, MD (800-684-0901), or approved equal, in custom colors to match colors of clean granite.
 - 2. Two-component, latex-modified cementitious compounds, specifically manufactured for masonry restoration. Provide Custom System 45, available from Edison Coatings, Inc., 3 Northwest Drive, Plainville, CT 06062 (800-341-6621) Provide custom colors to match colors of cleaned granite being patched.
- B. Cementitious Injection Grout for Cracked Stone Units with Cracks Not Exceeding 3/16 Inches Wide: (Jahn M30 No. 32) Single-component, water-vapor-permeable, synthetically modified cementitious grout formulated specifically for injecting cracks and voids in masonry with a record of at least 3 years of successful inservice performance and in custom formulations matching color of clean existing units being grouted. Provide grout with the following properties:

Compressive Strength (28 days)	Not less than 3000 psi
Tensile Strength (28 days)	Not less than 180 psi
Viscosity direct	80 cps
Concrete Granular Size	Smaller than 6.3E-04 inches

- C. Cementitious Injection Grout for Cracked Stone Units with Cracks Exceeding 3/16 Inches Wide: (Jahn M40) Single-component, water-vapor-permeable, cementitious grout without synthetic additives formulated specifically for injecting cracks and voids in masonry with a record of at least 3 years of successful inservice performance and in custom formulations matching color of clean existing units being grouted. Provide grout with the following properties:

Compressive Strength (28 days)	Not less than 1500 psi
Tensile Bending Strength (28 days)	Not less than 290 psi
Tensile Strength (28 days)	58 to 100 psi

- D. Surface Aggregate for Granite Crack Patches: Sound particles of ground stone with grains matching sizes, size distribution, colors, and color distribution of surface particles in existing granite to be patched.

2.4 MORTAR MIXES

A. General

1. Mortars specified hereinafter shall comply with ASTM C 1713, Standard Specification for Mortars for the Repair of Historic Masonry.
2. Mix mortars using proportions specified herein as adjusted, if necessary, by the amount of moisture in the ingredients. The proportions specified are for dry cements and limes and damp, loose (saturated, surface-dry) sand. If ingredients with different moisture contents are used (for example, lime putty is used in place of lime or dry sand is used in place of damp, loose sand), adjust quantities so that the proportions of ingredients in the mixes equal the proportions specified as approved by Architect or Restoration Consultant.

- B. Mortars for Setting Stone Masonry: Mortar mixes may change and may require adjustment before and during construction in accordance with pre-construction conformance testing, field-testing, and Architect or Restoration Consultant's evaluation of testing and test results.

1. Mortar for Setting Granite Masonry: Cement, lime, sand mortar. Proportion mortar by volume as follows to achieve a mortar with a minimum compressive strength of 1300 psi at 28 days.
 - a. 1 part by volume white Portland cement (Type I)
 - b. 1 part by volume hydrated lime (Type S)
 - c. 6 parts sand (Selected to match sand in original mortar)
 - d. Oxide pigments as needed to match color of the original mortar in the masonry being set but not to exceed 7 percent of the weight of the cement.

- C. Mortar for Pointing Joints in Stone Masonry: Provide the following mortars. Mortar mixes may change and may require adjustment before and during construction in accordance with preconstruction conformance testing, field-testing, and Architect or Restoration Consultant's

evaluation thereof.

1. Mortar for Pointing Stone Masonry: Cement, lime, sand mortar. Proportion mortar by volume as follows to achieve a mortar with a minimum compressive strength of 610 psi at 28 days.

- a. 1 part by volume white Portland cement, gray Portland cement, or a combination of white and gray Portland cement as required to produce mortar matching color of original mortar.
- b. 1 part by volume hydrated lime (Type S).
- c. 6 parts "00" sand (Selected to match sand in original mortar).
- d. Oxide pigments as needed to match color of the original mortar in the brownstone masonry and in the brick masonry, respectively, but not to exceed 7 percent of the weight of the cement and lime.

- D. Mortars for Setting Dutchmen: Mortar mixes may change and may require adjustment before and during construction in accordance with pre-construction conformance testing, field-testing, and Architect or Restoration Consultant's evaluation of testing and test results.

1. "Thick Set" Mortar for Setting Stone Dutchmen:

- a. 1 part by volume white Portland cement (Type I)
- b. 3 parts fine sand (selected to match color of existing clean stone)
- c. Temper to a workable consistency with Laticrete 3701 polymer admixture, or approved equal, mixed in accordance with manufacturer's recommendations for high strength, "thick set" mortar.
- d. Oxide pigments as required to adjust color of mortar mixed to as close a match to adjacent stone surface as possible using appropriate colored cements and aggregates to match color of adjacent stone surface but not to exceed 7 percent of the weight of the cement.

2.5 MIXING OF MORTARS AND GROUTS

- A. Measuring: Measure mortar and grout ingredients carefully using containers with fixed volumes so that proportions are controlled and maintained throughout the course of the work of this Section.
- B. Mixing Portland Cement Mortars: Mix mortars and grouts in an approved type of power-operated batch mixer. Mix for time required to produce a homogeneous plastic mortar but not be less than five minutes: approximately two minutes for mixing dry materials and not less than three minutes for mixing after water has been added. Do not mix mortars on floors or concrete sidewalks.
- C. Water: Use minimum amount of water to produce a workable consistency for mortar's intended purpose.
 1. Mortar for Pointing: As dry a consistency as will produce a mortar sufficiently plastic to be worked into joints.
 2. Grouts for Injection: Consistency that can be injected to fill voids and losses.
- D. After mixing, mortars for pointing or setting shall sit for 20 minutes prior to use to allow for initial shrinkage. Mortar shall be placed in final position within two hours of mixing. Re-tempering of partially hardened material is not permitted.
- E. Mortar for grout shall be placed in final position within two hours of mixing or within period

recommended by manufacturer of custom products, whichever is less. Re-tempering of partially hardened material is not permitted.

- F. Custom Patching Mortars and Grouts: Mix in strict accordance with manufacturer's written instructions.

2.6 TOOLS FOR JOINT PREPARATION

- A. Hand Tools for Joint Preparation: Chisels, hammers, and mallets.

1. Thickness of Chisels: Chisels used in masonry joints shall have a maximum thickness of 5/8 times joint width extending back from tip of chisel at least two-and-one-half times depth at which chisel will be inserted into joint.
2. Special Tools: Provide special knives or special thin cutter blades for use in joints less than 1/8-inch wide.

- B. Power Tools for Joint Preparation: Standard tools and equipment, modified tools and equipment, and custom designed and fabricated tools and equipment as required to remove mortar from joints without damaging masonry units. Use power tools only under conditions described in Part 3, below and only if specifically approved by Architect or Restoration Consultant. Failure to demonstrate that use of selected power tools removes mortar without damaging masonry units will result in prohibition of use of power tools and requirement that mortar be removed using hand tools only. If, after power tools have been approved for use in removing mortar, masonry units are damaged by the use of power tools, the further use of power tools will be prohibited and mortar shall be removed using hand tools only. Use power tools designed for cutting and grinding that have integrated dust collectors to minimize dust whenever possible.

1. Electric Grinders: Small, hand-held electric grinders with thin diamond or abrasive blades no greater than 1/16 inch thick and a maximum of 4-1/2-inch diameter.
2. Pneumatic Die Grinders: Specially modified pneumatic die grinders with thin diamond abrasive blades (0.060 inch thick). Subject to compliance with requirements, provide wafer blades as manufactured by CDP Diamond Products, Inc., P.O. Box 51727, Livonia, MI 48150 (800-521-0638), or approved equal.
3. Custom Pneumatic Head and Chisels Designed for Mortar Removal: Pneumatic head and thin carbide-tipped chisels specifically designed for removal of mortar from joints in historic masonry with air compressor, hoses, valves, and other equipment required to provide complete mortar removal system. Pneumatic head shall not have a retainer to hold chisels in place. Provide pneumatic head and chisels by Trow and Holden, 45 S. Main St., Barre, VT 05641 (800-451-4349), or approved equal.
 - a. Chisels for Use in Narrow Joints: Use custom ground thin carbide-tipped chisels for mortar removal from narrow joints.
4. Reciprocating Brick and Mortar Saw (Joints at Least 3/8-Inch Wide): Custom saw designed for removing mortar from joints in masonry with paired blades that have an orbiting movement providing both hammering and cutting action and that are designed for making plunge cuts and cutting square corners in masonry joints without overcutting. Provide Arbortech AS170 Brick and Mortar Saw, manufactured by Arbortech USA, 80 Erdman Way, Suite 200, Leominster, MA 01453 (866-517-7869), or approved equal.
5. Hand-Held Multipurpose Oscillating Tool with Diamond Blade: Multipurpose oscillating tool with thin diamond blade not exceeding 3/4 times width of joints designed for removal of grout and mortar. Provide Fein MultiMaster, manufactured by Fein Power Tools, Inc., 1030 Alcon Street, Pittsburgh, PA 15220 (877-771-0088); Dremel Multi-Max, manufactured by Dremel, 4915 21st St., Racine, WI 53406 (800-437-3635); Bosch Multi-

Tool, manufactured by Robert Bosch Tool Corp., 1800 W. Central Rd., Mount Prospect, IL 60056 (224-232-2000); or approved equal, with appropriate diamond blades.

2.7 MISCELLANEOUS MATERIALS AND EQUIPMENT

- A. Elastomeric Sealant for General Use: Medium modulus, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Uses Related to Exposure NT, Uses Related to Joint Substrates M and O, complying with ASTM C 719 requirements for ± 50 percent movement capability, designed to reduce residue rundown and substrate staining. Provide Dow Corning 756 SMS Silicone Building Sealant-H.P. as manufactured by Dow Corning Corporation, Corporate Center, P.O. Box 994, Midland, MI 48686 (989-496-4400), or approved equal.
 - 1. Color: Provide color selected by Architect or Restoration Consultant from full line of manufacturer's standard colors. Colors will not necessarily be limited to manufacturer's standard colors.
- C. Pointing Trowels: Long, thin pointing trowels narrower than joints being pointed.
 - 1. Fabricate special custom trowels for masonry pointing as necessary to ensure proper insertion and optimum compaction of mortar in thin joints.

PART 3 – EXECUTION

3.1 GENERAL PREPARATION

- A. Examination: Examine areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of work. Do not proceed until unsatisfactory conditions have been corrected.
- B. Protection: Erect dust impervious barriers and take other measures necessary to prevent dust from traveling beyond work platform before using power grinders, pneumatic chisels, other power tools, or hand methods that generate airborne dust.

3.2 MORTAR APPLICATION

- A. Wetting: Thoroughly drench masonry with water 24 hours prior to pointing joints. Thoroughly wet masonry again immediately before pointing joints and allow surfaces to dry slightly. At time of masonry pointing, surfaces shall be damp, so that they do not rapidly absorb moisture, but free of standing water (saturated, surface dry).
 - 1. Failure to Properly Wet Substrate: Evidence that masonry to be pointed has not been properly dampened to prevent water in the mortar from being too rapidly absorbed by the masonry will be cause for Architect or Restoration Consultant to reject pointing work. Remove rejected pointing, properly prepare joints for pointing, and provide new mortar to meet requirements of this Section at no additional cost to Owner.
- B. Masonry Pointing: Point joints as follows.
 - 1. Using a long, thin masonry pointing trowel, tightly pack mortar into joints in layers not exceeding 1/4-inch thick to fill joint to match original sound joints.
 - 2. Begin by filling areas from which mortar is missing to a depth greater than 3/4 inch in 3/8-inch-thick layers to within 3/4 inch of finished joint surface to provide a uniform substrate for final masonry pointing. Fill final 3/4-inch depth of joint continuously and uniformly in 1/4-inch-thick layers.

- a. Joints to Be Deep Pointed: Install mortar to fill portions of joints more than 2 inches behind finished joint surface in layers not exceeding 1-inch thick. Fill portions of joint between 3/4 inches behind the finished joint surface and 2 inches behind the finished joint surface in 3/8-inch-thick layers to provide a uniform substrate for final masonry pointing. Fill final 3/4-inch depth of joint continuously and uniformly in 1/4-inch-thick layers.
3. Firmly iron each layer to compact mortar and ensure full bond between mortar and masonry units and a firm, solid joint.
4. Allow each layer to reach leather hardness before applying succeeding layer. Do not let previous layer dry out before applying succeeding layer. Construct uniform joints.
5. Do not spread mortar over edges onto exposed surfaces of masonry units. Do not feather edge mortar.
6. When stopping work at end of each day or for other reasons, stagger layers of mortar so that there will be no through joints in mortar inserted into joints. Stagger joints in layers so that they are at least 3 inches from each other.
7. Where applying new work to that of a prior day, dampen previous work to ensure good bond.

3.3 JOINT TOOLING

- A. Tooling: After final layer of mortar is "leather hard," tool joints with a flat rule jointer, or as directed by Architect or Restoration Consultant.
- B. Profile: Tool joints to profile as shown on Drawings or to match original joint profiles as directed by Architect or Restoration Consultant. Solidly compress mortar so that it adheres well to masonry on both sides and forms a dense surface. Premature or late tooling will result in unacceptable finishes, which will be rejected.

3.4 CURING

- A. Keep newly pointed joints damp for at least 72 hours after mortar has been inserted. Do not apply a direct stream of water to joints for at least 7 days after mortar has been placed.
- B. Ensure masonry temperature remains as required by specifications until mortar is thoroughly cured.

3.5 CLEANING AND REPAIR OF MORTAR JOINTS

- A. Water Washing: Wash pointed masonry with clean filtered water and nonabrasive hand tools to remove mortar debris from masonry surfaces. Do not use chemical cleaners.
 1. Wash within 72 hours after completion of masonry pointing.
 2. Use blunt-edged wood scrapers, soft natural bristle brushes, and rough towels along with water to remove mortar debris. Do not use wire brushes. Do not scratch joint surfaces.
 3. Stop cleaning masonry unit surfaces free of misapplied mortar if methods and materials used damage pointed joints. Do not resume cleaning masonry free of misapplied mortar until methods and materials have been changed to avoid damage to mortar in joints.
- B. Repair of Pointed Joints: As cleaning progresses, examine joints to locate cracks, holes, and other defects. Carefully point up and fill such defects with mortar. Where joints are defective in opinion of Architect or Restoration Consultant cut out joints to minimum depth of 3/4 inch, or two-and-one-half times joint width, whichever is greater; properly prepare joint substrates; and provide new pointing mortar exercising extreme care to ensure that color matches that of adjacent

masonry pointing work. Exposed joint surfaces shall be free from protruding mortar, holes, pits, depressions, and other defects.

3.6 CORRECTIVE MEASURES

- A. Correcting Unacceptable Joints: Should a crack occur in any joint surface, should mortar separate from a masonry unit, indicating that it did not form a strong mechanical and chemical bond with the unit, or should Architect or Restoration Consultant determine that for another reason masonry pointing work does not equal or exceed the minimum standard established by the approved mock-up, remove mortar to a minimum depth of 3/4 inch, properly prepare joint substrates, and repoint following requirements of this Section to Architect or Restoration Consultant's satisfaction at no additional cost. At completion of work of this Section, joints shall be full of mortar soundly adhered to surfaces of masonry units at sides of joints and without defects.
- B. Repairing Damage: Repair damaged and deteriorated masonry resulting from work of this Section by patching damaged masonry units and/or replacing damaged masonry units to match original units to the satisfaction of the Architect or Restoration Consultant at no additional cost to Owner.

END OF SECTION
04 05 13

This Page Intentionally
Not Used

SECTION 05 01 70 – CONSERVATION and MAINTENANCE OF DECORATIVE METALS

PART 1 - GENERAL

1.1 REFERENCE

- A. Ray Dunetz Landscape Architecture, Inc. A Master Conservation Plan for Lincoln Square and Bronze Flagpole Base for Lincoln Square and Related Metal Components in Worcester, MA.
- B. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 DEFINITIONS

- A. "RMC" Reviewing Metals Conservator
- B. "CC" = Contract Conservator, the conservator or team of conservators chosen to work on the Bronze Flagpole Base and Bronze eagle, and one Dedicatory Bronze Plaques on the Exterior Wall.
- C. "CM" = Construction Manager
- D. "GC" = General or Prime Contractor
- E. "Conservation" refers to examination, and research to determine the original structure, materials, and extent of loss or fragility of an object as well as its documentation and treatment. The term also encompasses preventive measures taken to retard future deterioration.
- F. "Flagpole Base" and "Eagle Sculpture" refers to the Gilt Bronze Base and the Eagle Sculpture designed by sculptor Paul Jennewin in 1931. Note that the Flagpole base includes the top stylized "flame" element, currently painted a dark green-brown.
- G. "Dedicatory Plaque" refers to the bronze plaque on the exterior wall of the Memorial dating to 1933.
- H. "Bronze Stars" and "Two Bronze Cleats" refer to the Gilded Bronze Stars on the upper areas of the granite base and the Flagpole Base Cleats to secure flagpole lines to the Granite Base.
- I. "Memorial" refers to the entire Lincoln Square Memorial, including all stone, brick and metal parts.
- J. PR=proper right – the right as if the viewer were the object; PL = proper left – left as if the viewer were the object.
- K. BT, DT, AT = Before Treatment, During Treatment, After Treatment

1.3 SECTION INCLUDES

- A. Written and digital image documentation before, during and after treatment for the Gilt Bronze Base, the Gilt Bronze Eagle Sculpture, the Plaque, the Thirteen Gilt Bronze Stars, and the Two Bronze Cleats. See PART 4 for details.
- B. Examination, Analysis and Treatment of all bronze components.

- C. Scaffolding of the Flagpole Base.
- D. Protection of the Surfaces of the Flagpole Base, Thirteen Gilt Bronze Stars, Two Bronze Cleats, Eagle Sculpture, and Plaque throughout the Lincoln Square rehabilitation project.
- E. Protection of the Flagpole Base, Thirteen Gilt Bronze Stars, Two Bronze Cleats, Eagle Sculpture, and Plaque throughout the Lincoln Square rehabilitation project.
- F. Storage of the metal plaque and eagle.

PART 2 - QUALITY ASSURANCES – (PROVIDE WITH THE BID)

2.1. QUALIFICATIONS

- A. Contracted Bronze Conservator(s) (CC):
- B. Scaffold Subcontractor:
 - 1. CC shall identify and recommend scaffold erection companies to the GC, who are qualified to undertake the construction of the temporary scaffolding around the Flagpole Base.
 - 2. The CC shall submit resumes, references for each subcontracting firm employed in the conservation of the Relief. Submittal shall include at least five (5) examples of projects similar in scope and importance to the work of the Flagpole Base and all other bronze components. Project references shall include name and date of execution of each project as well as the names and telephone numbers or emails of references for each of the five (5) projects.
 - 3. CC and GC shall be responsible for seeing that subcontracting firms follow the American Institute for Conservation (AIC) Code of Ethics and Guidelines for Practice and the Secretary of the Interior's Standards for the Treatment of Historic Properties.

PART 3 - PROTECTION OF THE GILT BRONZE FLAGPOLE BASE, THIRTEEN GILT BRONZE STARS, TWO BRONZE CLEATS, GILT BRONZE EAGLE SCULPTURE AND PLAQUE THROUGHOUT THE WORK PERIOD

3.1

- A. Scaffolding
The GC will be responsible for erecting the scaffolding needed for work on the Flagpole Base. The CC will work closely with the GC and the stone conservator(s) to decide on the optimal location and design for setting up the scaffolding around the Flagpole Base. This includes determining the most effective way to access and work from the scaffold to carry out the necessary tasks. Importantly, the scaffolding must not make direct contact with any part of the Gilded Bronze Flagpole Base. Additionally, it must allow access to the Thirteen Gilt Bronze Stars.
- B. Protection of the Surfaces of the Gilt Bronze
The surfaces of the Gilt Bronze components and the Plaque shall always be protected from contact with dirt, air pollution, dust, mortar and stone or other abrasive dust, chemical stone cleaners, and all other potentially damaging materials or activities. The CC shall provide a written plan and drawing to the RMC for approval showing how this protection will be achieved in a non-damaging, reversible manner.
- C. Protection of all Bronze components from structural damage
The CC shall likewise provide a written plan and drawing to the RMC and CM for approval showing how the Gilt Bronze Base, the Gilt Bronze Eagle Sculpture, the Plaque, the Thirteen

Gilt Bronze Stars, and the Two Bronze Cleats shall be protected from potential *structural* damage in a non-damaging, reversible manner. This work shall be done in collaboration with the GC to determine the best manner of providing protection to the Flagpole Base. Typical damages to avoid are abrasions, dents, fracturing or breaking of the bronze by impact with equipment, tools, heavy supplies, or scaffolding. The GC shall be responsible for constructing and providing protection as required.

- G. Right to stop potentially dangerous work.
The CM, RMC and/or the CC shall have oversight of all aspects of the restoration of the Flagpole Base and all other components including the ability to stop the work of the other trades at hand if it is at any time considered dangerous to the well-being of the Flagpole Base, Sculpture, Decorative Bronze Elements, or Plaques.

3.2 WORK SITE CONDITIONS

- A. The CC will be responsible for maintaining high quality standards of care throughout the project. The work of re-gilding in place requires a dry, low air movement, and dust-free environment. This will require temporary installation of a tent around the Flagpole Base or other mitigation.
- B. The CC and technicians shall wear protective clothing and masks suitable for use with solvent-based materials when this work is required. They shall follow OSHA requirements.
- C. All equipment, materials and debris caused by the work of this section shall be removed and the site left in clean condition insofar as this work is concerned at the end of the day.

3.3 INSPECTION BY OWNER AND OWNER'S REPRESENTATIVE.

- A. The work of conservation will be open to inspection by the RMC, the CM and other representatives of the Owner as the Owner determines. It is recommended that at least a day's notice be given to the CC prior to inspections in order that the work underway is not adversely affected.

3.4 COMMUNICATIONS

- A. The CC shall present all notices, demands, requests, instructions, approvals, proposals and claims in writing or by email to the CM and RMC, requesting a confirmation response from the parties involved.

PART 4 SUBMITTALS

4.1 SUBMIT TO THE RMC THE FOLLOWING PRIOR TO COMMENCING ANY OPERATIONS OR ORDERING ANY MATERIAL IN BULK:

- A. A written proposal outlining each phase or process of the proposed conservation treatment program for each of the pieces to be conserved: Protection of the Surfaces of the Flagpole Base, Thirteen Gilt Bronze Stars, Two Bronze Cleats, Eagle Sculpture, and Plaque throughout the Lincoln Square rehabilitation project.
- B. A complete list of the product materials proposed for use on the Flagpole Base and all other bronze components and the planned method of use. Provide name, product name and material safety data sheets (MSDS) for each material. Provide manufacturer's technical data sheets for each product giving descriptive data, curing time if any, mixing if required, thinning and application instructions, and shelf life. Submit evidence that product materials to be used are within the manufacturer's expiration date or viability recommendations.

- C. Mockups for Treatment of the Flagpole Base, other Gilt Components and Dedication Plaque
 - 1. Mockup of Gilding samples to be carried out on 12" x 12" minimum 24 gauge metal sheet (brass, an alloy of copper, tin, and zinc, OR aluminum sheet may be used instead of bronze sheet).
 - a. Mockup to include DTM Primer in yellow, mordant gilding, and two layers of 21 gram 23.75K gold leaf.
 - 2. Mockup of Repatination color on Bronze Plaque can be done in situ with hot or cold patina, (with some preference for cold to reduce stone breakage or staining). The cold patina can be applied using Golden MSA resin in Raw Umber mixed with a small amount of (see other monuments in Worcester patinated with this technique:
 - a. Mockup to include replacement corner rosettes in cast bronze.

PART 5 DIGITAL PHOTODOCUMENTATION

5.1 DOCUMENTATION OF THE STAGES OF TREATMENT

- A. The digital images shall be documented in a clear and readable fashion before treatment, during treatment as needed to understand the progression of the project, and after treatment. The Gilt Bronze Base, the Gilt Bronze Eagle Sculpture, the Plaque, the Thirteen Gilt Bronze Stars, and the Two Bronze Cleats shall be digitally photographed on all sides as necessary to understand the condition of the work.
- B. The CC shall document the work using a digital camera with a minimum resolution of 244 dpi output size of 10-20MB.
- C. The general overview digital images shall include a Tiffen, Calibrite, or other photographic color scale and a measurement scale.
- D. All other images do not require a color scale. Each digital image should be labeled with a description and the condition status (BT, DT, or AT). DT images and detail photos are encouraged.

5.2 LABELING and SUBMITTAL OF THE DIGITAL IMAGES

- A. All images should be downloaded and individually labeled, grouped in separate digital photos for electronic submission.
- B. File names of the images shall include a description of work shown, location description by N, S, E, and W as needed, and using Proper Left (PL), or Proper Right (PR) as needed. Each image should then be labeled as BT, DT, or AT. Commas should not be used but should be replaced with an underline. As examples: "Plaque_W_PL_Missing Rosette_BT", or "Flagpole Base_W_Cleaning with Enzyme_DT".
- C. All images should be submitted electronically in three parts, before, during, and after treatment, via DropBox, WeTransfer, or other means acceptable to the GC.

5.3 PRINTED COPIES

- A. No printed copies are required.

PART 6 WRITTEN DOCUMENTATION

6.1 CONDITION REPORT

- A. The Condition Report shall include the name, title, maker, location, date, sources of historic information and comparable work by the same artist, materials, and condition descriptions of all bronze components of the Lincoln Square Project, including the Gilt Bronze Base, the Gilt Bronze Eagle Sculpture, the Plaque, the Thirteen Gilt Bronze Stars, the Two Bronze Cleats, and the Dedicatory Plaque.
- B. Sketches (hand-drawn and scanned or produced electronically) are encouraged to show previous damage or loss, or digital images with annotations.

6.2 TESTS AND ANALYSIS

- A. No analytical tests are currently required. As the work progresses, there may be some need to analyze or identify materials, such as information on gilding layers or identification of epoxy fills on the Gilded Bronze Eagle.

6.3 TREATMENT PROPOSAL

- A. The Treatment Proposal shall contain the Project Title, location, list of objects to be conserved, date of the proposal, name of the CC and include the stages proposed for conservation for each gilded bronze component and the Plaque. The proposal should include Material Safety Data Sheets (MSDS) and pertinent manufacturer's technical information including directions for application for all materials proposed for use.
- B. The treatment proposal should include, but is not necessarily be limited to the following:
- C. Cleaning methods for each component: Gilt Bronze Base, the Gilt Bronze Eagle Sculpture, the Plaque, the Thirteen Gilt Bronze Stars, the Two Bronze Cleats, and the Dedicatory Plaque.
 - 1. An enzyme digester as the first step of cleaning to remove bio-matter or biological growth for preliminary cleaning using a sustainable and environmentally safe treatment. This treatment will remove vestiges of bird droppings, urine, or bio-growth.
 - 2. Further Cleaning method(s) on all bronze components to remove superficial dirt, particulate, or soiling to include pH-neutral anionic detergent.
 - 3. Reduce loose corrosion using soft nylon bristle scrub brushes, nylon pads, or soft wood or plastic tools followed by a repeated washing with the pH neutral anionic detergent.
 - 4. Solvents in small containers should be used to remove any previous wax or coatings. Mineral spirits or naphtha may be used.
- D. Preparation for gilded components:
 - 1. Fill any small losses in bronzes with an epoxy filler, and smooth or sand surface.
 - 2. For all gilt bronze, apply a primer Direct to Metal (DTM) paint before gold leaf.
- E. Treatment of bronze plaque:

1. Clean as described.
2. For a cold patina, apply translucent application of thinned Golden MSA color Raw Umber 350 and a small amount of MSA color Burnt Umber 030 by brush.
3. For missing plaque rosettes: purchase new round metal rosettes online or by casting new rosettes. An acanthus style is appropriate, 1 ½" in width. Attach by drilling and pinning the rosettes into the existing drill holes, using a small amount of epoxy in the drill holes. Tone with MSA color to match.
4. For Bronze Plaque protective coating, wax surface with Butchers Bowling Alley Paste Wax™ and buff with soft lint-free cloths, shoe brushes, or nylon fabric to a soft gloss finish.

F. Treatment of Eagle Sculpture:

1. GC will remove eagle, hollow brass sphere, and brass tube from top of current pole.
2. Clean as described for all metal components.
3. Reshape or smooth old epoxy fills for a more even profile. Fill losses as needed with epoxy.
4. Apply gold leaf as described and make a new mechanical attachment plan with GC.

G. Two bronze cleats:

1. Clean as described above.
2. Wax surfaces with Butchers Bowling Alley Paste Wax™ and buff with soft lint-free cloths, shoe brushes, or nylon fabric to a soft gloss finish.
3. Apply second coat of wax and buff.

6.1 SUBMISSION OF THE CONDITION REPORT AND TREATMENT PROPOSAL

- A. The CC shall deliver electronic versions of the condition report and treatment proposal to the Ray Dunetz Landscape Architecture Inc., the RMC, and CM.

6.2 APPROVAL

The RMC shall approve the Condition Report, Treatment Proposal and Before Treatment photo-documentation prior to commencement of the treatment. Only work that the RMC has clearly authorized by signing off on the proposal shall proceed.

6.3 TREATMENT REPORT

- A. The Treatment Report shall contain the identifying information, dates of treatment, materials and methods used in treatment, an overall summary of the treatment with rationale for the treatment chosen and information regarding any unforeseen changes in condition or discoveries that occurred throughout the project. The treatment report should also include all digital images for each component labeled as described in Section 5.2.

PART 7 ALTERNATIVES

7.1 ALTERNATIVE METHODS AND MATERIALS

Ray Dunetz Landscape Architecture, Inc. Conservation and Maintenance of Decorative Metals
05 01 70-6

- A. If alternative methods and materials to those indicated are proposed for any phase of work, provide a written description including evidence of successful use on other comparable projects, and a program of testing to demonstrate its effectiveness for use on this Project.

PART 8 QUALITIES AND ASSURANCES:

8.1 PRODUCTS-GENERAL USAGE

- A. The CC shall keep MSDS sheets and technical information on the materials used in treatment available to the RMC throughout the treatment. At the conclusion of the treatment, the technical information shall be compiled into the final report. Technical information shall identify the materials used in treatment, their chemical names, what other names the product may go by, who manufactured the products and when they were procured, who was the distributor and their contact information.

8.2 MATERIALS

- A. All products shall be utilized in accordance with manufacturer's directions and within the expiration date or the manufacturer's suggested period of viability.
- B. All products should include on the label of their containers: manufacturer's name, type of product, manufacturer's stock number, color if applicable, batch number, instructions for diluting or removing where applicable, and ingredients or analysis. Product containers not displaying manufacturer's product identification will not be acceptable.
- C. Provide the manufacturer's best quality trade sale material of the various product types specified.
- D. Provide evidence that the materials to be used in conjunction with the Bas Relief and Plaques will not corrode the metal or otherwise impact it in any adverse way.
- E. Provide products that comply with all state and local regulations including VOC/VOS rules at the time of application.
- F. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating system can be applied.
- G. Apply solvent thinned paints or coatings only when the temperature of surfaces to be covered and surrounding air temperatures are between 55 degrees F [7 degrees C] and 85 degrees F [35 degrees C]. Do not apply paint or coatings when the relative humidity exceeds 70 percent.
- H. Apply protective coatings to Bronze Plaque only when work areas are free of airborne dust at the time of application and throughout the drying period.

8.3 PRODUCTS

- A. The following materials are approved for the treatment of the Lincoln Square Bronze Components:
 - 1. Water: Clean, potable water.
 - 2. Nilodor Bio-Enzymatic Urine Digester (Nilodor or UnoClean).
 - 3. Orvus WA by Proctor and Gamble, anionic, neutral pH detergent, followed by rinsing with clean potable water and with immediate drying of the metal to avoid corrosion.

4. 3M Scotch-Brite Non-Scratch Scrub Sponges.
5. Scrub brushes from an auto supply store (blue color with soft bristles) or soft bristled kitchen scrub brushes.
6. Cold patina colors in thin transparent layers using custom color formulation: GoldenMSA color Raw Umber 350, a small amount of MSA color Burnt Umber 030, thinned with MSA Gloss Varnish and Golden MSA Solvent (Talas Online).
7. Solvents: acetone, naphtha, mineral spirits, denatured alcohol, Golden MSA Solvent.
8. For hot patina if used: Ferric Nitrate and Potassium Permanganate, Chemical Reagent Grade.
9. Butcher's Bowling Alley Paste Wax (microcrystalline wax from BWC company) for bronze plaque. DO NOT wax restored gilding.

B. Fill Materials For Bronze:

1. PC-7 Epoxy: two-part slow curing epoxy putty for use with metals, exterior grade, high viscosity, highest quality, good stability, non- yellowing, not prone to cracking or failure, machinable and sandable. May be smoothed before curing with water, may be tinted with dry pigments, long history of use on historic outdoor bronze sculptures. Available at hardware stores or online.
2. Apoxie Sculpt, two-part slow curing epoxy putty or approved equivalent for use with metals, exterior grade, highest quality with good weathering properties, good stability, non-yellowing, not prone to cracking or failure, machinable and sandable. Available from Aves Studio; contact: avesstudio.com

C. Gilding Mordant and Gold-leaf for Bronze Flagpole Base and Eagle sculpture:

1. DTM acrylic paint in yellow color as primer: Benjamin Moore Ultra-Spec Low Lustre Acrylic Enamel in yellow (color TBD on site).
2. Mordant: Manetti 12 hour slow set oil size. Available from SEPP Gold Leaf in New York, seppleaf.com/or other gold leaf suppliers. Manetti 3 hour quick set oil size may be used for touch up areas.
3. Gold leaf: "Double" 22g gold leaf in 23.75 karat. Available from SEPP Gold Leaf in New York, seppleaf.com/or other gold leaf suppliers. No substitutions for other karats or other alloys. Apply TWO layers of gold leaf.

D. Replacement of 5 missing stars

1. Remove one original star from Flagpole Base and cast 5 replicas in Everdur Silicone Bronze alloy.
2. Gild as for Bronze Flagpole Base.

PART 9 QUALITY CONTROL

- A. The RMC reserves the right to test or contract an appropriate testing laboratory to confirm that products used on the Bronze Components conform to those specified

herein. If test results show material being used does not comply with specified requirements, the CC may be directed to stop work, remove the noncomplying product, pay for testing, and undertake retreatment or other remedies to bring the work in-to conformity with specifications.

- B. PROJECT STANDARDS: All work must comply with the U.S. Secretary of the Interior's Standards for the Treatment of Historic Properties and adhere to the Code of Ethics established by the American Institute for Conservation of Historic and Artistic Works (AICHAW).

PART 10 REMOVAL AND STORAGE

- A. The CC shall remove the fluted granite base in accordance with Section 02 41 91, SELECTIVE REMOVAL AND SALVAGE OF HISTORIC MATERIALS. The gilded bronze base shall remain attached during removal and storage. The CC shall keep the granite base as vertical as possible during removal. Straps should be padded in accordance with the Masonry Restoration Specialists recommendations.
- B. EAGLE REMOVAL. The CC shall cut the copper alloy tube on which the eagle is installed. The cut shall be 4" below the gilded copper sphere., keeping the eagle and sphere as one unit.
- C. BRONZE PLAQUE – The CC shall mechanically remove the fastener screws under the rosettes.
- D. STORAGE
1. The removed plaque and the removed eagle should be stored separately in wooden crates large enough to accommodate each piece. The crates should be made of 1/2" marine -grade plywood or 3/4" MDO board with lumber battens, using foam (expanded polyethylene) for cushioning. A photograph of each element shall be on the exterior of the wooden crate with the contents clearly labeled.
 2. Wooden crates shall be from one of the following, or approved equal:
 - a. Crozier Fine Arts, Wilmington, MA
 - b. USArt, Randolph, MA
 - c. Maquette, Boston
 - d. RC Mason, Peabody

END OF SECTION
05 01 70

This Page Intentionally
Not Used

SECTION 055001 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 SUMMARY

- A. Provide miscellaneous metal fabrication work, as indicated on Drawings and as specified herein. Include, but do not limit to:
 - 1. Miscellaneous connections and fasteners for metal fencing.
 - 2. Miscellaneous connections and fasteners for reinstalling the restored flagpole and attaching the restored eagle statuary.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that relate directly to work of this Section include, but are not limited to the following:
 - 1. Section 033000 - CAST-IN-PLACE CONCRETE.
 - 2. Section 050170 – CONSERVATION AND MAINTENANCE OF DECORATIVE METALS.
 - 3. Section 323113 - CONCRETE PAVEMENT
 - 4. Section 323119 – ORNAMENTAL METAL FENCE.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.
- B. Shop Drawings: Provide large scale shop drawings for fabrication, installation and erection of all parts of the custom fabricated steel work. Provide installation templates for work installed by others. Show all interfaces and relationships to work of other trades.
- C. Field Measurements: Take all necessary field measurements before preparation of shop drawings and fabrication. Do not delay progress of the job. If field measurements are not possible prior to fabrication, allow for field cutting and fitting.
- D. Initial Selection Samples: Submit samples showing complete range of colors, textures, and finishes available for each shop finished material used.
- E. Verification Samples: Submit representative samples of each shop finished material that is to be exposed in the completed work. Show full color ranges and finish variations expected. Provide samples having minimum size of 144 sq. in.
- F. Welders Certification: Provide certifications, signed by Contractor, certifying that welders

employed at project comply with requirements specified under AWS D1.1, AWS D1.3 and AWS D1.6.

1.5 GENERAL REQUIREMENTS

- A. The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1/D1.1M. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M, ASTM A 653/A 653M, or ASTM A 924/A 924M, as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

1.6 WORKMANSHIP

- A. Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Exposed connections of work in place shall not be tack welded. Exposed welds shall be ground smooth. Exposed surfaces of work in place shall have a smooth finish, and unless otherwise approved, exposed riveting shall be flush. Where tight fits are required, joints shall be milled. Corner joints shall be coped or mitered, well formed, and in true alignment. Work shall be accurately set to established lines and elevations and securely fastened in place. Installation shall be in accordance with manufacturer's installation instructions and approved drawings, cuts, and details.

1.7 QUALITY ASSURANCE

- A. Engineering: Provide services of a professional engineer, registered in Commonwealth of Massachusetts, to design and certify that work of this Section meets or exceeds performance requirements specified.
- B. Shop fabricate work to greatest extent possible. Label each piece in shop to facilitate field assembly.
- C. Welding: Perform welding in conformance with AWS D1.1 and D1.3. as applicable.
- D. Installer Qualifications: Arrange for installation of ornamental metal specified in this Section by the same firm that fabricated it.
- E. Fabricator Qualifications: A firm experienced in producing ornamental metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- F. Welding: Qualify procedures and personnel according to the following:

- 1. AWS D1.1, "Structural Welding Code – Steel", D1.3, "Structural Welding Code - Sheet

Steel" and AWS D1.6, "Structural Welding Code - Stainless Steel."

- G. Shop fabricate work to the greatest extent possible. Clearly label pieces in shop to facilitate field assembly.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Store work off of the ground and under cover. Protect from damage. Maintain shop applied coatings until installation is complete. Sequence deliveries to avoid delays, but minimize on-site storage.

1.9 PERFORMANCE REQUIREMENTS

- A. Thermal Movement: Design and engineer work of this section which allows for expansion and contraction throughout ambient temperature range of 120°F.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. General: Provide products and materials of new stock, free from defects, and of best commercial quality for each intended purpose.
- B. Steel Plates, Shapes, and Bars: ASTM A 36.
- C. Steel Tubing: ASTM A 500 or A 501, hot or cold rolled, as required for design loading.
- D. Steel Pipe: ASTM A 53, schedule 40, Type S (seamless), black except where galvanized is indicated, Grade A for cold-bending.
- E. Steel Sheet: ASTM A 366, A 570, or A 611, grade required for design loading.

2.2 STAINLESS STEEL

- A. Stainless Steel:
 - 1. Castings: ASTM A 743/A 743M, Grade CF 8M or CF 3M.
 - 2. Sheet, Strip, Plate, and Flat Bar: ASTM A 666, Type 316.
 - 3. Bars and Shapes: ASTM A 276, Type 316.
 - 4. Pipe: ASTM A 312, Type 316 stainless steel.

2.3 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:
 - 1. Stainless-Steel Items: Type 316 stainless-steel fasteners.
 - 2. Dissimilar Metals: Type 316 stainless-steel fasteners.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts

and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 2 (A4).

- D. Anchor Bolts: ASTM F 1554, Grade 36.
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- E. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
- F. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
- G. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).
- H. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.
- I. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Exterior Locations: Alloy Group [1 (A1)] [2 (A4)] stainless-steel bolts complying with ASTM F 593 (ASTM F 738M) and nuts complying with ASTM F 594 (ASTM F 836M).
- J. Provide anchors, bolts, sockets, sleeves, and other parts required for securing each item of work to other construction. Furnish inserts and sleeves to be set into concrete formwork and concrete.
 - 1. Anchor bolts, bolts smaller than 5/8 in., and fasteners shall be steel castings conforming to ASTM A 307. Bolts larger than 5/8 in. shall conform to ASTM A 325.
- K. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
- L. Provide concealed fasteners for interconnecting components and for attaching ornamental metal items to other work, unless otherwise indicated.
 - 1. Provide tamper-resistant flat-head machine screws for exposed fasteners, unless otherwise indicated.
- M. Grout for Exterior Applications: Provide Factory-packaged, non-shrink, non-staining, hydraulic controlled expansion cement formulation for mixing with water at project site. Provide formulation that is resistant to erosion from water exposure without need for protection by a sealer or waterproof coating. Provide Super Por-Rok, Erosion-Resistant

Anchoring Cement, manufactured by Minwax Construction Products Division, or equal as approved by Architect.

- N. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.4 FABRICATION, GENERAL

- A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces. Fabricate work to be truly straight, plumb, level and square and to sizes, shapes, and profiles indicated on approved shop drawings. Ease exposed edges. Cut, reinforce, drill and tap metalwork as necessary for proper assembly and use.
1. Fabricate all miscellaneous metal supports, brackets, braces and the like required to fully complete the work of this Section.
 2. Coordinate with work of other Specification Sections to ensure proper interface of various parts of the work.
 3. Obtain loading requirements from suppliers of work to be supported and design and fabricate support systems with factor of safety of at least 6.
- B. Form metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris. Take special care in choosing materials that are smooth and free of blemishes such as pits, roller marks, trade names, scale and roughness. Fabricate work with uniform, hairline tight joints. Form welded joints and seams continuously and grind flush and smooth. For exposed fasteners, use hex head bolts or Phillips head machine screws.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form simple and compound curves in bars and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
- E. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm), unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- F. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
- G. Provide weep holes where water may accumulate.
- H. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items, unless otherwise indicated.
- I. Comply with AWS for recommended practices in shop welding. Weld behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded joints of flux, and dress exposed and contact surfaces.

- J. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

2.5 GALVANIZED STEEL FINISHES

A. Galvanizing:

1. Ferrous metal under this Section for exterior use shall be hot-dip galvanized, including all bolts, nuts, washers, and other related ferrous metal items used therewith.
2. Hot-dip galvanizing process shall comply with ASTM A 123, A 153, A 385, and A 386, as applicable. After galvanizing, processed items shall be straightened to remove all warpage and distortion caused by the process.
3. Furnish to the Contractor, with copy to Architect, a certified statement that galvanizing complies fully with this Specification.

2.6 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Finish: Directional Satin Finish No. 4. Bollard finish shall match approved mockup.
- C. When finishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fabricated metal.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Provide anchorage devices and fasteners where needed to secure ornamental metal to in-place construction.
- B. Perform cutting, drilling, and fitting required to install ornamental metal. Set products accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of ornamental metal, restore finishes to eliminate evidence of such corrective work.
- D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or

provide new units as required.

- E. Install joint fillers as work progresses.
- F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
 - 1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude non uniform oxidation and discoloration.
- G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding, for appearance and quality of welds, and for methods used in correcting welding work. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent surfaces.
- H. Field Brazing: Comply with applicable AWS specification for procedures, appearance and quality of brazing, and methods used in correcting brazing work. Braze connections that are not to be left as exposed joints but cannot be shop brazed because of shipping size limitations. Grind exposed brazed joints smooth and restore finish to match finish of adjacent surfaces.
- I. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.3 INSTALLATION

- A. Miscellaneous Bearing and Leveling Plates: Clean concrete and masonry surfaces of bond reducing materials. Roughen surfaces if required to improve bond to surface. Clean bottom surface of leveling plates immediately prior to installation.
- B. Miscellaneous Items: Carefully review Drawings for miscellaneous metal items required by various trades but not specifically listed above, such as miscellaneous clip angles, miscellaneous steel bracketing, and other miscellaneous metal items as indicated on Drawings, reasonably implied therefrom, or reasonably necessary for thorough completion of work.

3.4 TOLERANCES

- A. The following allowable installed tolerances are allowable variations from locations and dimensions indicated by the Contract Document and shall not be added to allowable tolerances indicated for other work.
 - 1. Allowable Variation from True Plumb: $\pm 1/8$ in. in 20 ft. - 0 in.
 - 2. Allowable Variation from True Level: $\pm 1/8$ in. in 20 ft. - 0 in.
 - 3. Allowable Variation from True Line: $\pm 1/8$ in. in 20 ft. - 0 in.

3.5 CLEANING

- A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft, non-abrasive cloths.

3.6 PROTECTION

- A. Protect finishes of metal from damage during construction period with temporary protective coverings approved by metal fabricator. Remove protective covering at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION
05 50 01

SECTION 07 11 13 – BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Cold-applied, emulsified-asphalt dampproofing applied to the following surfaces:
 - a. Exterior, below-grade surfaces of concrete foundation walls.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 03 30 00 – CAST-IN-PLACE CONCRETE

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.
- B. Material Certificates: For each product, signed by manufacturers.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.5 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit asphalt dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. BASF Building Systems.
 - 2. Euclid Chemical Company.
 - 3. Henry Company.
 - 4. Karnak Corporation.
 - 5. Meadows, W. R., Inc.
 - 6. Tremco Inc.

2.2 BITUMINOUS DAMPPROOFING

- A. Cold-Applied, Emulsified-Asphalt Dampproofing, Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

2.3 MISCELLANEOUS MATERIALS

- A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
- B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
- C. Patching Compound: Manufacturer's fibered mastic of type recommended by dampproofing manufacturer.
- D. Protection Course: Multi-ply semi-rigid core composed of a mineral-fortified asphalt core formed between two outside layers of asphalt impregnated reinforced mats, manufactured in accordance with ASTM D 6506, or 1/4 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Applicator present, for compliance with requirements for surface smoothness and other conditions affecting performance of work.
 - 1. Proceed with dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

- B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.
- C. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and other imperfections.

3.3 APPLICATION

- A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
 - 1. Apply additional coats if recommended by manufacturer or required to achieve coverages indicated.
 - 2. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats.
 - 3. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing.
 - 4. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 5. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat required for embedding fabric is in addition to other coats required.
- B. On Concrete Foundations: Apply two brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat.

3.4 INSTALLATION OF PROTECTION COURSE

- A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing material manufacturer's written recommendations for attaching protection course. Support protection course with spot application of trowel-grade mastic where not otherwise indicated.

3.5 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by The City for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
- B. Cooperate with field quality control personnel. Allow inspectors access to scaffolding and work areas, as needed to perform inspections.
- C. Additional inspections and retesting of materials which fail to comply with specified material and installation requirements shall be performed at Contractor's expense.

3.6 CLEANING

- A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION

This Page Intentionally
Not Used

SECTION 09 91 13 – EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Attention is directed to the printed form of the Contract, General Conditions, Supplementary General Conditions and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

- A. The work of this Section consists of providing all labor, equipment, materials, incidental work, and construction methods to perform surface preparation, painting and finishing work throughout the Project as indicated on the Contract Documents including the stripping and painting of the flagpole and associated elements and as specified in this Section 099113, EXTERIOR PAINTING.
- B. Examine Contract Documents to determine full extent of surface preparation, painting and finishing work required. Materials provided under other Sections that need surface preparation, painting or finishing and are left unfinished under requirements of other Specification Sections shall be painted and finished to completion under work of this Section, unless specifically scheduled in this Section to be left unfinished.
- C. Preparatory work of materials and surfaces to receive paint and finishes beyond that specified to be performed as work of other Sections shall be included as work of this Section 099113, EXTERIOR PAINTING.

1.3 RELATED WORK

- A. Section 03 30 00 – CAST-IN-PLACE CONCRETE.
- B. Section 03 42 91 – REMOVAL AND SALVAGE OF HISTORIC MATERIALS.
- C. Section 05 01 70 – CONSERVATION AND MAINTENANCE OF DECORATIVE METALS.
- D. Section 05 50 01 – METAL FABRICATIONS.
- E. Section 32 30 00 – SITE IMPROVEMENTS.

1.4 REFERENCES

- A. The following standards shall apply to the work of this Section: Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - 1. SSPC Steel Structures Painting Council (SSPC):
 - SP1 Solvent Cleaning
 - SP6 Commercial Blast Cleaning
 - SP7 Brush-off Blast Cleaning
 - SP 11 Power Tool Cleaning to Bare Metal
 - PA 2 Measurement of Dry Coating Thickness with Magnetic Gages
 - 2. NEPCOAT Northeast Protective Coating Committee of Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Rhode Island and Vermont.
 - 3. Federal Standards
 - a. Standard No. 595B, Colors Volume 1
 - 4. ASTM American Society for Testing and Materials
 - D523-89 Standard Test Method for Specular Gloss
 - D4541-95e1 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - D4285-83 Standard Test Method for Indicating Oil or Water in Compressed Air
 - D3359 Standard Test Method for Measuring Adhesion by Tape Test

D3363 Standard Test Method for Film Hardness by Pencil Test
D4834 Standard Test Method for Detection of Lead in Paint by Direct
Aspiration Atomic Absorption Spectroscopy

5. Commonwealth of Massachusetts
a.M.G.L. c. 111 § 189A

1.5 SUBMITTALS

- A. The Contractor shall submit a complete and detailed finish schedule for all finish treatments provided for items provided under other Sections. The finish schedule shall list materials for prime, intermediate and finish coats, manufacturer, source and pertinent surface preparation requirements as applicable.
1. The schedule, in typed format, shall be submitted to the Owner Representative for the Owner's use in future maintenance of the project. Submittal of a complete and acceptable schedule shall be a prerequisite for acceptance of surface preparation, painting and finishing work.
- B. Contractor shall supply the name of a certified testing agency to determine the presence of lead paint on all work being prepared for repainting.
- C. Contractor shall supply a certified letter from the paint manufacturer stating that the supplied paint system is compatible with the galvanized surfaces of the metal as described in this Section.
- D. List: Submit paint and coating materials list giving the manufacturer's name, product name and product number for each material.
- E. Product Data: Submit manufacturer's printed product data and specifications, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.
- F. Timing: Samples of all colors and finishes shall be prepared in advance of requirements so as not to delay work, and shall be submitted to the Owner's Representative for approval before any work is commenced. Any work done without such approval shall be redone to the Owner's Representative's satisfaction, at the Contractor's expense.
- G. Initial Color Selection Samples: submit manufacturer's standard color charts or chips showing complete range of colors, textures, and finishes available for each paint system used.
- H. Verification Samples: After initial selection of colors from manufacturer's standard color charts, submit representative sample panels of each paint system color that is to be exposed in the completed work. Show full color ranges and finish variations expected. Provide texture to simulate actual conditions. Define each separate coat, including block fillers and primers. Resubmit samples until required sheen, color, and texture have been approved. Provide samples as follows:
1. Provide painted and finished color samples of all items called for under other Sections. Coordinate with Section 323000, SITE IMPROVEMENTS, of this Specification, for metal items requiring surface preparation and color finishing specified and paid for under this Section 099113, EXTERIOR PAINTING. Samples shall be on separate 8 inch x 10 inch x 18 gauge metal panels for painted metal surfaces. Finished samples may not be part of the finished work. Upon approval color finished site metal samples shall be the standard of quality for all surface preparation, painting and finishing specified, performed and paid for under this Section 099113, EXTERIOR PAINTING.

1.6 QUALITY ASSURANCE / QUALITY CONTROL

Ray Dunetz Landscape Architecture, Inc.

- A. Source: The same coating material manufacturer shall furnish all materials for the complete coating system. Intermixing of materials within and between coating systems will not be permitted. Thinning of paint shall conform to the manufacturer's written instructions.
- B. Where manufacturer makes more than one grade of any material specified, use the highest grade of each type, whether or not the material is mentioned by trade name in this Section 099113, EXTERIOR PAINTING.
- C. Include on labels of all containers the manufacturer's name, the product name and number, the color and batch number.

1.7 TESTS

- A. Contractor shall engage the lead paint approved testing agency to assess the salvaged elements for lead paint. In the event said test confirms the presence of lead paint beyond the allowable legal limits, Contractor shall supply to the Owner's Representative written documentation of the abatement process for each element for approval prior to any paint removal is performed.
- B. An Owner's Representative will visit the Project site after installation of painted miscellaneous metals items to perform on-site testing of paint finishes. The Owner's Representative will perform the following tests:
 - 1. Adhesion: ASTM D3359-97, using Permacel 99 tape or equivalent determined by Owner's Representative. Permacel 99 is manufactured by Permacel, a Nitto Denko Company, New Brunswick, NJ.
 - 2. Hardness: ASTM D3363-00 using calibrated drafting leads from 6B to 6H.
 - 3. Mil thickness: using a Tooke Gauge, a hand held devise that scores the paint finish and provides for a magnified visual inspection of the mil thickness of the coating system.
- C. All of the above tests are destructive of the paint finish system including the galvanized surface. The Contractor shall touch up and repair areas of paint finish damaged by field testing by Owner's Representative under the work of this Section 099113, EXTERIOR PAINTING, at no additional cost to the Owner.
- D. In the event that any of the 3 aforementioned tests indicate that the requirements of this Section 099113, EXTERIOR PAINTING, have not been met as determined by the Owner's Representative, the Contractor shall perform and provide the following at no additional cost to the Owner:
 - 1. The Contractor shall select a qualified independent Testing Agency to perform laboratory testing of the paint finish of miscellaneous metal items to verify the testing performed by Owner's Representative. Owner's Representative will select no fewer than 3 miscellaneous metal items to be tested by the Testing Agency.
 - 2. Contractor shall remove selected representative samples from the site and have the samples delivered to the laboratory of the approved Testing Agency.
 - 3. On each of the 3 miscellaneous metal items the Testing Agency shall measure adhesion strength per ASTM D4541 using apparatus under Annex A4, shall measure hardness of paint coating per ASTM D3363, and shall measure coating thickness per ASTM D1186, Method B. Contractor shall pay all costs of the work performed by the Testing Agency and shall have the Testing Agency submit reports directly to the Owner's Representative for review, analysis and direction. In the event that any of the tests performed on any of the 3 miscellaneous metal items by the Testing Agency indicates to the Owner's Representative that the requirements of the Section 099113, EXTERIOR PAINTING, have not been met, the Contractor shall remove all miscellaneous metal items from the site and have said items delivered to an approved paint shop for stripping of the painting

finish, re-galvanizing in accordance with the requirements of the Section 055200, METAL RAILINGS, of this Specification, new surface preparation, and new paint finishing in accordance with the requirements of this Section 099113, EXTERIOR PAINTING, at no additional cost to the Owner.

4. After completion of the re-painting operation, the Contractor shall have all miscellaneous metal items delivered to the Project site and reinstalled in accordance with the requirements of the Section 324000, SITE IMPROVEMENTS, of this Specification at no additional cost to the Owner.

E. The Contractor may choose to forgo the laboratory testing procedures describe above and have all miscellaneous metal items removed from the site, stripped, re-galvanized, surface prepared and repainted in accordance with the requirements of this Section 099113, EXTERIOR PAINTING, and delivered to the Project site and reinstalled in accordance with the requirements of the Section 324000, SITE IMPROVEMENTS, of this Specification at no additional cost to the Owner.

F. The Owner may employ an independent testing agency to perform tests, evaluations, and certifications of products used. Cooperate and permit samples of materials to be taken as they are used.

1.8 PROJECT CONDITIONS

A. The complete coating system shall be applied in an enclosed shop except for field touch-up painting which shall be applied after Miscellaneous Metal items have been installed in accordance with the requirements of the Section 324000, SITE IMPROVEMENTS, of this Specification. The enclosed shop shall be a permanent facility with outside walls to grade and a roof where surface preparation and coating activities are normally conducted in an environment not subject to outdoor weather conditions and/or blowing dust.

1. Indoor temperature: Maintain indoor temperature at 65 degrees Fahrenheit during application and drying of paints.
2. Lighting: Since lighting conditions can alter appearances of finish painting work, perform work of this Section 09 91 13, EXTERIOR PAINTING, under lighting conditions simulating permanent lighting system to the greatest extent possible.

B. Field Touch Up:

1. Outdoor Temperature and Conditions: Air and surface temperature shall be between 50 degrees Fahrenheit and 90 degrees Fahrenheit. Surfaces shall be dry within limits of finish system manufacturer.
2. Do not paint exterior surfaces while surfaces are exposed to the hot sun.

1.9 STORAGE AND USE OF MATERIALS

A. Touch-up materials brought to the site shall be stored in an approved location in manufacturer's original sealed containers, bearing the manufacturer's standard label, indicating type and color. Materials shall be delivered in sufficient quantities in advance of the time needed in order that work will not be delayed in any way.

B. All touch-up materials shall be stored in designated spaces in fully sealed containers, outside the building, preferably in exterior storage shed, well ventilated, and with a minimum ambient temperature of 45 degrees Fahrenheit, in a manner that meets the requirements of applicable codes and fire regulations. When not in use, such spaces shall be kept locked and inaccessible to those not employed under the work of this Contract. Oily rags and waste must be removed from the building every night, and under no circumstances will be allowed to accumulate. Each space containing stored paint materials shall be provided with UL labeled fire extinguisher of

suitable type, class, and capacity.

- C. Do not use building sanitary system for mixing or disposal of refuse material. Carry water to mixing rooms and dump waste material in a refuse receptacle.

PART 2- PRODUCTS

2.1 PAINT COATINGS OVER GALVANIZED STEEL SURFACES

- A. The Contractor shall select a system of paint from the current Qualified Products List as maintained by NEPCOAT. The system chosen for bare steel application shall have a prime coat that has achieved a Class B slip coefficient or better.
- B. Touch-up paint for field touch-up of galvanized surfaces shall be a two-component, moisture-cured, zinc-rich inorganic or organic primer as listed on the NEPCOAT Qualified Product List. Recommended Dry Film Thickness shall be as recommended by manufacturer and approved by Owner's Representative. Acceptable products and their manufacturers shall include the following:
 - 1. Ply-Tile Epoxy Organic Zinc Rich Primer
Manufactured by M.A.B Industrial Coatings
Broomall, PA 19008
 - 2. Dimetcote 9
Ameron International
Alpharetta, GA 30004
 - 3. Metalhide 97-673 Series, 1001 Inorganic Zinc Rich Coating
PPG Architectural Finishes, Inc.
One PPG Place
Pittsburgh, PA 15272
 - 4. Zinc Clad III HS, Organic Zinc-Rich Epoxy Primer
Sherwin-Williams Company
www.sherwin-williams.com
 - 5. MC Zinc
Wasser High-Tech Coatings
Kent, WA 98032
- C. Primer coating for shop painting of galvanized surfaces shall be an epoxy or urethane coating as listed on the NEPCOAT Qualified Product List. Recommended Dry Film Thickness shall be as recommended by manufacturer and approved by Owner's Representative. Acceptable products and their manufacturers shall include the following:
 - 1. Ply-Tile 520-W-45 Epoxy Primer
Manufactured by M.A.B Industrial Coatings
Broomall, PA 19008
 - 2. Amercoat 385
Ameron International
Alpharetta, GA 30004
 - 3. Pitt-Guard 97-946 Series All Weather Direct-to-Rust Epoxy Coatings
PPG Architectural Finishes, Inc.
One PPG Place
Pittsburgh, PA 15272
 - 4. Macropoxy 646 Fast Cure Epoxy
Sherwin-Williams Company
www.sherwin-williams.com
 - 5. MC-Ferrox B
Wasser High-Tech Coatings
Kent, WA 98032

- D. Finish over epoxy or urethane coating shall be an aliphatic urethane coating. Recommended Dry Film Thickness shall be as recommended by manufacturer and approved by Owner's Representative. Acceptable products and their manufacturers shall include the following:

1. Ply-Thane 890 HS Coating
Manufactured by M.A.B Industrial Coatings
Broomall, PA 19008
2. Amercoat 450HS
Ameron International
Alpharetta, GA 30004
3. Pitthane II
PPG Architectural Finishes, Inc.
One PPG Place
Pittsburgh, PA 15272
4. Acrolon 218 HS Acrylic Polyurethane
Sherwin-Williams Company
www.sherwin-williams.com
5. MC-Ferrox A
Wasser High-Tech Coatings
Kent, WA 98032

Surface Preparation: Coat over preceding epoxy or urethane coat within 24 hours

Color shall be selected by the Owner's Representative.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION OF GALVANIZED ITEMS

- A. All approved abatement procedures for the presence of lead shall be performed in accordance with applicable laws and standards prior to any elements being prepared for painting.
- A. Galvanized surfaces of miscellaneous metal items shall be inspected by the painting Contractor prior to the start of the work of this Section 099113, EXTERIOR PAINTING. Any defects in the galvanized surfaces such as lumps, sags, or spikes that would make the item not smooth to human touch, exposed bare steel not prime painted by the galvanizer with an approved paint from the same manufacturer of paint coatings approved under this Section 099113, EXTERIOR PAINTING, or prime paint not compatible with approved paint coatings shall be reported to the Owner's Representative immediately by telephone followed by a hard copy letter addressed to the Owner's Representative describing the defects. Do not start work of this Section 099113, EXTERIOR PAINTING, if any defects are detected. The commencement of work by the painting Contractor shall indicate his acceptance of the galvanized surfaces of the miscellaneous metals items, and he shall assume full responsibility for the work of this Section 099113, EXTERIOR PAINTING.
- B. Prior to abrasive blast cleaning, all rough surfaces shall be ground smooth. All galvanized surfaces shall then be solvent cleaned in accordance with SSPC-SP1 - "Solvent Cleaning" before being blast cleaned.
- C. Abrasive blast cleaning shall be performed in accordance with SSPC-SP7, "Brush-off Blast Cleaning" using a production line shot and grit blast machine or by air blast. The abrasive working mix shall be maintained such that the final surface profile is within the range specified in this Section.

- D. All compressed air sources shall have properly sized and designed oil and moisture separators, attached and functional, to allow air at the nozzle, either for blast cleaning, blow-off, painting or breathing, to be oil-free, and moisture-free. They shall have sufficient pressure to accomplish the associated work efficiently and effectively.
- E. No surface preparation or coating shall be done when the relative humidity is at or above 80 percent or when the surface temperature of the steel is less than 5 degrees Fahrenheit above the dewpoint temperature as determined by a surface thermometer and an electric or sling psychrometer.
- F. Surface Profile: The galvanized surface profile shall be 1 to 3 mils. Fabricated and galvanized miscellaneous metal items shall have the surface profile measured at a minimum of 3 locations on one piece at the beginning of abrasive blast operations and at least every 4 hours and at the end of abrasive blast cleaning operations. This measurement shall be performed with both coarse (0.8 -2.0) and extra coarse (1.5 - 4.5) Testex Replica Tape. During this measurement, special attention shall be given to areas that may have been shielded from the blast wheels.

3.2 SURFACE PREPARATION FOR FIELD WELDING AND FIELD TOUCH UP

- A. Field Touch-up and Field-Welded Ferrous Metal and Galvanized Surfaces: In accordance with the requirements for surface preparation noted in this Section for Field Touch-up. All surface preparation shall be specified and performed under the work of this Section 09 91 13, EXTERIOR PAINTING, and paid for under the work of Section 05 52 00, EXTERIOR PAINTING, of this Specification.

3.3 APPLICATION OF PAINT AND FINISHES TO METAL SURFACES

- A. All coatings shall be applied in the shop except for field touch-up after installation. See requirements for field touch-up as described in this Section 099113, EXTERIOR PAINTING. All surface preparation and coating work, including field touch up work, shall be as specified and performed under the work of this Section 099113, EXTERIOR PAINTING of this Specification.
- B. All galvanized steel surfaces shall receive the 2-coat shop applied paint system and bare steel surfaces shall receive the 3-coat shop applied coating system as specified in this Section 0991 13, EXTERIOR PAINTING, except the following particular locations that shall be masked off and treated as follows:
 - 1. Faying surfaces of slip-critical bolted connections shall receive only a single application of primer. The dry film thickness shall be no greater than the thickness tested on the coating manufacturer's Certified Test Report for slip coefficient.
 - 2. Miscellaneous metal surfaces within 4 inches of field welds shall receive only a single coating of primer at 0.5 - 1.5 mils dry film thickness.
 - 3. Galvanized steel surfaces to be in contact with concrete shall not be coated. For galvanized posts to be set in cast or cored concrete walls, footings or foundations, ensure that 2 coat paint coatings extend below the horizontal surface of the concrete by no less than one inch.
 - 4. Bare steel surfaces to be in contact with concrete shall receive only a single application of primer to the full extent of the contact with the concrete.
 - 5. Hand Striping

- a. Edges and shop welds on bare steel shall be locally hand-striped with a brush in the longitudinal direction with an additional coat of a zinc-rich primer prior to application of the full intermediate coat. The coating manufacturer shall be consulted to determine the appropriate zinc-rich primer to use for striping. The application of the striping materials shall be in accordance with the coatings manufacturer's written instructions. The striping material shall be tinted to distinguish it from the primer and intermediate coats.
 - b. Edges and shop welds of galvanized steel items shall be locally hand-striped with a brush in the longitudinal direction with an additional coat of the epoxy or urethane coating prior to application of the finish aliphatic urethane coating. The coating manufacturer shall be consulted to determine the appropriate epoxy or urethane coating to use for striping. The application of the striping materials shall be in accordance with the coatings manufacturer's written instructions. The striping material shall be tinted to distinguish it from the intermediate coats.
- C. Application Methods: The coating system shall be applied by spray equipment of a type and size capable of applying each coat within the required thickness range. The applicator shall strictly adhere to the manufacturer's recommendations about application methods, cure times, temperature and humidity restrictions and recoat times for each individual coat of the specified system. Brushes shall be used in areas where spray application will not achieve acceptable results. Brushing technique shall be performed in a manner that will provide a uniform, blended finish. No coating material shall be thinned in any way except as directed by manufacturer.
 1. Conventional spray equipment with mechanical agitators shall be used for prime coat application on bare steel and for epoxy or urethane intermediate coat on galvanized surfaces.
 2. All storage, mixing, thinning, application and curing efforts, techniques and methods shall be accomplished in strict accordance with the printed material data sheets and application instructions published by the respective coating material manufacturer.
 3. Surfaces shall be painted with the specified prime coat material before the end of the same work shift that they were blast cleaned and before any visible rust back occurs.
 4. Applied coatings shall not have runs, sags, holidays, pinholes or discontinuities.
 5. The dry film thickness shall be within the range specified in the manufacturer's printed literature for the specified coating system. Dry film thickness shall be measured in accordance with SSPC-PA 2.
 6. The intermediate coat shall be of a contrasting color to the prime and top coat colors.
 7. There shall be no color variation in the topcoat as determined by comparison with Federal Standard 595B.
- D. All storage, mixing, thinning, application and curing efforts, techniques and methods shall be accomplished in strict accordance with the written requirements and procedures published by the respective coating material manufacturer.
- E. Additional coats: Provide additional coats necessary to eliminate show through and bleed through conditions.
- F. Drying Time: Allow manufacturer's recommended drying time between successive coats. However, allow each coat to thoroughly dry prior to application of subsequent coat.
- G. All compressed air sources shall be properly sized and designed with oil and moisture separators, attached and functional, to allow air at the nozzle, either for blast cleaning, blow-off, painting or breathing, to be oil-free and moisture-free. It shall be of sufficient pressure to accomplish the associated work efficiently and effectively.

- H. Surfaces not in contact with other steel surfaces but inaccessible after assembly shall be coated prior to assembly.
- I. Critical attention shall be given to edges and bolted connections. All bolts, nuts and washers shall be fully coated and no gaps left unfilled and un-coated.
- J. Adhesion strength of the fully coated assemblies shall be within 80 percent of the values for Adhesion as described in the approved manufacturer's literature measured per ASTM D4541 using apparatus under Annex A4.
- K. Strict attention must be directed to the re-coat times of all applied materials. Shop bolted connections shall also have all bolt heads and nuts striped in a circular brush motion with the same material.
- L. All applied coating shall have no runs, sags, holidays or discontinuities; the dry film thickness shall be within the range specified. There shall be no color variation in the topcoat as determined by Federal Standard 595B. Also, there shall be no gloss variation in the topcoat where tested in accordance with ASTM D523.

3.4 MISCELLANEOUS CONSTRUCTION

- A. Protection of Coated Miscellaneous Metal: All fully coated and cured assemblies shall be protected from handling and shipping damage with the prudent use of padded slings, dunnage, separators and tie downs. Loading procedures and sequences shall be designed to protect all coated surfaces.
- B. Erection marks for field identification of members and weight marks shall be affixed in such a manner as to facilitate removal upon final assembly without damage to the coating system.
- C. The Contractor shall protect property, pedestrians, vehicular and other traffic upon, underneath, or in the vicinity of the work against damage or disfigurement from errant coating materials.

3.5 FIELD TOUCH UP

- A. Touch-up and repair finishes that, for any reason, have been damaged during construction work.
- B. Field application of coatings shall be in accordance with the manufacturer's written application guidelines and these specifications. All areas cleaned to bare metal must be coated with a zinc-rich primer before any visible rust back occurs. The topcoat material for field touch-up painting and additional field topcoat application shall be from the same lot and batch used in the shop provided its shelf life has not expired. If the shelf life has expired, the same material of the same color from a different lot and batch shall be used. The materials used for the field primer and intermediate coat must be compatible with the shop primer and intermediate coats.
- C. All rust, scale, dirt, grease, concrete splatter and other foreign material on connections, bolts, nuts and around field welds shall be completely removed by power tool cleaning per SSPC-SP 11. Areas cleaned to SSPC-SP 11 shall have a 1-3 mil profile and must be primed prior to rusting. All debris generated from cleaning operations must be contained and properly disposed of.
- D. Bolts, nuts and washers shall receive brush applications of intermediate and topcoat after final tensioning. Careful attention shall be given to bolted connections to insure that all bolts, nuts and washers are fully coated and that no gaps are left unfilled and uncoated.
- E. Field welded areas shall be treated in the same manner as shop welded areas, including special treatment requirements.

- F. At damaged areas that extend back to the steel surface (such as scratches, gouges or nicks), the entire three-coat system shall be locally reapplied after power tool cleaning to bare metal in accordance with SSPC-SP 11. The coating system adjacent to the damage shall be feathered back to increase the surface area for touch up painting. The area cleaned to SSPC-SP 11 shall be primed with a zinc-rich primer before rustback occurs. The coating manufacturer shall be consulted to determine the appropriate zinc-rich primer to use. Application of the zinc-rich primer shall be in accordance with the coating manufacturers written instructions. The specified intermediate and topcoats shall be reapplied in accordance with the manufacturer's written instructions.
- G. At damaged areas that extend back only to the prime or intermediate coat, the area shall have the topcoat applied. Application of the touch-up materials in these damaged areas shall be performed by brush only.
- H. Tarps shall be used to collect all surface preparation debris. The Contractor shall be responsible for disposing of all removed materials, including tarps.

3.6 ACCEPTANCE STANDARDS

- A. Finished work shall be free from runs, sags, hairs, defective brushing, and clogging of lines and angles. Flaws visible in the completed work shall be removed and the area satisfactorily repaired.
- B. Completed Work: Provide finishes that match approved samples and mock-ups for color, texture, and coverage, remove, refinish, or repaint work not in compliance with specified requirements.

3.7 COMPLETION OF PAINTING OF METAL ITEMS

- A. Cleaning: At completion of work of this Section 099113, EXTERIOR PAINTING, remove paint and finish spots, and oil, grease, and other stains caused by this work from exposed vertical and horizontal surfaces. Leave finished work in a satisfactory condition.
- B. At completion of work of this Section 099113, EXTERIOR PAINTING, remove masking materials and other debris. Reinstall or replace fixtures, plates, etc., removed to facilitate application of paint.
- C. Final Inspection: Protect painted surfaces against damage until date of Substantial Completion. Owner's Representative will conduct final inspection of painting work. Areas that do not comply with requirements of these Specifications shall be repainted or retouched to satisfaction of Owner's Representative at no additional cost to Owner.

End of Section
09 91 13

SECTION 26.00.00 - ELECTRICAL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. This section specifies requirements for electrical construction. The Electrical Contractor shall furnish, install the materials, and components required to complete all Work related to this Section.
- B. All of the Contract Documents, including General and Supplementary conditions and Division 0 – Bidding Documents, Contract Forms and Conditions of the Contract and Division 1 – General Requirements, apply to the work in this Section.
- C. Carefully examine all the Contract Documents for requirements which affect the work of this Section. The exact scope of this Section cannot be determined without a thorough review of all specifications sections and other Contract Documents.
- D. Where referred to, Standard Specifications, Recommendations of Technical Societies, and/or Manufacturer's Associations, plus Codes of Federal, State, and Local Agencies shall include all amendments current as of date of issue of these specifications.

1.02 GENERAL

- A. The General Conditions and Supplementary General Conditions of these specifications are hereby made a part of this Section.
- B. Refer to drawings for further definition of location, extent, and details of work described herein.
- C. Cooperate and coordinate with other trades in executing work as described in this Section.
- D. Where referred to, Standard Specifications, Recommendations of Technical Societies, and/or Manufacturer's Associations, plus Codes of Federal, State, and Local Agencies shall include all amendments current as of date of issue of these specifications.
- E. Refer to alternates section and allowance section for items affecting electrical.

1.03 SCOPE

- A. Work described herein shall be interpreted as work to be done by the Electrical Subcontractor. Work to be performed by other trades will be referenced to a particular contractor or subcontractor.
- B. Provide all labor, materials, tools, and equipment, including scaffolding, to complete the installation of the electrical system. Install, equip, adjust, and put into operation the respective portions of the installation specified, and so interconnect various items or sections of work in order to form a complete and operating whole. The work shall consist of, but shall not necessarily be limited to, the following:
 - 1. Secondary distribution equipment and panelboards including feeders and sub-feeders.
 - 2. Lighting systems exterior, including fixtures, lamps, time clocks, and lighting controls.
 - 3. All raceway systems, including boxes, couplings, and fittings.
 - 4. All branch circuit wiring systems, including wiring devices, plates.
 - 5. Excavation and backfill for any underground raceways.
 - 6. Telecommunication wiring, devices, and testing.
 - 7. Drilling, coring, and cutting of holes and openings
 - 8. Scaffolding, rigging, and staging required for all electrical work.
 - 9. Fire stopping shall be performed by the electrical contractor.
 - 10. Provide seismic restraints for all electrical systems and conform to Massachusetts State Building Code.
 - 11. Phasing and demolition.
 - 12. Closed Circuit Television (CCTV) installation is to be coordinated with Siemens Corporation (owners' vendor). Electrical scope is work not carried within the Siemens work proposal. E.C. is to carry the cost of the Siemens work within their bid. Refer to Appendix A for Siemens scope of work and costs.
 - 13. All testing of equipment installed. Each enclosure shall have a duplex outlet installed as part of the electrical contractor scope. Coordinate outlet location with Siemens.
 - 14. Unit pricing for Siemens work on the CCTV system
 - 15. Any other item of work hereinafter specified or indicated on electrical drawings.

1.04 DEFINITIONS

- A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:
 - 1. Furnish: Purchase and deliver to a specific location within the building or site.

2. Install: With respect to equipment furnished by others, install means to receive, unpack, move into position, mount, and connect including removal of packaging materials.
3. Conduit: Raceways of the metallic type, which are not flexible. Specific types as specified.
4. Connect: To wire up, including all branch circuitry, control and disconnection devices so item is complete and ready for operation.
5. Subject to Mechanical Damage: Equipment and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.
6. Wherever the terms "shown on drawings" are used in the specifications, they shall mean "noted", "indicated", "scheduled", "detailed", or any other diagrammatic or written reference made on the drawings.
7. Wherever the term "provide" is used in the specifications it will mean "furnish" and "install", "connect", "apply", "erect", "construct", or similar terms, unless otherwise indicated in the specifications.
8. Wherever the term "material" is used in the specifications it will mean any "product", "equipment", "device", "assembly", or "item" required under the Contract, as indicated by trade or brand name, manufacturer's name, standard specification reference or other description.
9. The terms "approved", or "approval" shall mean the written approval of the Architect.
10. The term "specification" shall mean all information contained in the bound or unbound volume, including all "Contract Documents" defined therein, except for the drawings.
11. The terms "directed", "required", "permitted", "ordered", "designated", "prescribed", and similar words shall mean the direction, requirement, permission, order, designation or prescription of the Architect; the terms "approved", "acceptable", "satisfactory", and similar words shall mean approved by, acceptable or satisfactory to the Architect; and, the terms "necessary", "responsible", "proper", "correct", and similar words shall mean necessary, reasonable, proper or correct in the judgment of the Architect.
12. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings, embedded in construction or in crawl spaces.
13. "Exposed" means not installed underground or "concealed" as defined above.
14. "The Subcontractor" shall refer to the "Electrical Subcontractor" responsible for all work under the Electrical Section of these specifications, as applicable and as defined under Supplementary General Conditions and other Sections of these specifications. It is the intent of these specifications that the Electrical Subcontractor and his Sub-Subcontractors shall be responsible for furnishing and installation of all work indicated on the Electrical Contract Drawings and Specifications, and all related or implied work specified in other Sections of these

specifications, as such information and requirements relate to the Electrical Trade.

1.05 ITEMS TO BE INSTALLED ONLY

A. Install the following items furnished under designated sections.

1. Fire pump remote supervisory panel, including power source.

1.06 RELATED WORK

A. The following related work is to be performed under designated sections.

1. Excavation and Backfill: SECTION 31.00.00, EARTH WORK
2. Concrete Bases, Pads, and Duct Envelopes: DIVISION 03.30.00, CONCRETE.
3. CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: SECTION 01 74 19
4. Patching: To be done by trade responsible for surface requiring patching.

1.07 CONTRACT COST BREAKDOWN

A. The following related work is to be performed under designated sections.

1.08 INSPECTION OF SITE

A. It is optional, for the Electrical bidders to inspect site. Failure to inspect existing conditions or to fully understand work which is required shall not excuse Electrical Subcontractor from his obligations to supply and install work in accordance with specifications and the drawings and under all site conditions, as they exist.

1.09 CONTRACTOR'S REPRESENTATIVE

A. Retain a competent representative on the project.

1.10 COOPERATION

A. Work shall be carried on under usual construction conditions, in conjunction with other contractors work. Cooperate with other contractors, coordinate work, and proceed in a manner as not to delay progress.

- B. Before proceeding, examine all construction drawings and consult other contractors to coordinate installation and avoid interference.
- C. In case of dispute, the Architect will render a decision in accordance with General and Supplementary General Conditions.

1.11 CODES, ORDINANCES, AND PERMITS

A. Codes and Ordinances

- 1. All material and work provided shall be in accordance with the following codes and standards as most recently amended.

NFPA -70 "*National Electrical Code*", 2020 Edition
Massachusetts Electric Code Amendments, 2020 Edition
Commonwealth of Massachusetts State Building Code, 9th Edition
International Building Code (IBC), 2015 Edition
State Department of Public Safety
Standards of the Underwriters Laboratories (UL)
Occupational Safety and Health Act (OSHA)
Americans with Disabilities Act (ADA)
Energy Conservation Code
International Energy Conservation Code (IECC), 2015 Edition
City of Worcester
ANSI/TIA/EIA-568-B.1 and addenda "Commercial Building
Telecommunications Cabling Standard - Part 1: General Requirements"
Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling and
Components Standard"
ANSI/TIA/EIA-569-B and addenda "Commercial Building Standard for
Telecommunications Pathways and Spaces"
ANSI/TIA/EIA-606-A and addenda "Administration Standard for the
Telecommunications Infrastructure of Commercial Buildings"
ANSI-J-STD-607-A and addenda "Commercial Building Grounding and
Bonding Requirements for Telecommunications"
ANSI/TIA/EIA-526-7 "Measurement of Optical Power Loss of Installed
Single-Mode Fiber Cable Plant"
IEC/TR3 61000-5-2 - Ed. 1.0 and amendments "Electromagnetic
compatibility (EMC) - Part 5: Installation and mitigation guidelines -
Section 2: Earthing and Cabling"
ISO/IEC 11801:2002 Ed2.0 and amendments "Information technology -
Generic Cabling for Customer Premises"
EIA 310-D "Cabinets, Racks, Panels, and Associated Equipment."
EIA-455-21A- FOTP-21 "Mating Durability of Fiber Interconnecting
Devices"
TIA/EIA-492CAA "Class IVa Dispersion-Unshifted Single Mode Optical
Fibers"

TIA/EIA-526-7 "OFSTP-7 Measurement of Optical Power Loss of
Installed Single Mode Fiber Cable Plant"

2. Where contract documents indicate more stringent requirements than codes, the contract documents shall take precedence.

- B. Permits: Be responsible for filing documents, payment of fees, and securing of inspection and approvals.

1.12 ELECTRICAL ROOMS OR SPACES

- A. Be responsible for ensuring that the dedicated space and clearances required in the NEC, Article 110.26 is maintained for all electrical equipment.
- B. Call other contractors' attention to the requirements contained in the above mentioned code sections, prior to the installation of equipment by other contractors, in order to ensure no violations.

1.13 SUBMITTALS

- A. Refer to Supplementary General Conditions for information relative to submission of shop drawings. No equipment for which review is required shall be installed prior to review, except at Contractor's own risk. Shop Drawings will be required for all electrical equipment.
- B. Notwithstanding any restrictions upon contractor proposed substitutions, should apparatus or materials be permitted by Architect to be substituted for those specified for good cause, and such substitution necessitates changes in or additional connections, piping, supports, or construction, same shall be provided. Assume cost and entire responsibility thereof.
- C. Submit the following samples:
 1. Lighting fixtures other than specified item.
 2. Other items as may be requested.

1.14 GUARANTEE

- A. Keep work in repair without expense to Owner as far as concerns defects in workmanship or materials for a period of not less than one year from date of substantial completion.

1.15 RECORD DRAWINGS

- A. Refer and comply with SECTION 01.77.00, PROJECT CLOSEOUT and the following;

- B. Provide two (2) sets of black or blue line on white drawings to maintain and submit record drawings, one set shall be maintained at site and which shall be accurate, clear, and complete showing actual location of all equipment as installed. Record drawings shall be updated at least monthly. Record drawings shall show outlet from which homeruns are taken, and location of all junction boxes and access panels. These drawings shall be available to Architect/Engineer field representative.
- C. Any addenda sketches and supplementary drawings issued during course of construction shall be attached to drawings.
- D. At completion, submit an accurate checked set of drawings.
- E. After approval of these drawings, photo reproductions of original tracings shall be revised to incorporate changes, including addenda sketches and supplementary drawings. Fit-up drawings for tenant areas shall also be revised in the same manner. These "as-built" photo reproductions shall be certified as correct and delivered to the Architect along with two (2) sets of black line prints. Sepia reproductions are not acceptable.

1.16 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Refer to and comply with SECTION 01.77.00, PROJECT CLOSEOUT and the following:
- B. Operating Instructions: Furnish operating instructions to Owner's designated representative with respect to operations, functions, and maintenance procedures for equipment and systems installed. Cost of such instruction up to a full three (3) days of Electrical Subcontractor's time shall be included in contract. Cost of providing a manufacturer's representative at site for instructional purposes shall also be included.
- C. Maintenance Manuals
 - 1. Provide four copies of complete manuals containing the following:
 - a. Complete shop drawings of equipment.
 - b. Operation description of systems.
 - c. Names, addresses, and telephone numbers of suppliers of systems.
 - d. Vendors' P.O. numbers for equipment installed.
 - e. Preventive maintenance instructions for systems.
 - f. Spare parts list of system components.
 - 2. All information shall be in binders.

1.17 INSPECTIONS AND TESTS

- A. Inspection: If inspection of materials installed shows defects, such defective work, materials, and/or equipment shall be replaced and inspection and tests repeated.
- B. Tests: Make reasonable tests and prove integrity of work and leave electrical installation in correct adjustment and ready to operate. All panels and switchboards shall have phases balanced as near as practical. A consistent phase orientation shall be adhered to at all terminations.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore do not indicate what is not acceptable or suitable for a particular location or application. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.
- B. For purpose of establishing a standard of quality and not for purpose of limiting competition, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.
- C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers' standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers' products will be unacceptable.
- D. Where Specifications list manufacturers' names and/or "as approved" or "Equal approved by Architect", other manufacturers' equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Architect.
- E. All material shall be new and shall be UL listed.

2.02 RACEWAYS AND FITTINGS

- A. Raceways - General
 - 1. No raceway shall be used smaller than 1/2" diameter and shall have no more than four (4) 90° bends in any one run, and where necessary, pull

boxes shall be provided. Only rigid metal conduit or intermediate metal conduit is allowed for slab work. Cable systems, if allowed to be used by other sections of this specification, shall not be used exposed or in slabs, whether listed by "UL" for such use or not.

2. Rigid metal conduit conforming to, and installed in accordance with, Article 344 shall be heavy wall zinc coated steel conforming to American Standard Specification C80 1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, where raceway may be subject to mechanical damage.

- a. Design and Performance Requirements

- 1) Condulet Bodies shall be dust-tight. Certified to UL50E
 - 2) Condulet Bodies shall be NEMA 3R raintight when installed with a cover and gasket.
 - 3) Conduit bodies when Iron made shall be protected with a three coat finish consisting of cadmium, zinc and aluminum acrylic paint
 - 4) Conduit bodies shall have a rounded bottom that helps prevent the snagging of fish wire
 - 5) Conduit bodies when Iron made shall be able to be removed from an installation by cracking with a hammer
 - 6) Condulet Bodies shall be approved for Class I, Division 2 when installed in compliance with NEC 501.10(B)(4)
 - 7) Condulet Bodies shall be approved for Class II, Division 1 when installed in accordance with NEC 502.10(A)(3)
 - 8) Condulet Bodies shall be approved for Class II, Division 2 when installed in accordance with NEC 502.10(B)(4)
3. Intermediate Metal Conduit (IMC) conforming to, and installed in accordance with, Article 342, may be used for all applications where rigid metal conduit is allowed by these specifications.
 4. Electrical Metallic Tubing (EMT), conforming to, and installed in accordance with, Article 358 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings, where exposed but not subject to mechanical damage, and shall be used for fire alarm work.
 5. Flexible metal conduit shall be used for final connections to recessed lighting fixtures from above ceiling junction boxes and for final flexible connections to motors and other rotating or vibrating equipment. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include an insulated grounding conductor.
 6. Rigid non-metallic conduit may be used at the contractor's option for underground electric and low tension services outside the foundation wall and shall be Polyvinyl Chloride (PVC) schedule 40, 90°C.

7. Rigid non-metallic conduits shall be polyvinyl chloride (PVC) schedule 80, 90°C (thick wall) conforming to and installed in accordance with ARTICLE 352.
8. Acceptable manufacturers:

Robroy Industries
Republic Conduit
Youngstown Tube Company
Carlton
Allied Tube and Conduit
9. Fittings
 - a. Provide insulated bushings on all raceways 1-inch diameter or larger.
 - b. Manufacturer's standard fittings shall be used for raceway supports.
 - c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap.
 - d. PVC expansion fittings shall be used where it is expected to be more than a ¼" or greater in a straight run between securely mounted items such as boxes, cabinets, elbows or other conduit termination. Comply with table 352.44 for expansion characteristics for PVC conduits.
 - e. Couplings for rigid metal and intermediate metal conduit shall be threaded type.
 - f. Threadless fittings for EMT shall be watertight compression type (wet locations) or set screw type (dry locations). All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1-inch diameter.
 - g. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
 - h. Wall entrance seals shall be equal to O.Z. Gedney type "WSK".
 - i. Couplings, elbows and other fittings used with rigid nonmetallic conduit shall be of the solvent cemented type to secure a waterproof installation.
 - j. Acceptable manufacturers:
O.Z.
Crouse Hinds
Appleton
EFCOR
Steel City

B. Outlets, Pull and Junction Boxes

1. Outlets

- a. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations or surface mounted shall be of the cast metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction. Thru the wall boxes are not permitted.
- b. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of Code. Boxes shall not be less than 1 1/2" deep unless shallower boxes are required by structural conditions and are specifically approved by Architect. Ceiling and bracket outlet boxes shall not be less than 4" octagonal except that smaller boxes may be used where required by particular fixture to be installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4" square or of comparable volume.
- c. Far side box supports shall be Caddy J 1A.
- d. Acceptable manufacturers:
Appleton
Crouse Hinds
Steel City
RACO

2. Pull and Junction Boxes

- a. Where indicated on plans, and where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be as required by Code.
- b. Boxes in moist or wet areas shall be galvanized type. Boxes larger than 4 11/16 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.
- c. Acceptable Manufacturers:

Hoffman
Keystone
Lee Products Co.

2.03 CONDUCTORS

- A. All conductors shall be a minimum size of #12 AWG except for control wiring and fire alarm wiring where #14 AWG may be used. For all exit sign circuits, normal/emergency and/or emergency only circuits, exterior lighting circuits, and also where distance from panelboard to first outlet exceeds 80', #10 AWG shall be minimum size wire allowed. All feeder and branch circuit conductor shall be color coded as follows:
- | | | | |
|----|--------------------|---------|-------|
| 1. | 208Y/120V | Phase A | Black |
| 2. | 208Y/120V | Phase B | Red |
| 3. | 208Y/120V | Phase C | Blue |
| 4. | Grounded Conductor | 120/208 | White |
| 5. | Equipment Ground | 120/208 | Green |
- All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.
- B. Connections throughout the entire job shall be made with solderless type devices.
- For #10 AWG and smaller: spring type.
 - For #8 AWG and larger: circumferential compression type.
 - Acceptable manufacturers:
3M "Scotchlock"
IDEAL "Wingnut"
BURNDY
 - Any splices made up in ground mounted pull boxes shall be resin cast waterproof type or waterproof pressure type, as manufactured by King Technology, St. Louis, MO.
- C. Conductors shall be copper, soft drawn, and annealed of 98% conductivity. Conductors larger than #10 AWG shall be stranded; #10 AWG and smaller shall be solid. Conductors shall be insulated for 600 volts and be of following types:
- All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75°C) except as follows:
 - In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75°C, 90°C) may be used.
- D. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.
- E. Type MC cable may be used for concealed branch circuits where allowed by code if installed and terminated as specified under Execution Section. Armor to be galvanized steel or aluminum, and shall be UL listed for 2 hour fire wall penetration.

2.04 SLEEVES, INSERTS, AND OPENINGS

- A. Sleeves: Provide sleeves of proper sizes for all openings required in concrete floors and walls. Sleeves passing through floors shall be set with top of sleeve 1" above finished floor. Core drilling will also be acceptable if in accordance with any structural standards. Any un-sleeved openings shall be waterproofed.
- A. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction as required to support raceways and equipment.
- B. Openings: Where an opening is required in concrete slabs to allow passage of a multitude of raceways, give adequate notice to General Contractor so he may box out opening in form work.
- C. Sleeves or openings through slabs for passage of future cables shall be located within 6 inches of walls and shall be in a single row and shall be proofed whether used or not.
- D. Any openings through fire rated surfaces shall be closed off with fireproofing materials providing the same rating as the surface penetrated.
- E. Acceptable Manufacturers:
 - Specified Technologies Inc.
 - Thomas & Betts
 - 3M Fire Protection Products
 - Dow Corning

2.05 WIRING DEVICES

- A. Receptacles: Receptacles shall be flush mounted. All devices to be of same manufacturer.

Acceptable Manufacturers:

Tamper Resistant

Twenty (20) ampere duplex grounding type NEMA 5 20R,
Cooper TR8300,

Pass and Seymour TR63

Leviton TBR20

Twenty (20) ampere ground fault interrupter, grounding type NEMA 5 20R,
Cooper VFG20

Pass and Seymour 2095TR

Twenty (20) ampere ground fault interrupter, grounding type NEMA 5 20R,
Cooper VFG20

Pass and Seymour 2095TR

Leviton X7899-T

Twenty (20) ampere ground fault interrupter, grounding type NEMA 5 20R,
Weather Resistant
Cooper TWRVGF20
Pass and Seymour 2095TRW
Leviton W7899-TRE

B. ELECTRONIC TIME SWITCHES

1. ELECTROMECHANICAL-DIAL TIME SWITCHES

- a. Electromechanical-dial time switches; complying with UL 917.
- b. Contact Configuration: SPST
- c. Contact Rating: //30-A inductive or resistive, 240-V ac// //20-A ballast load, 120/240-V ac//.
- d. Wound-spring reserve carryover mechanism to keep time during power failures.

C. Composition material of wiring devices to be nylon with ivory finish.

D. Cover plates

- 1. On commercial projects Extra-Duty box/covers shall be used per NEC 406.9(B)(1).

2.06 LIGHTING FIXTURES

- A. Provide lighting fixtures complete with lamps, ballasts, and other devices as required for a first class installation. Furnish Ceiling Subcontractor with instructions concerning openings necessary, and provide frames for NEMA standard ceiling types or special mounting frames, as may be required. Fixtures shall be supported independently of hung ceiling construction.
- B. Electronic ballasts shall be equal to Advance Centium in single, two, three and four lamp versions and input current total harmonic Distortion not exceeding 10%. Compact fluorescent electronic ballasts shall sense end of life conditions.
- C. All specialized lamps to be of a type recommended by the fixture manufacturers in their photometric reports.
- D. Exterior LED sources shall meet the following requirements:
 - 1. Operating temperature rating shall be between -40°F [-40°C] and 120°F [50°C].
 - 2. Color Rendering Index (CRI): ≥65.

3. The manufacturer shall have performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).
- E. Fixture types shall be as scheduled. The note on fixture schedule "Possibly Acceptable Alternate Manufacturers" means that the manufacturers listed have products which could be equal. The determination of "equal" will be determined based upon features of the product specified by catalog number. A sample of any proposed substitution will be required. Standard cataloged products have been selected. Fixtures specially manufactured for this particular project and not part of a manufacturer's standard line will not be acceptable.
- F. All light fixtures are to meet the IBC, Energy Code for that area by using COMcheck program. A program created by the United States Department of Energy. All substituted fixtures are to be approved by the engineer and must have the wattage for each fixture in order for it to be reviewed. All submittals relating to the lighting shall be rejected, until this COMcheck is reviewed by the Engineer of Record (EOR).

2.07 GROUNDING SYSTEM

- A. All equipment and systems shall be grounded. Refer especially to NEC Article 250.52 Requiring Connections to Building Steel, Foundation, Water Service, and Interior Piping. Provide transformer pad grounding to be in accordance with utility company standards.
- B. The grounded conductor shall be supplemented by an equipment grounding system.
- C. The equipment grounding system shall be installed so all conductive items in close proximity to electrical circuits operate continuously at ground potential and provide a low impedance path for ground fault currents.
- D. Grounding conductors shall be so installed as to permit shortest and most direct path to ground.
- E. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250.122.
- F. Grounding conductors shall be insulated with green color. Grounding conductors for use on isolated ground receptacles shall be green with trace color to differentiate between normal ground conductors.

- G. Branch circuits shall consist of phase and grounded conductor installed in common metallic raceway. The raceway system may not serve as the grounding conductor. All circuits shall have a separate insulated grounding conductor installed. Any flexible cable system or non-metallic raceway system shall have an insulated grounding conductor. Any cable system for use on isolated ground circuits shall have both an isolated ground conductor as well as an equipment ground conductor, both of which shall be insulated.
- H. Each electrical expansion fitting shall be furnished with a bonding jumper. Provide grounding bushings and ground connections for all raceways terminating below equipment where there is no metal to metal continuity.
- I. Continuity between all metallic and non-metallic raceway systems and equipment shall be maintained.
- J. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.
- K. Grounding Equipment
 - 1. Ground Rods
 - a. Copper clad steel/, 19 mm (0.75 inch) diameter by 3 M (10 feet) long.
 - b. Quantity of rods shall be as shown on the drawings, and as required to obtain the specified ground resistance.
 - 2. Ground Connections
 - a. Above Grade:
 - 1) Bonding Jumpers: Listed for use with aluminum and copper conductors. For wire sizes No. 8 AWG and larger, use compression-type connectors. For wire sizes smaller than No. 8 AWG, use mechanical type lugs. Connectors or lugs shall use zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
 - 2) Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with zinc-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.08 LOAD CENTERS

A. Manufacturers

1. The loadcenters shall be a PL or ES Series Load Center manufactured by Siemens or pre-approved equal. Approved manufacturers are as follows:
 - a. Siemens
 - b. Murray
 - c. Square D
 - d. Cutler Hammer

B. RELATED STANDARDS

1. The loadcenters shall comply with UL 67 and shall be UL Listed and shall comply with the requirements of the National Electrical Code. Panelboard enclosures shall comply with NEMA 250.
2. Circuit protection devices shall be UL Listed and shall comply with the following standards:
3. UL 489, Molded Case Circuit Breakers
4. UL 489 and 943, Ground Fault Circuit Interrupters
5. UL 489 and 1699, Arc Fault Circuit Interrupters
6. Loadcenters shall comply with the requirements of Federal Specification W-P-115B, Panel Power Distribution

C. Enclosures

1. Loadcenters shall have a [NEMA 1] [NEMA 3R with G90 galvanized steel] enclosure. Mounting as noted on the drawings
2. The knockouts shall be pre-stamped into the enclosure.
3. The trims shall have mounting tabs so that the cover can be hung in place freeing both hands to install the hardware.
4. The width shall be 14-3/8" wide to fit between standard wall studs.

D. Interior

1. The interior shall be convertible from main breaker to main lug and vice-versa. The main shall be designed for straight in wiring. Bending the cable 90 degrees is not required.
2. The neutral bar shall be visible to simplify the insertion of neutral conductors.
3. The screws shall be installed in the neutral, bond and ground bars, yet backed out so that the installer can quickly land neutral and ground wire.
4. The screws for the neutral, ground, breaker, trim and pan adjustment shall have a combination head to fit a square and a flathead slot.
5. The circuit numbers shall be stamped on the dead front.

E. Breakers

1. The loadcenter main circuit breakers as indicated on the drawings.
2. The loadcenter with main lugs, as indicated on the drawings.
3. Indoor loadcenters shall be 180 degree invertible.

4. The breakers shall be fully rated and shall be plug-in type. The breakers shall be molded case and thermal-magnetic rated as noted on the drawings. The terminals shall be rated for copper or aluminum conductors.
5. The loadcenter shall be designed to accept a surge arrestor breaker that mounts inside the panel in a 2-pole breaker position. The surge arrestor will not reduce the quantity of useable breaker spaces. It shall be equal to Murray, model MSA2020SPDP
6. Ground fault circuit interrupters (GFCI) shall be installed where shown on the schedule.

F. Bus

1. The bus bar shall be copper for all installations.

G. SERVICE Entrance

1. The panel shall be labeled for use as service entrance equipment.]

2.09 UNDERGROUND DUCTBANKS

- A. General: Furnish and install the ductbanks and extension of existing as herein specified and as shown on the drawings.

B. Division of Work:

1. The General Contractor shall be responsible for the work and material required for the following:
 - a. Excavation
 - b. Backfill
 - c. Concrete envelope for conduits including reinforcing rods and tie down rods.
 - d. Brick or concrete collars to bring manhole frames and covers up to grade. Installation of frames and collars, which are to be furnished by the Electrical Subcontractor.
2. All other material, equipment, and labor required for the complete ductbank extension shall be furnished and installed by the Electric Subcontractor under this Section, including the following:
 - a. Service raceways.
 - b. Grounding material.
 - c. Detectable Ductbank warning tape. Equal to Ideal model, 42-251
 - d. Pre-cast manholes.

C. Materials

1. Conduit: Type Schedule 40 PVC where installed in concrete envelope. See BASIC MATERIALS SECTION.
2. Conduit Supports (duct system): Shall be molded plastic with interlocking lugs and skeletonized structure, minimum separation 3".
3. Tags: Non-ferrous metal or fiber, 1/4" high letters.
4. Detectable Warning tape shall be solid aluminum foil, 6" wide, as manufactured by Ideal Industries, and shall be installed above all ductbanks both high and low tension.

D. Duct System

1. The duct system shall consist of Schedule 40 PVC conduit encased in concrete except where otherwise specified. The size and number of conduits shall be as indicated on the drawings. Provide a pull wire in each conduit.
2. The entire length between manholes and end of ductbank shall be excavated and graded before any conduit is laid.
3. The ductbank shall be set on undisturbed earth.
4. The conduit shall be installed so that top of concrete is a minimum of 36" below finished grade unless otherwise indicated, and shall be laid to a minimum grade of 4" for each 100 feet of length. Duct system shall drain to manholes.
5. Changes in direction shall be made by long sweep bends, minimum radius 25 feet except that at the end of a run, within 10 feet of termination. Manufactured ends may be used having a minimum radius of 48 inches.
6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other, but shall be staggered a minimum of 6".
7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered, minimum space between joints in adjacent conduit shall be 6".
8. When the required number of conduits has been installed, securely tie the assembly together at distances not exceeding 7 feet. Tie shall consist of three (3) turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.
9. Duct envelope shall be of monolithic construction and shall be vibrated to eliminate voids.
10. Pouring of concrete shall be continuous throughout the length of construction. The end of the pour shall be interlocked or sloped. If the installation is halted, the ends of conduit shall be plugged.
11. Concrete shall not be poured until the conduit installation has been observed by the Architect.
12. Detectable Warning tape shall be installed during backfilling and shall be placed approximately 12" above the concrete encasement.
13. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and a stiff bristle brush shall be

pulled through each conduit. The mandrel shall not be less than 12" long and the diameter approximately 1/4" less than the conduit.

14. Manholes shall be furnished and installed by electrical Subcontractor. Provide frames and covers as indicated on the drawings.

2.10 BACKBONE CABLING

- A. Optical Fiber Cable: In addition to meeting the applicable performance specifications, all optical fiber cable shall be appropriate for the environment in which it is installed.

B. Fiber Connectors

1. LC Connector – Singlemode

- a. Meet the Fiber Optic Connector Intermateability Standards (FOCIS) specifications of TIA-604-10A.
- b. Be available in simplex and duplex versions.
- c. Utilize same termination kit available for ST and SC versions with the addition of an LC upgrade kit.
- d. Have a quick field termination process, which does not require power.
- e. Have a termination process, which incorporates use of a reliable anaerobic adhesive, which has a high resistance to environmental extremes.
- f. Utilize a precision Zirconia ceramic ferrule.
- g. Have jacketed and buffered versions.
- h. An outer housing color-coded (blue) in accordance with TIA and ISO cabling standards.
- i. Meet the following performance specifications:

Parameter	Performance (dB)
Insertion Loss (typ)	0.1
Insertion Loss (max)	< 0.2
Durability (500 cycles)	< 0.1
Return Loss (min)	55

C. Generic XGLO Singlemode Cable

1. Qualified singlemode optical fiber cables shall meet all of the following industry standards: ISO/IEC 11801:2011 Ed2.2 OS1, ANSI/TIA-568-C.3, Telcordia GR-409-CORE and ITU-T G.652.C. Attenuation and Zero Dispersion limits are noted below for convenience

Fiber	Cable Type	Maximum Attenuation (dB/km)			Zero Dispersion		Index of Refraction	
		1310 nm	1385 nm	1550 nm	Wavelength (nm)	Slope (nm ² •km)	1310 nm	1550 nm
Singlemode	Inside Plant	0.50	0.50	0.50	1300-1324	< 0.093	1.467	1.468
	Outside Plant	0.35	0.35	0.25				

2. Attenuation:
Qualified cables shall perform in accordance with the attenuation limits as noted above when tested per ANSI/TIA-455-46, -53, -61 or -78 (as applicable).
3. Zero Dispersion Wavelength and Slope:
Qualified cables shall perform in accordance with the Zero Dispersion wavelength and slope limits as noted above when tested per ANSI/TIA-455-168, -169, or -175 (as applicable).
4. Physical Characteristics:

Mode and Fiber Type	Core Size (Microns)	Cladding Size (Microns)	Coating Size (Microns)	Buffer Size (Microns)	Core Cladding Concentricity (Microns)
Singlemode	8.3 ± 1.0	125 ± 1.0	245 ± 10	900 ± 50	≤ 0.8

5. Shall be able to support extended distance 10 Gigabit Ethernet (>550m) applications as well as emerging applications such as 40 Gb/s Synchronous Optical Network (SONET).
6. Be available in cable ratings including OFNR and OFNP.

D. Fiber Enclosures: All interconnect centers, panels and trays (units) shall provide cross-connect, inter-connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers.

1. Not be bigger than one rack mount space and accommodate up to 36 ports for LC.
2. Have preloaded adapter plates in 6 and 8-port version,
3. Have blank adapter plates for future growth of the fiber infrastructure.
4. Have six and eight port fiber adapter plates, which allow for color coding connectors.
5. Have fiber adapter plates with snap-in installation and one-finger removal.
6. Accommodate hybrid adapter plates for ST-to-SC or SC-to-ST connections.
7. Be modular in design with internal fiber managers that provide slack storage to comply with fiber bend radius and the recommended slack storage length.
8. Have a snap-on front shield to be used as a labeling surface and to protect jumpers. This shield can also relocate to another position during termination to maintain circuit identification.
9. Accommodates a splice tray for mechanical or fusion splices.

10. Be available with a drawer mechanism, which allows the panel to slide forward or to the rear, and has defeatable latches to allow removal from the rack or cabinet.
11. Must be certified by Underwriters Laboratories to United States Standards.
12. Siemon Fiber Connect Panel FCP3 Recommended

PART 3 - EXECUTION

3.01 WORK COORDINATION AND JOB OPERATIONS

- A. Equipment shall not be installed in congested and possible problem areas without first coordinating installation of same with other trades. Relocate electrical equipment installed in congested or problem areas should it interfere with the proper installation of equipment to be installed by other trades.
- B. Particular attention shall be directed to coordination of lighting fixtures and other electrically operated equipment requiring access which is to be installed in ceiling areas. Coordinate with other trades, the elevations of equipment in hung ceiling areas to insure adequate space for installation of recessed fixtures before said equipment is installed. Conflicts in mounting heights and clearances above hung ceilings for installation of recessed lighting fixtures or other electrically operated equipment requiring access shall be brought to the attention of Architect for a decision prior to equipment installation.
- C. Furnish to General Contractor and other subcontractors information relative to portions of electrical installation that will affect other trades sufficiently in advance so that they may plan their work and installation.
- D. Obtain from other trades information relative to electrical work which he, the Electrical Subcontractor, is to execute in conjunction with installation of other trades' equipment.
- E. Lighting fixtures in mechanical spaces or utility/ storage rooms shall only be installed after all mechanical equipment is in place.

3.02 PLANS AND SPECIFICATIONS

- A. Plans:
 1. Drawings showing layout of electrical systems indicate approximate location of raceways, outlets and apparatus. Runs of feeders and branch circuits are schematic and are not intended to show exact routing. Final determination as to routing shall be governed by structural conditions and other obstructions.

B. Specifications:

1. Specifications supplement drawings and provide specifics pertaining to methods and material to be used.

3.03 IDENTIFICATION

A. Equipment shall be marked for ease of identification as follows.

1. Provide screw on nameplates on switchboards, panel boards, F.A. terminal cabinets, starters, and disconnect switches. Nameplates to be of black phenolic with white engraving. For starters and disconnect switches lettering shall be minimum of 1/4" high. Nameplates on panel boards shall have the following information.
 - a. Line 1 - Panel designation in 1/2" high letters.
 - b. Line 2 - Utilization voltage in 3/8" high letters.
 - c. Line 3 - Distribution source "Fed from ____" in 1/4" high letters.
 - d. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panel boards. Spare circuits shall be penciled.
 - e. Color coding schedules. If there is more than a single system voltage, different voltages shall have secondary switchboard and distribution panel and shall be of the phenolic nameplate type as previously specified. A typewritten color code schedule shall also be affixed, under plastic, inside each panel board door.
 - f. Outlet boxes both concealed and exposed shall be identified as to panel origination and circuit number by means of fibre pen on the inside of cover plate.
 - g. All conductors in boxes larger than standard outlet boxes, in all wireways, trench headers, etc. shall be grouped logically and be identified.
 - h. Grounding conductors and neutrals shall be labeled in panels, wireways, etc. as to circuits associated with.

3.04 PROTECTION AND CLEANUP

A. Protection

1. Materials and equipment shall be suitably stored and protected from weather.
 - a. During progress of work, pipe and equipment openings shall be temporarily closed so as to prevent obstruction and damage.
 - b. Be responsible for maintenance and protection of material and equipment until final acceptance.

B. Cleanup

1. Keep job site free from accumulation of waste material and rubbish. Remove all rubbish, construction equipment, and surplus materials from site and leave premises in a clean condition.
 - a. At completion, equipment with factory finished surfaces shall be cleaned and damaged spots touched up with the same type paint applied at factory.
 - b. Particular attention is called to Article 110 12(c) of the NEC, which requires that internal parts of electrical equipment not be contaminated by construction operations.

3.05 PORTABLE OR DETACHABLE PARTS

- A. Retain possession of and be responsible for spare parts, portable and detachable parts, and other removable portions of installation including fuses, keys, locks, blocking clips, inserts, lamps, instructions, drawings, and other devices or materials that are relative to and necessary for proper operation and maintenance of the system until final acceptance, at which time such parts shall be installed or turned over to the Owner, as the case may be.

3.06 SAFETY PRECAUTIONS

- A. Provide proper guards, signage, and other necessary construction required for prevention of accidents and to insure safety of life and property. Remove any temporary safety precautions at completion.

3.07 MOUNTING HEIGHTS

- A. All electrical equipment shall be mounted at the following heights unless noted or detailed otherwise on drawings. Notes on architectural drawings shall supersede those noted below or detailed on the electrical drawings. If mounting height of an electrical component is questionable, obtain clarification from Architect before installation.
 1. Duplex convenience outlets, microphone outlets, and telephone outlets - 18 inches.
 - a. Light switches, pushbutton stations, HOA switches, and all other toggle or control switches for the operation of heating, ventilating, and air conditioning, plumbing, and general service - 48 inches.
 - b. Panelboards for lighting, power, telephone, and other auxiliary systems - 78" to top.

- c. Equipment located in lobbies shall be located as detailed on architectural drawings or as directed by Architect.
 - d. Exterior and interior wall brackets shall be as detailed on architectural drawings or as directed by Architect.
- B. Mounting heights given are from finished floor to centerline. In the case of a raised floor, surface of raised floor is the finished floor.

3.08 WORKMANSHIP AND INSTALLATION METHODS

- A. Work shall be installed in first class manner consistent with best current trade practices. Equipment shall be securely installed plumb and/or level. Flush mounted outlet boxes shall have front edge flush with finished wall surface. No electrical equipment shall be supported by work of other trades. Cable systems shall be supported and not draped over ducts and piping or laid on ceiling suspension members. Lighting fixtures shall be installed to agree with Architects reflected ceiling plans.
- B. Supports
 - 1. Support work in accordance with best industry practice and by use of standard fittings.
 - 2. In general, walls and partitions will not be suitable for supporting weight of panelboards, dry type transformers and the like. Provide supporting frames or racks extending from floor slab to structure above.
 - 3. Provide supporting frames or racks for equipment, intended for vertical surface mounting in free standing position where no walls exist.
 - 4. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of equipment.
 - 5. Provide 3/4" thick painted plywood mounting surfaces in all electric and telephone areas and for all equipment on free standing racks. All plywood shall be fire retardant and painted both sides and edges with 2 coats of white paint.
 - 6. No work for exposed installations in damp locations shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4" air space between building surfaces and work.
 - 7. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric raceways or cables for support. All outlet, pull, and junction boxes shall be independently supported.
 - 8. Nothing shall rest on, or depend for support on, suspended ceiling or its mounting members.
 - 9. From outlet box by means of an interposed metal strap, where weight is less than five pounds.

10. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
11. Where support members must of necessity penetrate air ducts, provide airtight sealing provisions which allow for a relative movement between the support members and the duct walls.
12. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.
13. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, provide proper dunnage as required to distribute the weight in a safe manner.
14. Support metallic raceways by either running within steel frame or hung from the building frame. Anything hung from building frame shall be attached with metallic fasteners.

C. Fastenings

1. Fasten electric work to building structure in accordance with the best industry practice.
 - a. Where weight applied to attachment points is 100 pounds or less, fasten to building elements of:
 - b. Wood - with wood screws.
 - c. Concrete and solid masonry - with bolts and expansion shields.
 - d. Hollow construction - with toggle bolts.
 - e. Solid metal - with machine screws in tapped holes or with welded studs.
 - f. Where weight applied to attachment points exceeds 100 pounds, fasten as follows:
 1. At field poured concrete slabs, provide inserts with 18" minimum length slip through steel rods, set transverse to reinforcing steel.
 2. Where building is steel framed, utilize suitable auxiliary channel or angle iron bridging between structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
 - g. Floor mounted equipment shall not be held in place solely by its own dead weight. Provide floor anchor fastenings. Floor mounted equipment over 72 inches in height shall also be braced to nearest wall or overhead structural elements.
 - h. For items which are shown as being mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging to building structural elements.

- i. Fastenings for metallic raceways using the fastening as support shall be of the metallic type. Fastenings to hold raceways or cables in place may be via tie wraps.

D. General Raceway Installation

1. Install the various types of raceways in permitted locations as previously specified. All raceways shall be run concealed. Consult Architect for instruction for raceways which must be exposed in public spaces.
 - a. Raceways for normal emergency or emergency only wiring cannot contain other conductors.
 - b. Raceways shall be properly aligned, grouped, and supported in accordance with code. Exposed raceways shall be installed at right angles to or parallel with structural members. Concealed raceways may take most direct route between outlets.
 - c. Raceways run on trapeze hangers shall be secured to the trapeze.
 - d. Raceways shall be continuous and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from service to all outlets. Provide grounding bushings and bonding jumpers where raceways attach to painted enclosures or terminate below equipment.
 - e. Where raceways enter boxes, cabinets, tap boxes, other than those having threaded hubs, a standard locknut shall be used on the outside and locknut and bushing on the inside.
 - f. Where raceways terminate below equipment and there is no direct metal-to-metal continuity, provide grounding bushings on raceways and interconnect with equipment grounding conductor.
 - g. All empty raceways shall be provided with a pull wire.
 - h. All raceway sleeves, stub ups, or stub outs, where not connected to a box or cabinet, shall be terminated with a bushing.
 - i. All raceway joints shall be made up tight and no running threads will be permitted.
 - j. Where raceways are cut, the inside edge shall be reamed smooth to prevent injury to conductors.
 - k. All vertical raceways passing through floor slabs shall be supported.
 - l. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.
 - m. Electric raceways and/or sleeves passing through floors or walls shall be of such size and in such location as not to impair strength of construction. Where raceways alter structural strength or the installation is questionable, the structural engineer shall be contacted for approval.
 - n. Raceways shall not run directly above or below heat producing apparatus such as boilers, nor shall raceways run parallel within 6

- inches of heated pipes. Raceways crossing heated pipes shall maintain at least a 1 inch space from them.
- o. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.
 - p. Raceways passing between refrigerated and non-refrigerated spaces and those penetrating enclosures with air movement shall be provided with seals.
 - q. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.
 - r. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.
 - s. Each exterior raceway or assembly in a ductbank shall be provided with continuous detectable warning tape installed 12 inches above raceway or ductbank.
 - t. Underground rigid non-metallic raceways where allowed and run as a ductbank encased in concrete shall be installed with plastic spacers to ensure a separation of 3 inches between raceways. Top of ductbanks shall be 30 inches below grade, unless otherwise detailed.
 - u. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.
 - v. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.
 - w. Raceways entering building through foundation wall into a basement area shall be provided with wall entrance seals or with other acceptable waterproofing method.

E. General Outlet Box Installation:

- 1. Boxes shall be set flush with finish surface and provided with proper type extension rings or plaster covers. Through-the-wall boxes are not permitted. Check device or fixture to be mounted to box to ensure box orientation is proper.
 - a. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operation.
 - b. Remove knockouts only as required and plug unused openings.
 - c. Where required for horizontal and vertical alignment of boxes in stud partitions, bar hangers spanning two studs shall be used. Device boxes for insertion type receptacles shall be provided with far side box supports where there are less than two entering nonflexible raceways, and where bar rangers are not provided.
 - d. Boxes flush mounted in fire rated partitions and on opposite sides of the partition shall be separated by a distance of 24 inches in accordance with UL listing for the box.

- e. Locations of outlets indicated on drawings are approximate. For items exposed to view, refer to architectural drawings and coordinate locations with masonry joints, panel joints, ceiling grids, structural members, etc.
- f. In case of conflict with standard mounting heights and device alignment, consult Architect prior to roughing.
- g. Check all door swings on architectural drawings to ensure lighting switches are installed on strike side of door.
- h. The right to make any reasonable change in location of outlets prior to roughing is reserved by Architect. "Reasonable change" shall be interpreted as movement within 10 feet of location shown.
- i. Obtain dimensioned plan from Architect for floor outlets.
- j. Outlet boxes for use where surface metal raceways are allowed shall be of a type specifically designed to be used with such surface metal raceway systems.

F. Conductor Installation

- 1. No conductors shall be pulled into individual raceways until such raceway system is complete and free of debris. No harmful lubricants shall be used to ease pulling.
 - a. All conductors shall be wired so that grounded conductor is unbroken; switches in all cases being connected in ungrounded conductor.
 - b. Connections throughout the entire job shall be made with solderless type devices of approved design satisfactory to Inspector of Wires.
 - c. All taps and splices shall be insulated equal to that of conductor insulation.
 - d. All conductors of each feeder in pull boxes etc. shall be grouped, tied together, supported, and identified.
 - e. All conductors in panelboards and other wiring enclosures shall be neatly formed and grouped.
 - f. All conductors of emergency only and/or normal/emergency shall be run in separate raceway systems to final outlet box.
 - g. Provide support for conductors in vertical raceways in accordance with Article 300 19.
 - h. Strip insulation from conductors with approved tools and only of sufficient length for proper termination. Cutting of conductor stranding is unacceptable.
 - i. Taps from paralleled conductors shall be of a type which tap each conductor, such as ILSCO "PTA" series.
 - j. Grounding conductors are to be identified as to associated power circuits.

G. Stranded Conductor Installation

1. If Contractor selects stranded conductors for # 10 AWG and smaller, terminate such conductors as follows:
 - a. No stranded conductor may be terminated under a screw head. Provide insulated terminal lugs for all screw connections equal to Thomas & Betts "STA KON" type RC with forked tongue and turned up toes. Installation of lugs shall be done with compression tool such as T&B WT 145C which prevents opening of tool until full compression action is completed.
 - b. Backwired wiring devices shall be of clamp type; screw tightened. Force fit connections not allowed.
 - c. Stranded conductors will not be allowed for fire alarm work.

H. Accessibility

1. Electrical equipment requiring service or manual operation shall be accessible.
 - a. Work switches for equipment within accessible hung ceiling spaces, such as fan powered terminal boxes, shall be located at terminal box, and so located so as to be accessible.

I. Vibration Elimination

1. All equipment connections to rotating equipment or equipment capable of vibration shall be made up by flexible raceways.

J. Wiring Device Gaskets

1. Provide wiring device gaskets at coverplates where device is mounted in wall separating conditioned and non-conditioned spaces.

3.09 FEEDER CIRCUITS

- A. Provide feeders as called for on the drawings.

3.10 BRANCH CIRCUITS

- A. Provide all branch circuit wiring and outlets for a complete and operating system. The system shall consist of insulated conductors connected to the panelboards and run in raceways or as cable systems if permitted under products section, as required to the final outlet and shall include outlet boxes, supports, fittings, receptacles, plates, fuses, etc.
- B. Physical arrangement of branch circuit wiring shall correspond to circuit numbering on drawings. Ground fault circuit breakers and isolated ground outlets

shall be wired with separate neutrals and separate grounding conductors per circuit. A consistent phase orientation shall be adhered to throughout project at terminations.

- C. Circuits feeding three-phase equipment shall not be combined into common raceways, unless specifically indicated.
- D. All wiring in panelboards and cabinets shall be neatly formed and grouped.

3.11 FIREPROOFING AND WATERPROOFING

A. Examination

- 1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.

- B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.

- C. Provide masking and temporary covering to protect adjacent surfaces.

- D. Do not proceed until unsatisfactory conditions have been corrected.

E. Installation

- 1. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- 2. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

F. Field Quality Control

- 1. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.
- 2. Keep areas of work accessible until inspection by authorities having jurisdiction.
- 3. Where deficiencies are found, repair firestopping products so they comply with requirements.

G. Adjusting and Cleaning

- 1. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.

2. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

H. Schedules

	Concrete Floor	Concrete Wall	Gypsum Board Wall
Penetrant Type			
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101	
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Conduits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076	W-L-2093, W-L-2241
Cables	F-A-3021, F-A-3037	W-J-3098, W-J-3130, W-J-3158, W-J-3180	W-L-3218, W-L-3255, W-L-3306, W-L-3377

3.12 CUTTING AND PATCHING

- A. All cutting of surfaces, including core drilling of walls and slabs, shall be done by Electrical Subcontractor. Openings through new wall surfaces will be provided by General Contractor if Electrical Subcontractor gives suitable notice as erection of surface proceeds. If suitable notice is not given, Electrical Subcontractor shall then be responsible for cost of corrective work required.
- B. Patching will be provided by the trade responsible for the surface to be patched.

3.13 DISTRIBUTION EQUIPMENT TESTING

- A. All dry-type transformers, individual motor starters, switchboard and main distribution panels, motor controls, motor control centers, feeder conductors, branch circuits and emergency systems shall be tested in accordance with the following. In general, all tests shall be done in accordance with the 2009 Acceptance Testing Specifications of the International Electrical Testing Association.
- B. The Testing Subcontractor may be an independent contractor or a manufacturer of the equipment which is to be tested.
- C. Test report forms, delineating tests to be made, and method of recording same shall be submitted prior to commencing work. Test reports when submitted shall include interpretation of results and recommendation for any corrective work required.
- D. Load centers
 1. Visual Inspection:

- a. Check for foreign material within bus enclosure.
 - b. Check for missing hardware.
 - c. Inspect entire assemblies for transit damage or factory defects.
 - d. Check for all bus dimensions and bracing per specifications.
 - e. Check ratings of all protective relays per drawings.
 - f. Physical Inspection:
 - g. Torque all bus hardware to proper tension.
 - h. All doors and hinged panels open and close properly.
 - i. All circuit breakers operate, close and trip mechanically.
 - j. Torque all feeder conductors to terminal manufacturers' recommendations.
- E. Conductors: All secondary service conductors and all feeder conductors from switchboards and distribution panels shall be tested.
 - 1. Visual and mechanical inspection
 - a. Conductors to be inspected for physical damage and proper connection and sizing in accordance with single line diagram.
 - b. Conductor connections shall be torque tested to manufacturer's recommended values.
 - c. Electrical Tests
 - d. Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.
 - e. Perform continuity test to insure proper conductor connection.

3.14 SITE SURVEY

- A. Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables.
- B. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

3.15 CABLE PATHWAYS

- A. Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
- B. Grounding / Earthing and bonding of pathways shall comply with applicable codes and regulations.
- C. Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.

- D. The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.
- E. Pathways shall not be located in elevator shafts.

3.16 WORK AREA TERMINATION

- A. All balanced twisted-pair cables wired to the telecommunications outlet/connector, shall have 4-pairs terminated in eight-position modular outlets in the work area. All pairs shall be terminated.
- B. The telecommunications outlet/connector shall be securely mounted at planned locations.
- C. The height of the telecommunications faceplates shall be to applicable codes and regulations.

3.17 PULLING TENSION

- A. The maximum cable pulling tensions shall not exceed manufacturer's specifications.

3.18 BEND RADIUS

- A. The maximum cable bend radii shall not exceed manufacturer's specifications.
- B. In spaces with balanced twisted-pair cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
- C. During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

3.19 SLACK

- A. In the work area, a minimum of 300 mm (12 in) should be left for balanced twisted-pair cables, while 1 m (3 ft) be left for fiber cables.
- B. In telecommunications rooms a minimum of 3m (10 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

3.20 VELCRO CABLE TIE WRAPS

- A. Velcro Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These velcro wraps shall not be over tightened to the point of deforming or crimping the cable sheath.
- B. Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent.
- C. Siemon Company VCM Series Recommended.
- D. No plastic zip ties will be used on any telephone and data cabling.

3.21 GROUNDING

- A. All grounding / earthing and bonding shall be done to applicable codes and regulations.

3.22 WORKMANSHIP

- A. All work shall be done in a workman-like fashion of the highest standards in the telecommunications industry.
- B. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed.
- C. Workers must clean any debris and trash at the close of each workday.

3.23 TESTING

- A. Testing of all newly installed cable channels shall be performed prior to system cutover.
- B. Fiber Optic Testing
 - 1. Fiber horizontal cables shall be 100% tested for insertion loss and length.
 - a. Length shall be tested using an OTDR, optical length test measurement device or sequential cable measurement markings.
 - b. The horizontal link performance guarantees are as follows:
 - c. Backbone Fiber Testing:
 - d. Fiber backbone cables shall be 100% tested for insertion loss and length.
 - e. Insertion loss shall be tested at 1310 and 1550 for single-mode cabling in at least one direction using the Method A.1 (1-jumper) test procedure as specified in ANSI/TIA/EIA-526-7.

- f. Length shall be tested using an OTDR, optical length test measurement device or sequential cable measurement markings.

2. LightSystem – Backbone – Singlemode

Backbone Link Performance		
Parameter	Singlemode (1310/1550nm)	
	Inside Plant Cable	Outside Plant Cable
Max. Attenuation (dB)	4.50/4.50	3.00/3.00
Min. Return Loss (dB) ¹	26	
Zero Dispersion Wavelength (nm) ²	1300-1324	
Zero Dispersion Slope (nm ² •km) ²	< 0.093	

¹ If the insertion loss is within the limits as noted in the above chart, it is indicative that the Return Loss performance of the link will be within the limits as indicated.

² Dispersion is an important performance parameter, but because it is intrinsic to the fiber and cannot be adversely affected by installation practices, it does not require testing in the field.

- a. Acceptable attenuation test results shall be determined using the following calculation:
- b. Link Attenuation = Cable Attenuation + Connector Attenuation + Splice Attenuation where:

Cable Attenuation (dB) = Attenuation Coefficient (dB/km) x length (km)

Attenuation Coefficient (Inside Plant) = 1.0 dB/km @ 1310 and 1550 nm

Attenuation Coefficient (Outside Plant) = 0.5 dB/km @ 1310 and 1550 nm

Connector Attenuation (dB) = Number of Connector Pairs (n) x Connector Loss = n x 0.5 dB

Splice Attenuation (dB) = Number of Splices (s) x Splice Loss (dB) = s x 0.3 dB

3. XGLO – Backbone – Singlemode

Backbone Link Performance		
Parameter	Singlemode (1310nm/1550nm)	
	Indoor Cable	Outdoor Cable
Max. Attenuation (dB)	2.9/2.9	1.85/1.55
Zero Dispersion Wavelength (nm) ¹	1300 - 1322	
Zero Dispersion Slope (nm ² •km) ¹	<0.092	
Gigabit Transmission Distance (m) ²	3,000/3,000	
10 Gigabit Transmission Distance (m) ³	3,000/3,000	
Min. Return Loss (dB) ⁴	40	

¹ Dispersion is an important performance parameter, but because it is intrinsic to the fiber and cannot be adversely affected by installation practices, it does not require testing in the field.

² The protocol pertinent to the transmission distances as noted is Gigabit Ethernet per IEEE 802.3z.

³ The protocol pertinent to the transmission distances as noted is 10 Gigabit Ethernet per IEEE 802.3ae.

⁴ If the insertion loss is within the limits as noted in the above chart, it is indicative that the Return Loss performance of the link will be within the limits as indicated.

- a. Acceptable attenuation test results shall be determined using the following calculation:
- b. Link Attenuation = Cable Attenuation + Connector Attenuation + Splice Attenuation where:

Cable Attenuation (dB) = Attenuation Coefficient (dB/km) x length (km)

Attenuation Coefficient (Inside Plant) = 0.5 dB/km @ 1310 and 1550 nm

Attenuation Coefficient (Outside Plant) = 0.4 dB/km @ 1310; 0.3 dB/km @ 1550 nm

Connector Attenuation (dB) = Number of Connector Pairs (n) x

Connector Loss = n x 0.5 dB

Splice Attenuation (dB) = Number of Splices (s) x Splice Loss (dB) = s x 0.3 dB

4. XGLO – Horizontal – Singlemode

Horizontal Link Performance	
Parameter	Singlemode (1310nm/1550nm)
Max. Insertion Loss (dB)	0.8/0.8
Zero Dispersion Wavelength (nm) ¹	1300 - 1322
Zero Dispersion Slope (nm ² •km) ¹	<0.092
Gigabit Transmission Distance (m) ²	3,000/3,000
10 Gigabit Transmission Distance (m) ³	3,000/3,000
Min. Return Loss (dB) ⁴	40

¹ Dispersion is an important performance parameter, but because it is intrinsic to the fiber and cannot be adversely affected by installation practices, it does not require testing in the field.

² The protocol pertinent to the transmission distances as noted is Gigabit Ethernet per IEEE 802.3z.

³ The protocol pertinent to the transmission distances as noted is 10 Gigabit Ethernet per IEEE 802.3ae.

⁴ If the insertion loss is within the limits as noted in the above chart, it is indicative that the Return Loss performance of the link will be within the limits as indicated.

3.24 ADMINISTRATION AND DOCUMENTATION

A. Labeling

1. Horizontal and backbone cables shall be labeled at each end. The cable or its label shall be marked with its identifier.
 - a. A unique identifier shall be marked on each faceplate to identify it
 - b. Each port in the faceplate shall be labeled with its identifier.
 - c. A unique identifier shall be marked on each piece of connecting hardware to identify it as connecting hardware.
 - d. Each port on the connecting hardware shall be labeled with its identifier.

B. Drawings

1. As-built drawings shall be supplied by the contractor showing the locations of and identifiers for all:
 - a. Horizontal cable routing and terminations
 - b. Telecommunications outlets/connectors
 - c. Backbone cable routing and terminations

C. Records and Reports

1. All records shall be created by the installation contractor and turned over at the completion of work

- a. The format shall be computer based and both soft copies and hard copies shall be part of the As-built package. The minimum requirements include:
- b. Cable records must contain the identifier, cable type, termination positions at both ends, splice information as well as any damaged pairs/conductors.
- c. Connecting hardware and connecting hardware position records must contain the identifier, type, damaged position numbers, and references to the cable identifier attached to it.
- d. Test documentation on all cable types shall be included as part of the As-built package.
- e. All reports shall be generated from the computer-based program used to create the records above. These reports should include but not limited to:
- f. Cable Reports
- g. Cross-connect Reports
- h. Connecting Hardware Reports

3.25 WARRANTY

- A. Either a basic link or channel model configuration may be applied to the horizontal and/or backbone sub-systems of the structured cabling system. Applications assurance is only applied to a channel model configuration. All channels are to be qualified for linear transmission performance up to 250 MHz to ensure that high-frequency voltage phase and magnitude contributions do not prove cumulative or adversely affect channel performance.
- B. System Warranty
 - 1. A twenty (20) year warranty available for the category 6, structured cabling system shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware, and the labor cost for the repair or replacement thereof.
 - a. Additional features of the warranty shall include:
 - b. Margin over category 6 channel specifications on all parameters across the entire frequency range of 1-250MHz as noted in the following table:

Parameter	Guaranteed Margin 1-250MHz
Insertion Loss	4.3 – 8.1%
NEXT Loss	5.0 dB
PS NEXT Loss	7.0 dB
ACR	5.0 dB
PS ACR	7.0 dB
ACR-F	7.0 dB
PS ACR-F	9.0 dB
Return Loss	2.0 dB
Propagation Delay	0 ns
Delay Skew	5 ns

- c. Performance claims based on worst case testing and channel configurations.

C. Product Warranty

1. The manufacturer of passive telecommunications equipment used in a manner not associated with the Systems Warranty must have a minimum five (5) year Component Warranty on all its products.
2. The Products Warranty covers the components against defects in material or workmanship under normal and proper use.

D. Applications Supported

1. Existing and future applications supported for a channel model warranty include those approved by the Institute of Electronic and Electrical Engineers (IEEE), the Asynchronous Transfer Mode (ATM) Forum, the American National Standards Institute (ANSI) or the International Organization of Standards (ISO) that specify compatibility with the cable referenced herein.

END OF SECTION

SECTION 312000 – EARTHWORK

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section (excluding earthwork for building and retaining wall construction), including but not limited to the following:
 - 1. Excavation, backfill, and compaction for pavements, pads, utility trenches and structures, and landscaping.
 - 2. Preparation and protection of subgrades.
 - 3. Removal of underground utilities as applicable.
 - 4. Excavation of all unsuitable materials encountered below indicated subgrade elevations.
 - 5. Placement of subbase course for concrete pavements.
 - 6. Placement of subbase and base course for asphalt paving.
 - 7. Bedding for utility trenches.
 - 8. Dewatering and support of excavation of trenches and excavations.
 - 9. Removal of items covered by Section 012200 - UNIT PRICES as applicable.
 - 10. Disposal of unsuitable or excess excavated material.
 - 11. Coordinate with all trades for complete building and site utility systems.
 - 12. Coordination with maintenance of safe path of travel for the public.
- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. SECTION 024113 - SITE PREPARATION for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements.
 - 2. SECTION 312500 – EROSION AND SEDIMENTATION CONTROLS for temporary erosion and sedimentation control measures.
 - 3. Division 02, 22, 23, and 26 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
 - 4. SECTION 334000 – STORM DRAINAGE UTILITIES for installing underground drain pipes, manholes, area drains, water quality structures, and water storage tanks.

1.3 DEFINITIONS

- A. Backfill: Soil material or Controlled Density Fill (CDF) used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving and concrete paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

- E. Dewatering includes lowering the water table and intercepting seepage which would otherwise emerge from the slopes or bottom of the excavation; increasing the stability of excavated slopes; preventing loss of material from beneath the slopes or bottom of the excavation; reducing lateral loads on sheeting and bracing; improving the excavation and hauling characteristics of sandy soil; preventing rupture of heaving of the bottom of any excavation; and disposing of pumped water.
 - 1. Normal dewatering is defined as using conventional pumps installed in open excavations ditches, or sumps.
- F. Drainage Course: Course supporting the pavement that also minimizes upward capillary flow of pore water.
- G. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner's Representative or the Designer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner's Representative or the Designer. Unauthorized excavation, as well as remedial work directed by Designer, shall be without additional compensation.
- H. Fill: Soil materials used to raise existing grades.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material as defined herein, that cannot be removed by normal rock excavating equipment without systematic drilling, ram hammering, ripping, or blasting, when permitted.
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- L. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- M. Utilities: Onsite underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- N. Unsuitable Soils: Excavated soils that are determined by the Designer to not be reusable as fill or backfill on-site due to gradation, moisture content, and/or the presence of deleterious materials.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data: For the following:
 - 1. Each type of plastic warning tape.
 - 2. Geotextile.

3. Controlled Density Fill, including design mixture.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
 2. Laboratory compaction curve according to ASTM D 1557 for each onsite and borrow soil material proposed for fill and backfill.
- D. Dewatering system: Contractor shall submit, for record, drawings and design data prepared, stamped, and signed by a registered professional engineer in the Commonwealth of Massachusetts who is experienced in groundwater control system design. The submittal shall show arrangement locations, and details of wells and well points and sump pumps; locations of risers, headers, filters, pumps, power units, all treatment components, and discharge lines; and means of discharge, control of sediment, and disposal of water. The submittal of the dewatering system will not relieve the Contractor from the responsibility for the adequacy of the dewatering system to achieve the required results specified in these Specifications and all permit requirements.
1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 2. Include a written plan for dewatering operations including control procedures to be adapted if dewatering problems arise.
 3. Include design calculations demonstrating adequacy of the proposed dewatering system and equipment.
 4. Provisions and methods of sediment removal and disposal of water.
 5. All permits required for the work.
- E. Support of Excavation: Contractor shall submit, for record, proposed excavation support systems (if required). The proposed lateral support systems shall be designed and stamped by a registered professional engineer licensed in the Commonwealth of Massachusetts. Despite the submittal of the design of excavation support and protection systems, the Contractor shall remain solely responsible for the adequacy and safety of materials and methods used in construction. Include the following as a minimum on the drawings:
1. Details, arrangements, and methods of construction of the proposed system(s).
 2. The method of installation and installation equipment.
 3. The elevation of struts, shores, and tiebacks, as applicable, and permissible depth to which excavation may be carried before such supports are installed.
 4. The excavation depths, the depth below the main excavation to which the support system will be installed, and the maximum design load to be carried by various members of the support system.
 5. Design calculations including references to design methods used, assumptions, design parameters, design soil profile, material properties, allowable stresses, and other pertinent information stamped by a Professional Engineer registered in the Commonwealth of Massachusetts.
 6. The location of existing utilities, facilities and/or structures nearby.
- F. Pre-Excavation Photographs and Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins. Maintain catalog of up-to-date photographs at the site.
- G. Plan to Maintain Safe Path of Travel: Submit plans for maintaining safe paths of travel for the general public during the entire project, including requirement for police details of necessary.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by the Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify the Owner's Representative not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without the Owner's Representative's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
 - a. The Contractor shall notify "Dig Safe" at 1-888-DIG-SAFE prior to commencing any excavation work.
- B. Demolish and completely remove from site existing underground utilities and structures indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Neither the Owner nor the Geotechnical Engineer will be responsible for interpretations or conclusions drawn from the data.
 - 1. The geotechnical report does not represent and shall not be construed to represent a guarantee of subsurface conditions.
 - 2. Interpretation of this data for purposes of construction is the responsibility of the Contractor. It is the Contractor's responsibility to make interpretations and draw conclusions with respect to the character of materials to be encountered and groundwater conditions at the site and their impact upon Contractor's work based on his expert knowledge of the area, construction dewatering methods, and support of excavation methods.
 - 3. Make additional test borings and conduct other exploratory operations necessary for dewatering and excavation support and protection.
 - 4. The geotechnical report is referenced elsewhere in the Project Manual.
- D. Survey Work: Contractor shall engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During earth moving operations, installation of excavation support and protection systems and dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner's Representative if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- E. The Contractor shall not close or obstruct any street, sidewalk, or passageway without written permission from authorities having jurisdiction unless otherwise indicated on the Contract Drawings. The Contractor shall conduct the construction operations as to minimize interference with the use of roads, driveways, or other facilities near enough to the project to be affected by the work.
- F. The Contractor shall provide police details when working in roadways as required by local jurisdictional authorities. The Contractor shall pay for any and all police details.

1.6 EXCAVATION SUPPORT AND PROTECTION

- A. The Contractor shall furnish, install, monitor and maintain excavation support and protection systems (sheeting, shoring, and bracing) at locations necessary to support the sides of excavations and resist soil and hydrostatic pressure and superimposed and construction loads;

to prevent danger to persons or damage to adjacent pavements, facilities, utilities, or structures; to prevent injurious caving or erosion or the loss of ground; and to maintain pedestrian and vehicular traffic as required by the Contract Documents, the Contractor's sequence of construction, and as directed by the Owner's Representative.

- B. In all sheeting, shoring and bracing operations, care shall be taken to prevent collapse of excavations, injury to persons or damage to adjacent structures, facilities, utilities, and services. Any injuries to persons shall be the responsibility of the Contractor; and any damage to the work occurring as a result of settlement, water or earth pressure, or other causes due to inadequate bracing or other construction operations of the Contractor shall be satisfactorily repaired and made good by the Contractor, at no additional cost to the Owner.
- C. The excavation support system shall be of sufficient strength and be provided with adequate bracing to support all loads to which it will be subjected. The excavation support system shall be designed to prevent any movement of earth that would diminish the width of the excavation or damage or endanger adjacent structures.
- D. Where sheeting is to be used, it shall be driven ahead of excavation operations to the extent practicable so as to avoid the loss of material from behind the sheeting; where voids occur outside of the sheeting, they shall be filled immediately with ordinary fill, thoroughly compacted.
- E. The Contractor shall leave in place all sheeting and bracing at the locations and within the limits ordered by the Owner's Representative in writing. The Contractor shall cut off the sheeting at elevations as indicated on the Contract Drawings or to be determined with the approval of the Owner's Representative.
- F. The Contractor shall comply with all federal, state, and local safety regulations, and requirements.

1.7 DEWATERING

- A. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to maintain the excavated area sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The flows of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent property.
- B. Any damage resulting from the failure of the dewatering operations of the Contractor, and any damage resulting from the failure of the Contractor to maintain all the areas of work in a suitable dry condition, shall be repaired by the Contractor, as directed by the Owner's Representative and/or the Designer, at no additional cost to the Owner. The Contractor's pumping and dewatering operations shall be carried out in such a manner as to prevent damage to the Contract work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous to protect the work and/or to maintain satisfactory progress.
- C. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water from the trenches, excavations, and stormwater management operations shall be disposed of in such a manner as to avoid public nuisance, injury to public health or the environment, damage to public or private property, or damage to the work completed or in progress.
- D. The Contractor shall control the grading in the areas surrounding all excavations so that the surface of the ground will be properly sloped to prevent water from running into the excavated area. Where required, temporary ditches shall be provided to control drainage. Upon

completion of the work and when directed, all areas shall be restored by the Contractor in a satisfactory manner and as directed.

- E. Remove dewatering system when no longer required for construction.
- F. The Contractor shall obtain and maintain all required local, state, and federal permits necessary for construction dewatering for the duration of dewatering activities including all chemical testing required for disposal and discharge of dewatering effluent. The Contractor shall be responsible for treatment of water, if necessary, to meet minimum discharge criteria specified in the permits.

1.8 QUALITY CONTROL

- A. Inspection and testing will be performed by the Contractor to ensure that the materials placed meet the requirements in this section. Fill materials imported from off-site sources shall be chemically and geotechnically tested once for every 2,000 tons of material.
- B. If fill soils are not obtained from a commercial gravel pit, the Contractor shall provide certified analytical testing of offsite backfill to demonstrate that the soil does not exceed the limitations for MCP reference/reportable concentrations. Analyses shall include RCRA-8 metals, Extractable and Volatile Petroleum Hydrocarbons (EPH/VPH), and Volatile Organic Compounds (by EPA Method 8260B/5035). No testing will be required of imported fill soils obtained from a commercial gravel pit, provided the soils are free of odors, discoloration, staining or other conditions indicative of contamination, in the opinion of the Geotechnical Engineer and/or the Designer.
- C. Tests and analysis of soil material will be performed in accordance with ASTM D422, ASTM D1557, ASTM D2922, ASTM D3017 and ASTM D4318.
- D. If tests indicate materials do not meet specified requirements, the Contractor shall identify an alternative borrow source, test the new material, and submit results to the Designer at no cost to Owner.

1.9 LAYOUT AND GRADES

- A. The Contractor is responsible for establishing vertical and horizontal control for the work and shall establish permanent bench marks and replace as directed any that are destroyed or disturbed. The Contractor shall maintain sufficient reference points at all times during construction to properly perform site grading. The existing survey benchmark shall be protected throughout the construction project.
- B. Finished grades, contours, and elevations indicated on the Drawings describe final surface elevation for completed construction. The words "finished grade" as used herein shall mean final grade elevations indicated on the Drawings. Spot elevations shall govern over proposed contours. Where not otherwise indicated, project site areas shall be given uniform slope between points and existing established grades.

1.10 QUALITY ASSURANCE

- A. Field inspection and testing may be performed by a Geotechnical Engineer at the Owner's expense to supplement the Contractor's Quality Control testing. Classification of all materials will be made by the Geotechnical Engineer whose decision shall be final and binding on the Contractor.
- B. The Contractor shall be responsible for managing and tracking all materials excavated and placed in stockpiles for testing.

- C. Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.
- D. The Contractor is responsible for the adequacy of the dewatering systems.
 - 1. The dewatering systems shall be capable of effectively reducing the hydrostatic pressure and lowering the groundwater levels to a minimum of 2 feet below excavation bottom, unless otherwise directed by the Designer, so that all excavation bottoms are firm and dry.
 - 2. The dewatering system shall be capable of maintaining a dry and stable subgrade until the structures, pipes, and appurtenance to be built therein have been completed to the extent that they will not be floated or otherwise damaged.
 - 3. The dewatering system and excavation support shall be designed so that the lowering of the groundwater level outside the excavation does not adversely affect adjacent structures, utilities or other improvements.
- E. The Owner will perform in place density tests in accordance with ASTM D2922 or D3017 as the Work progresses, to determine the degree of compaction. Any corrective work required as a result of such tests, such as additional compaction, or a decrease in the thickness of layers, shall be performed by the Contractor at no additional expense to Owner. In place density testing shall be made at the Contractor's expense by a qualified geotechnical testing laboratory.
- F. The Designer's duties do not include the supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Designer nor any observation and testing by the Geotechnical Engineer shall excuse the Contractor from defects discovered in his Work at that time or subsequent to the testing.
- G. Contractor shall assist the Owner's Testing Laboratory in performing in-place density testing at a minimum frequency of one test per lift but no less than one test per 200 cubic yards of material placed in any one lift. Compaction testing will be performed in accordance with ASTM D1557, D2922, and D3017.
- H. Subgrades shall be approved for compactness and material composition prior to placing subsequent lifts. If inspections indicate Work does not meet specified requirements, the work shall be removed, replaced, and compacted at no additional cost to Owner.

1.11 REGULATORY REQUIREMENTS

- A. Comply with the Safety and Health regulations of the U.S. Department of Labor set forth in 29 CFR, Part 1926, and to the Massachusetts Department of Labor and Industries, Division of Industrial Safety "Rules and Regulations for the Prevention of Accidents in Construction Operations (454 CMR 10.0 et seq.). Contractors shall be familiar with the requirements of these regulations.
 - 1. All excavations shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P), State, and local requirements. Where conflict between OSHA, State, and local regulations exists, the most stringent requirements shall apply.
- B. Comply with governing EPA notification regulations before, during, and upon completion of dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Comply with all rules, regulations, laws, and ordinances of the municipality, the Commonwealth of Massachusetts, and other authorities having jurisdiction over the project site or work. All labor, materials, equipment, and services necessary to make the work comply with requirements shall be provided by the Contractor without additional cost to the Owner.

- D. The Contractor shall obtain and pay for all permits and licenses required to complete the work specified herein and indicated on the Contract Drawings.

1.12 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

PART 2-PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Ordinary Borrow: Ordinary borrow shall meet the requirements of MassDOT M1.01.0. It shall be well-graded, natural inorganic soil containing no stone greater than 6 inches maximum dimension. The materials shall be free of trash, ice, snow, tree stumps, roots, and other organic and deleterious materials. It shall be free of highly plastic clays, of all materials subject to decay, or other materials that will corrode piping or metals. Ordinary borrow shall have a maximum dry density of not less than 110 pounds per cubic foot. It shall be of such a nature and character that it can be compacted to the specified densities. Topsoil shall not be considered ordinary borrow. Existing available fill materials from onsite excavations may be reused as ordinary borrow if it meets the above requirements. It shall be graded within the following limits:

<u>U.S. Standard Sieve Size</u>	<u>Percent Finer by Weight</u>
6 inch	100
No. 10	30-90
No. 40	10-70
No. 200	0-15

- E. Gravel Borrow: Gravel borrow shall meet the requirements of MassDOT M1.03.0, Type B. It shall be an inert, hard, durable sand and gravel or stone soil obtained from an offsite commercial source. It shall be free of ice, snow, roots, sod, rubbish, oil, hazardous material, and other deleterious or organic matter. It shall be graded within the following limits:

<u>U.S. Standard Sieve Size</u>	<u>Percent Finer by Weight</u>
3 inch	100
½ inch	50-85
No. 4	40-75
No. 50	8-28
No. 200	0-10

- F. ¾" Crushed Stone: ¾" crushed stone shall meet the requirements of MassDOT M2.01.4. It shall consist of durable crushed rock or crushed gravel stone, free of ice, snow, sand, silt, clay, loam, shale, or other deleterious or organic matter. It shall be graded within the following limits:

<u>U.S. Standard Sieve Size</u>	<u>Percent Finer by Weight</u>
1 inch	100
¾ inch	90-100
½ inch	10-50
3/8 inch	0-20
No. 4	0-5

- G. 1-1/2" Crushed Stone: 1-1/2" crushed stone shall meet the requirements of MassDOT M2.01.1. It shall consist of durable crushed rock or crushed gravel stone, free of ice, snow, sand, silt, clay, loam, shale, or other deleterious or organic matter. It shall be graded within the following limits:

<u>U.S. Standard Sieve Size</u>	<u>Percent Finer by Weight</u>
2 inch	100
1-1/2 inch	95-100
1 inch	35-70
¾ inch	0-25

- H. Dense Graded Crushed Stone: Dense graded crushed stone shall meet the requirements of MassDOT M2.01.7. It shall consist of a mixture of crusher-run aggregate of crushed stone mixed with natural sand and gravel soil obtained from an offsite commercial source. It shall be free of ice, snow, roots, sod, rubbish, soil, hazardous material, and other deleterious or organic matter. It shall be graded within the following limits:

<u>U.S. Standard Sieve Size</u>	<u>Percent Finer by Weight</u>
2 inch	100
1-½ inch	70-100
¾ inch	50-85
No. 4	30-55
No. 40	8-24
No. 200	3-10

- I. Sand: Sand shall meet the requirements of MassDOT M1.04.1. It shall consist of clean inert, hard, durable grains of quartz or other hard durable rock, free from clay, organics, surface coatings, or other deleterious or organic matter. It shall be graded within the following limits:

<u>U.S. Standard Sieve Size</u>	<u>Percent Finer by Weight</u>
½ inch	100
3/8 inch	85-100
No. 4	60-100
No. 16	35-80
No. 50	10-55
No. 100	2-10

- J. Controlled Density Fill (CDF) shall be a cement concrete backfill material that flows like a liquid, supports like a solid when cured, and levels without tamping or vibrating to reach 100 percent compaction. CDF shall meet the requirements of MassDOT Specifications M4.08.00 for Type 1E (Very Flowable, Excavatable) or type 2E (Flowable, Excavatable) CDF. The mix formulation will be submitted to the Designer for review prior to placement of the material in the project.
- K. Reuse of Excavated Rock: Excavated on-site rock materials processed by the Contractor meeting the gradation limits for ¾" Crushed Stone, 1-1/2" Crushed Stone, Dense Graded Crushed Stone, and Stone for Pipe Ends contained herein may be segregated and reused as approved by the Owner's Representative and/or the Designer.

B. BEDDING COURSE AND VOID FILLER AGGREGATE

1. The bedding course and void filler aggregate for the permeable pavers and the shall be washed, crusher run, free of fines, organics and soluble salts or other contaminants likely to cause efflorescence. Color of aggregate shall be in a gray to closely match the color of the pavers. The grading requirement shall comply with the following table for ASTM No. 8:

ASTM No. 8 Grading Requirements for Bedding Course Aggregates

<i>ASTM Sieve Size</i>	<i>Percent Passing (by weight)</i>
1/2 in.	100
3/8 in.	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

C. BASE COURSE AGGREGATES

1. The base course aggregate for the pervious concrete shall consist of open-graded stone and comply with the following standards for ASTM No. 57:

ASTM No. 57 Grading Requirements for Bedding Course Aggregates

<i>ASTM Sieve Size</i>	<i>Percent Passing (by weight)</i>
1-1/2 in.	100
1 in.	95 to 100
1/2 in.	25 to 60
No. 4	0 to 10
No. 8	0 to 5

D. SUB-BASE COURSE

1. The sub-base course and void filler aggregate for the pervious concrete shall be washed, open graded stone and comply with the following standards for ASTM No. 2:

ASTM No. 2 Grading Requirements for Sub-Base Course Aggregates

<i>ASTM Sieve Size</i>	<i>Percent Passing (by weight)</i>
3 in.	100
2-1/2 in.	90 to 100
2 in.	35 to 70
1-1/2 in.	0 to 15
3/4 in.	0 to 5

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Elongation: 50% minimum; ASTM D 4632
3. Grab Tensile Strength: 160 lbs.; ASTM D 4632.
4. Trapezoid Tear Strength: 60 lbs.; ASTM D 4533.
5. CBR Puncture Strength: 410 lbs.; ASTM D 6241
6. Apparent Opening Size: No. 70 sieve maximum; ASTM D 4751.
7. Permittivity: 1.50 sec-1 minimum; ASTM D 4491
8. Water Flow Rate: 110 gal/min/SF minimum; ASTM D 4491
9. UV Stability: 70% after 500 hours' exposure; ASTM D 4355.

- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 1; AASHTO M 288.
2. Elongation: 15% maximum; ASTM D 4632
3. Grab Tensile Strength: 315 lbs.; ASTM D 4632.
4. Trapezoidal Tear Strength: 120 lbs.; ASTM D 4533.
5. Puncture Strength: 1,000 lbs.; ASTM D 6241.
6. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.05 sec-1 minimum; ASTM D 4491.
8. UV Stability: 70% after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

- A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer
White	Proposed Excavation

2.4 USES OF MATERIALS

- A. Fill materials listed in Paragraph 2.1 above shall be utilized as follows and as otherwise indicated on the Drawings, specified or directed.
- B. Gravel Borrow:
1. As fill and base coarse soils below cement concrete and hot-mix asphalt pavements as shown on the Contract Drawings.
 2. Trench backfill within paved areas.
 3. Bedding for ductile iron drain, water, and sewer piping.
- C. Dense Graded Crushed Stone:
1. As base course soils below cement concrete and hot-mix asphalt pavement as shown on the Contract Drawings.
- D. $\frac{3}{4}$ -inch and 1-1/2-inch Crushed Stone:
1. Base for drain manholes, catch basins, sewer manholes, and utility structures.
 2. Bedding for drain pipe and sewer pipe.
 3. Around perforated drain lines.
 4. To stabilize wet subgrade conditions.
 5. Elsewhere as shown on the Drawings or specified herein.
 6. To aid in dewatering.
- E. Sand:
1. Bedding for drain, water, sewer, and other utility piping.
 2. Elsewhere as shown on the Drawings or specified herein.
- F. Ordinary Borrow:
1. For general site fill outside of the proposed building footprint, concrete, and bituminous concrete areas.
 2. Trench backfill material outside of paved areas.
 3. Elsewhere as shown on the Drawings or specified herein.
- G. Geotextiles:
1. Subsurface non-woven Drainage Geotextile shall fully wrap 3-4-inch Crushed Stone.
 2. Use to prevent soil intrusion into drains and/or to assist in stabilizing soil subgrades prior to placement of fill materials.
 3. Subsurface woven separation geotextile as separation material between crushed stone and gravel borrow base materials below cement concrete and hot-mix asphalt pavement as shown on the Contract Drawings.
 4. Where indicated or shown in the Contract Drawings.
- H. Controlled Density Fill (CDF):
1. CDF shall be used as shown on the Contract Drawings.

2. CDF shall be used if directed by the DESIGNER as fill at the limits of the excavation areas.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The Contract Drawings indicate the proposed finish alignment, elevation, and grade of the work. Establish the line and grade in close conformity with the Contract Drawings.
- B. The Contractor is responsible for establishing construction phasing, means, and methods and interim grading and temporary conditions required to attain the finish product required by the Contract Documents. The Contractor is responsible for all construction, protection, movement, and maintenance of stockpiles. Establish and maintain suitable benchmarks and grade control to accurately perform the work.
- C. No excavation shall be deposited or stockpiled at any time to endanger portions of new or existing structures, either by direct pressure or indirectly by overloading banks contiguous to the operation. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of the construction. If there is not sufficient area available for stockpiling within the limits of the project, the Contractor will be required to furnish his own area for stockpiling.
- D. When the plans require excavation in areas in close proximity to existing buildings, roads, structures and utilities it shall be the responsibility of the Contractor at his expense to use satisfactory means and methods to protect and maintain the stability of such roads, and structures located immediately adjacent to but outside the limits of excavations.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Section 311000 - SITE CLEARING.
- C. Protect and maintain erosion and sedimentation controls, which are specified in Section 312500 – EROSION AND SEDIMENTATION CONTROLS, during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.3 DEWATERING

- A. Provide Dewatering as required to maintain dry excavations.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3. Where soil has been softened or eroded by flooding, equipment, traffic or placement of fill or concrete during unfavorable weather or such other conditions, it shall be removed and replaced by the Contractor with suitable material and at the Contractor's expense. The necessity and extent of such removals shall be determined by the Designer.
- D. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
- E. Monitor dewatering systems continuously.
- F. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
 1. Space well points or wells at intervals required to provide sufficient dewatering.
 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- G. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- H. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- I. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- J. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- K. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to the Owner.
 1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- L. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.4 EXCAVATION SUPPORT AND PROTECTION

- A. Work shall not be started until all materials and equipment necessary for the construction are either on the site of the work or satisfactorily available for immediate use as required.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
 1. Shore, support and protect utilities encountered.

- C. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner's Representative and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- D. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces or installation of improvements is not impeded.
- E. The excavation support and protection systems shall be securely and satisfactorily braced to withstand all pressures to which it may be subjected and be sufficiently tight to minimize lowering of the groundwater level outside the excavation.
- F. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- G. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.
- H. Responsibility for the satisfactory construction and maintenance of the excavation support system, complete in place, shall rest with the Contractor. Any work done, including incidental construction, which is not acceptable for the intended purposed shall be either repaired or removed and reconstructed by the Contractor at his expense
- I. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
 - 2. Fill voids immediately with approved backfill compacted to density specified herein.
 - 3. Repair or replace, as approved by Owner's Representative, adjacent work damaged or displaced by the installation, performance, and removal of the excavation support and protection systems.

3.5 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the dimensions noted herein:
- B. Provide sheeting, shoring and bracing to complete and protect all excavated areas, as required for safety and compliance with OSHA. Cost for sheeting, shoring and bracing shall be included as a part of the contract price for completing the work and Owner shall make no separate payment for this work.
- C. Perform excavation work in accordance with all applicable Federal, State, and Local regulations regarding safe excavation work.

- D. Excavation in the area of existing utilities. Expose utilities by hand or other excavation methods that will prevent damage. Required excavation near electric, gas, water lines, and fiber-optic telecommunication lines shall be hand dug within 3 feet of the lines.
- E. Do not excavate to full depths when freezing temperatures may be expected unless subgrades are protected from freezing.

3.6 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavation for Underground Tanks, Manholes, Basins, Mechanical and/or Electrical Utility Structures, Drainage and Sewer Systems, Infiltration Systems, and Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.7 EXCAVATION FOR WALKS AND PAVEMENTS

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

3.8 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
 - 2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
 - 3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.9 ROCK EXCAVATION

- A. Definitions and Classifications: The following classifications of excavation will be made only when rock excavation is required.
 - 1. "Earth Excavation" consists of removal and disposal of pavement and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, material of any classification indicated in data on subsurface conditions, and other materials encountered that are not classified as rock excavation.

2. "Rock Excavation" consists of removal and disposal of materials encountered that cannot be excavated without continuous and systematic drilling and blasting or continuous use of a ripper or other special equipment, except such materials that are classified as earth excavation. Typical of materials classified as rock excavation are as follows:
 - a. Rock or stone in original ledge.
 - b. Hard shale in original ledge.
 - c. Boulders on-site, outside trench limits, exceeding three cubic yards in volume.
 - d. Boulders within trench limits, exceeding one cubic yard in volume.
3. Should highly fractured or weathered bedrock be encountered during excavation, the following shall apply:
 - a. When the material is encountered in trenching operations or under footings, it shall be excavated or ripped with a hydraulic backhoe equal to or larger than Caterpillar 225 backhoe, and will be classified as Earth Excavation. When it is demonstrated that this material can no longer be removed with a hydraulic backhoe and requires drilling and blasting, this material shall be classified as Rock Excavation. For excavation procedures when this material is encountered under footings, refer to paragraph below.
 - b. When this material is encountered in open excavation, it shall be classified as earth excavation until drilling and blasting or continuous ripping is necessary as defined hereinabove.
4. Intermittent drilling and ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
5. Allowance for Rock Excavation: The Contractor shall carry in the Base Bid an allowance for rock encountered in trench excavation removed from the site. The Contractor shall also carry in the Base Bid an allowance for open rock excavation removed from the site. The Base Bid shall cover all costs relating to such rock excavation, including blasting, removal, disposal and replacement of the excavated material, overhead and profit. No amount other than that herein specified will be paid by the Owner for excavation herein defined.
 - a. If the total quantity of Rock Excavation, open and/or trench, exceeds the amount of Rock Excavation included in the Contract as listed above, the Owner shall pay the excess excavation at the unit price submitted in the Bid Form.
 - b. If the total quantity of Rock Excavation, open and/or trench, is less than the amount of Rock Excavation included in the Contract as listed above, the Contract sum will be decreased by the difference in Rock Excavation multiplied by the unit price submitted in the Bid Form.

B. Measurements:

1. When, during the process of excavation, rock is encountered, such material shall be uncovered and exposed in such a manner that the unbroken ledge surface is clearly visible, and the Owner's Representative and/or the Designer shall be notified by the Contractor, before proceeding further. The areas in question shall then be cross-sectioned as hereinafter specified.
2. Failure on the part of the Contractor to uncover such material and to notify the Owner's Representative and/or the Designer and proceeding by the Contractor with the rock excavation before cross-sections are taken, will forfeit the Contractor's right of claim towards the stated allowance or additional payment over and above the stated allowance at the quoted unit price.
3. The Contractor shall employ and pay for a licensed Registered Civil Engineer or Land Surveyor to take cross-sections of rock before removal and to make computations of volume of rock encountered within the Payment Lines. Cross-sections shall be taken

in the presence of the Owner's Representative and the computations approved by the Designer. The Owner has the option to perform independent cross-sections and computation of rock quantities.

4. Where removal of boulder or ledge is required outside the established payment lines, the extent of this removal and basis of payment shall be reviewed by the Owners Project Manager.
- C. Rock excavation for foundations outside of the Building Area: Remove rock to foundation or footing subgrade. All rock bottoms for foundations shall be carefully examined. Loose or shaken rock shall be removed to solid bearing, and the rock surface leveled, or shelved to a slope not exceeding one inch per two feet, or as directed.
- D. Excavate rock encountered in grading under paved areas, lawns and plant beds to subgrade as specified herein and shown on the Drawings. All boulders or protruding rock outcrops shall remain undisturbed at lawns and plant beds. Rock shall be fractured six inches below subgrade of paved areas but this six-inch layer shall remain in place. Rock in lawns and plant beds shall be similarly treated.
- E. Prepared rock subgrades shall be compacted with at least four passes of a self-propelled vibratory roller such as Dyna Pac CA-30D (44,000 lbs. Centrifugal force) or equivalent. Rock subgrades in utility trenches shall be recompacted with at least four passes a walk-behind vibratory drum roller or other equivalent equipment having at least 10,000 pounds centrifugal force and sufficient to provide a firm, stable subgrade.
- F. If any part of the rock excavation at footings to be carried beyond the depth and the dimensions indicated on the Drawings or called for in the Specifications, the Contractor shall, at his own expense, furnish and install concrete of same strength as footings to the required subgrade level of the footings as shown on the Drawings. Dowelling or other corrective structural measures may also be required to properly anchor or reinforce the concrete. If rock excavation is carried beyond the depth and dimensions to subgrade in other areas, the Contractor shall, at his own expense, furnish and install compacted gravel fill to subgrade.
- G. Basis of Payment: The total amount of rock excavation will be based upon the in-situ volume of rock excavated within and/or above the lines referred to in the next paragraph as "Payment Lines". The payment lines are only to be used as a basis of payment, and are not to be used as limits of excavation. Limits of excavation area as shown on the Drawings and as specified herein.

Payment Lines for Rock Excavation:

1. Payment lines for footings outside of the building shall be six inches below the bottom of footings. Vertical payment lines shall be as specified hereinafter.
2. Payment lines for manholes and catch basins shall be one-foot outside of the outer wall and six inches below subgrade beneath the structure.
3. Payment lines for rock excavation under slabs on grade shall be six inches below the bottom elevation of the specified gravel base course outside of the building and 12 inches below subgrade for slabs within the building. Payment lines for rock excavation at plant beds shall be 12" at edge and full depth of required elevation for loam.
4. Payment lines for rock excavation at paved areas and lawns shall be six inches below respective subgrades.
5. Payment lines for rock excavation under pipes for utility trenches outside the building lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus two feet for pipes up to 18 inches. For pipes 18 inches and larger payment lines shall in no case be calculated as greater in width than the outside diameter of the pipe plus three feet. Payment lines at bottom of all pipe and utility trenches shall be six inches below subgrade.

3.10 SUBGRADE INSPECTION

- A. Notify the Owner's Representative when excavations have reached required subgrade.
- B. If the Owner's Representative, Geotechnical Engineer and/or the Designer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll granular subgrade below structures and pavements with heavy vibrating drum roller to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with approved equipment weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Designer, and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Geotechnical Engineer and/or the Designer, without additional compensation.
- E. Protect all subgrades from disturbance.
 - 1. Place Gravel Borrow or Crushed Stone wrapped in non-woven geotextile over clayey, silty or wet footing subgrades. Fill shall not be placed in standing water.
 - 2. Grade around prepared subgrade areas to direct stormwater runoff away from the work area.
 - 3. Protect subgrades from frost at all times during construction. Fill should not be placed over frozen soil.

3.11 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavations under site improvement construction or utility pipe as directed by Designer. Lean concrete fill, with 28-day compressive strength of 2500 psi may be used when approved by Designer.

3.12 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials (from off-site sources) and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
 - 2. Stockpile soil materials in a location, acceptable to the Owner's Representative, that will preclude having to relocate stockpiled soil materials that would otherwise delay or impact the Work.

3.13 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.

7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on previously placed and compacted fill and/or subgrades free of mud, frost, snow, or ice.
 - C. Excavated on-site natural soils may be used as Ordinary Fill, provided the material can be placed and compacted as required herein and at the approval of the Designer.
 - D. The Contractor shall not commence backfilling operations without approval of the Owner's Representative and/or the Designer.
 - E. The Contractor shall maintain a dry and firm subgrade throughout construction. Dewatering shall be performed as needed at the Contractor's expense.
 - F. The Contractor shall strip the existing subgrade of any vegetation, topsoil, organics, debris, or other unsuitable materials. The subgrade shall be proof compacted using a vibratory roller to treat any loose or disturbed areas and to provide a dense uniform surface.
 - G. After the subgrade has been prepared, fill material shall be placed and built-up in successive layers until the required elevations are reached. No fill shall be placed on a frozen surface, nor shall snow, ice, or other frozen materials be included in fill. Wet materials containing moisture in excess of the amount necessary for satisfactory placement or compaction shall not be used.
 - H. All fill shall be brought up in essentially level lifts and shall be placed in levels by standard methods. Layers of fill outside of utility trenches shall not exceed nine (9) inches in uncompacted thickness before compaction, unless otherwise specified, or as required for proper subgrade stabilization.
 - I. Filling operations shall continue until the fill has been brought up to the finished slopes, lines, and grades making proper allowances for thickness of the overlying topsoil.
 - J. The entire surface of the work shall be maintained free from ruts and in the condition that will permit construction equipment to travel over any section readily. The top surface of each layer shall be made level or slightly sloped toward the center of the filled area.
 - K. Backfilling shall not be performed when weather conditions or the conditions of the materials are such that, in the opinion of the Geotechnical Engineer or the Designer, work cannot be performed satisfactorily.

3.14 BACKFILLING AGAINST STRUCTURES

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Backfilling against masonry or concrete shall not be done until permitted by the Owner's Representative. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage.
- C. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed and approved, special leakage tests of the structures shall be made by the Contractor, as required by the Owner's Representative. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in connection with the structures, the backfilling around the structures shall proceed using suitable and approved excavation material.

- D. The best of the backfill material shall be used for backfilling within 2-feet of the structure. Just prior to placing backfill, the areas shall be cleaned of all excess construction material and debris and the bottom of excavations shall be in a thoroughly compacted condition.
- E. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures. During backfilling operations, care shall be exercised that the equipment used will not overload the structures in passing over and compacting these fills. Except as otherwise specified or directed, backfill shall be placed in layers not more than 12 inches in loose depth and each layer of backfill shall be compacted thoroughly and evenly using approved types of mechanical equipment. Each pass of the equipment shall cover the entire area of each layer of backfill.
- F. In compacting and other operations, the Contractor shall conduct his operations in a manner to prevent damage to structures due to passage of heavy equipment over, or adjacent to, structures, and any damage thereto shall be made good by the Contractor at no additional expense to the Owner.

3.15 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 - CAST-IN-PLACE CONCRETE.
- D. Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.
- E. Place and compact initial backfill of subbase material free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- G. Backfill material shall be placed in maximum 6-inch lifts and mechanically compacted as specified herein.
- H. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- I. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.
- J. Any trenches or excavations improperly backfilled or where settlement occurs shall be reopened, to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and condition, at no additional expense to the Owner.
- K. During filling and backfilling operations, pipelines will be checked by the Owner's Representative to determine whether any displacement of the pipe has occurred. If the observation of the pipelines shows poor alignment, displaced pipe or any other defects they shall be

remedied in a manner satisfactory to the Owner's Representative at no additional cost to the Owner.

3.16 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
- C. Place soil fills on subgrades free of mud, frost, snow, or ice.

3.17 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
 - 3. Fill material shall not be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.

3.18 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

Area	ASTM Density Degree of Compaction
Pavement and walkway base course	95%
Pavement and walkway subgrade	95%
General fill below pavement and walkway subbase	95%
Trench backfill - below pavements	95%
- below landscaped areas	92%
- below structures	95%
All other areas	90%

- 1. Under structures and pavement, proof-compact existing subgrade. Compact each layer of backfill soil material at 95 percent of the soils' maximum dry density (per ASTM D 1557). Fill areas within the 1H:1V influence zone of foundations and retaining wall footings shall also be compacted to 95 percent of the soils' maximum dry density (per ASTM D 1557).

2. Under walkways, scarify and re-compact top 6 inches below subgrade to 95 percent of the soils' maximum dry density (per ASTM D 1557). Fill and base course material within 2 feet of the finished asphalt or concrete pavement grade shall be compacted to 95 percent of the soils' maximum dry density (per ASTM D 1557).
 3. For utility trenches in paved areas, compact each layer of initial and final backfill soil material to at least 95 percent of the soils' maximum dry density (per ASTM D 1557).
 4. For utility trenches in lawn or unpaved areas, compact each layer of backfill soil material to at least 92 percent of the soils' maximum dry density (per ASTM D 1557).
 5. Under lawn or unpaved areas, scarify and re-compact top 6 inches below subgrade and compact each layer of backfill or fill soil material to at least 90 percent of the soils' maximum dry density (per ASTM D 1557).
- D. In confined areas, place Crushed Stone in maximum 6-inch lifts and compact each lift with at least 4 passes of a vibratory plate compactor to a firm and unyielding surface. In open areas, place Crushed Stone in maximum 12-inch lifts and compact each lift with at least four passes of a vibratory drum roller with a minimum static weight of 10,000 pounds. Crushed stone fill shall be wrapped on all sides with non-woven filter fabric.

3.19 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.

3.20 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Division 2 Section "Subdrainage."
- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 1557.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 1557.
 2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.21 SUBBASE AND BASE COURSES

- A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
 - 1. Install separation geotextile fabric on prepared subgrade, where indicated on the Contract Drawings, according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place base course material over subbase course under hot-mix asphalt pavement.
 - 3. Shape subbase and base course to required crown elevations and cross-slope grades.
 - 4. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
 - 5. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 6. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.22 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under pavements, walkways and cast-in-place concrete slabs-on-grade as follows:
 - 1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.23 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Cooperate with the Independent Testing Agency engaged by the Owner for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
- B. Cooperate with field quality control personnel.
- C. Additional inspections and retesting of materials which fail to comply with specified material and installation requirements shall be performed at Contractor's expense.
- D. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. or less of paved area or structural slab, but in no case fewer than 3 tests.
 2. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained. Costs related to retesting due to unacceptable quality of work and failures discovered by the testing shall be borne by the Contractor.
- G. Notify the Independent Testing Agency a minimum of 72 hours prior to start of earthwork operations, to comply with Code requirement that a registered design professional be present at all times during backfill to assure adequate compaction with no bridging effects. The services of the Testing Agency, Geotechnical Engineer, and the Designer shall include but not be limited to the following:
1. Observation during excavation, backfilling, and compaction.
 2. Laboratory testing and analysis of fill materials specified or proposed for use as required.
 3. Observation of construction and performance of water content, gradation, and compactions tests at a frequency and at locations that he/she shall select. The results of these test will be submitted to the Owner's Representative so that the Contractor can take such action as is required to remedy any indicated deficiencies.
 4. Observation of proof-compaction of exposed subgrades. Proof-compaction may be waived if, in the opinion of the Geotechnical Engineer, disturbance will occur and cause loss of strength of underlying soil.
- H. The Contractor shall make provisions for allowing observations and testing of Contractor's Work by the Testing Agency and the Geotechnical Engineer, and the Designer. The presence of the Testing Agency, Geotechnical Engineering, and/or the Designer does not include supervision or direction of the actual work by the Contractor, his/her employees, or agents. Neither the presence of the Testing Agency, Geotechnical Engineer, and/or the Designer nor any observations and testing performed by those entities or any notice or failure to give notice, shall excuse the Contractor from defects discovered in his/her work.

3.24 PROTECTION

- A. No excavation will be permitted below a line drawn downwards at 2 horizontal to 1 vertical from the underside of the closest edge of any proposed in-place footing or utility at a higher elevation without providing adequate sheeting and bracing or underpinning to prevent loss of support of the footing or utility.
- B. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- C. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
1. Scarify or remove and replace soil material to depth as directed by Designer; reshape and recompact.
- D. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.25 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Contractor shall remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION

SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROLS

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Control measures to prevent all erosion, siltation, and sedimentation of wetlands, waterways, construction areas, adjacent areas and off-site areas.
 - 2. Control measures shall be accomplished adjacent to or in the following work areas:
 - a. Soil stockpiles and on-site storage and staging areas.
 - b. Cut and fill slopes and other stripped and graded areas.
 - c. Constructed and existing swales and ditches.
 - d. Retention ponds.
 - 3. The Contract Drawings indicate the minimum requirements for sedimentation and erosion control. The Contractor shall install all measures needed to control sediment and erosion as required by the Contractor and Sub-contractor's construction methods and operations, the weather conditions, and as directed by the Engineer.
 - 4. Additional means of protection shall be provided by the Contractor as required for continued or unforeseen erosion problems, at no additional cost to the Owner.
 - 5. Periodic maintenance of all sediment control structures shall be provided to ensure intended purpose is accomplished. Sediment control measures shall be in working condition at the end of each day.
 - 6. After any significant rainfall, sediment control structures shall be inspected for integrity. Any damaged device shall be corrected immediately.
 - 7. Maintain all erosion controls and systems established as part of Bid Package #1 Site Enabling, including maintaining stabilization of all slopes.
- B. Alternates: Not Applicable.
- C. Items to Be Installed Only: Not Applicable.
- D. Items to Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 0204113 – SITE PREPARATION for protection of existing trees and other vegetation to remain.
 - 2. Section 312000 – EARTHWORK for soil materials, excavating, backfilling, and site grading and removal of site utilities.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. At least 20 days prior to the start of the project, the Contractor shall submit an Appendix by a qualified person to the Draft Stormwater Pollution Prevention Plan (SWPPP) indicating project phasing, Contractor operation areas, work areas, stockpile locations, construction staging/sequencing, and sedimentation and erosion control measures to be used. This Appendix shall become part of the SWPPP that is to be updated and maintained by the Contractor.
2. As part of the Contract Closeout procedures, the Contractor is responsible for filing a Notice of Termination with the EPA once the project has been completed and is permanently stabilized. Stabilization is complete when all temporary storm water and erosion controls have been removed, all permanent storm water and erosion controls are in place and functional and all vegetated areas are at least 70% viable.
3. The Contractor shall provide the manufacturer's literature, material specification, and installation instructions for sedimentation and erosion control materials and devices for approval. Do not order materials until approval of certifications or test results has been obtained. Delivered materials shall match the approved submittals.

1.4 QUALITY ASSURANCE

- A. Comply with the requirements of Stormwater Pollution Prevention Plan prepared for the NPDES permit, which are incorporated herein by reference, and all other applicable requirements of governing authorities having jurisdiction. The specifications and drawings are not represented as being comprehensive, but rather convey the intent to provide complete slope protection and erosion control for both the project site and adjacent property.
 1. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to a sediment and erosion control plan specific to the site, that complies with EPA 832/R-92-005 or requirements of The City of Worcester Conservation Commission, whichever is more stringent.
- B. Erosion control measures shall be established at the beginning of construction and maintained during the entire period of construction. On-site areas which are subject to severe erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.
- C. The Contractor shall install and maintain sedimentation control devices during construction to prevent the movement of sediment from the construction site to off-site areas, into adjacent water bodies via surface runoff or into underground drainage systems. Measures to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at no additional cost to the Owner.
- D. All land-disturbing activities are to be planned and conducted to minimize the size of the area to be exposed at any one time, and the length of time of exposure.
- E. Surface water runoff originating upgrade of exposed areas should be controlled to reduce erosion and sediment loss during the period of exposure.
- F. When the increase in the peak rates and velocity of storm water runoff resulting from a land-disturbing activity is sufficient to cause accelerated erosion of the receiving stream bed, provide measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream.
- G. All land-disturbing activities are to be planned and conducted so as to minimize off-site sedimentation damage.
- H. The Contractor is responsible for cleaning out and disposing of all sediment once the storage capacity of the sediment facility is reduced by one-half.

- I. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- J. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

1.5 REFERENCE STANDARDS

- A. The following standards are applicable to the work of this Section to the extent referenced herein:
 - 1. "Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers and Municipal Officials", prepared by the Massachusetts Department of Environmental Protection, Bureau of Resource Protection, dated March 1997, reprinted May 2003.

1.6 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.7 PERMITS, CODES, AND REGULATIONS

- A. Comply with the conditions of the Order of Conditions issued by the City of Worcester Conservation Commission for this project.
- B. Comply with all rules, regulations, laws, and ordinances of the City and State, and all other authorities having jurisdiction over the project site. All labor, materials, equipment, and services necessary to make the work comply with such requirements shall be provided by the Contractor without additional cost to the Owner.
- C. Comply with all applicable regulations of the Commonwealth of Massachusetts Department of Environmental Protection (DEP) and the EPA.
- D. Comply with the requirements of the NPDES CGP for this project.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Straw Bales: Wire or nylon bound bales of straw, oriented around sides, rather than over and under.
- B. Stakes: Stakes for bales shall be one of the following materials: Wood stakes of sound hardwood 2 by 2 inches in size or steel reinforcing bars of at least No. 4 size. Lengths shall be approximately three feet.
- C. Straw Wattles
 - 1. Straw wattles shall consist of weed free rice straw inside biodegradable netting. Straw wattles shall measure at least 12 inches in diameter.

2. Stakes for wattles shall be one of the following materials. Lengths shall be approximately two feet (2').
 - a. Wood stakes of sound hardwood, one inch by one inch (1" x 1") in size.
 - b. Steel reinforcing bars of at least No. 4 size.
- D. Siltation Fence
1. Fabricated or prefabricated unit consisting of the following filter fabric properties:

a. Grab Tensile Strength (lbs)	124	ASTM D4632
b. Elongation at Failure (%)	15	ASTM D4632
c. Mullen Burst Strength (PSI)	280-300	ASTM D3786
d. Puncture Strength (lbs)	60-65	ASTM D4833
e. Water Flow Rate (gal/min/sf)	8-10	ASTM D4491
f. Apparent Opening Size (Sieve)	30	ASTM D4751
g. Ultraviolet Radiation Stability (%)	70-80	ASTM D4355
 2. Use only commercially available fabric that is certified in writing by the manufacturer for the purpose intended.
 3. Acceptable fabric materials include "Mirafi Envirofence" by Mirafi Construction Products, "Style 2130" by Amoco Fabrics Co., and "IVI 3617C Silt Fence" by Indian Valley Industries, Inc., or approved equal by the Engineer.
 4. Silt fence posts: Posts may be wood or metal. Wood post shall be a minimum 1¼ inch by 1¼ inch by 5 feet long hardwood stakes commonly used to support siltation fabric. Metal posts shall be a minimum of 1 inch wide and 5 feet long. Posts shall be spaced at a maximum distance of 8 feet on center.
 5. Provide suitable heavy nylon cord for securing abutting silt fence posts.
- E. Fencing: Steel posts shall be standard 6-foot long metal stamped drive stakes commonly used to support snow fences. Fencing shall be new four-foot height wood lath snow fencing. Provide suitable steel staples or heavy nylon cord for securing filter cloth to support system.
- F. Crushed Stone: Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious or organic material. The crushed stone shall be uniformly blended and shall conform to the following requirements.

Percent Passing by Weight		
Sieve Size	1 1/2-inch Stone	3/4-inch Stone
2-inch	100	---
1 1/2-inch	95-100	---
1 1/4-inch	---	---
1-inch	35-70	100
3/4-inch	0-25	90-100
1/2-inch	---	10-50
3/8-inch	---	0-20
No. 4	---	0-5

- G. Protective Measures: As temporary coverings on ground areas subject to erosion, provide one of the following protective measures, and as directed by the Designer with concurrence of the Owner's Representative:
 - 1. Hay or straw temporary mulch, 100 pounds per 1,000 square feet.
 - 2. Wood fiber cellulose temporary mulch, 35 pounds per 1,000 square feet.
 - 3. Tackifier for anchoring mulch or straw shall be a non-petroleum based liquid bonding agent specifically made for anchoring hay or straw.
 - 4. Provide natural (jute, wood excelsior) or man-made (glass fiber) covering with suitable staples or anchors to secure to ground surface. Note that wire staples and non-biodegradable coverings shall not be used for any area that will be mown turf.
 - 5. Temporary vegetative cover for graded areas shall be undamaged, air dry threshed straw or hay free of undesirable weed seed.
- H. Temporary Covers for Drainage Structures
 - 1. Filter fabric for use as temporary covers for drainage structures shall be the same as noted above for siltation fence.
 - 2. Wire mesh for use at temporary drainage structure covers shall be 6" x 6", W2.9 welded wire mesh.
 - 3. Crushed stone shall be as specified herein before.
 - 4. Silt-Sac, Hydro-FloGard + Plus Catch Basin Insert, Ultra-DrainGuard Insert, or approved equal, may be used in lieu of hay bales and filter fabric at catch basins.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The Contractor shall provide suitable and adequate means of sedimentation and erosion control during construction. Control measures shall prevent all erosion, siltation, and sedimentation of waterways, drainage systems, construction areas, adjacent areas and off-site areas. Work shall be accomplished on and/or adjacent to the following work areas:
 - 1. Earthwork stockpiles and on-site storage and staging areas.
 - 2. Cut and fill slopes and other stripped and exposed graded areas.
 - 3. Constructed and existing swales and ditches.
 - 4. Unestablished lawns and seeded embankments.
- B. Means of protection as noted on the Contract Drawings indicate the minimum provisions necessary. Additional means of protection shall be provided by the Contractor as required for continued or unforeseen erosion problems, at no additional expense to the Owner.
- C. Periodic maintenance of all sediment control installations shall be provided to ensure intended purposes are accomplished. Sediment control measures shall be in working condition at the end of each day.
- D. After any significant rainfall, sediment control devices shall be inspected for integrity. Any damaged device shall be corrected immediately.
- E. The Contractor shall provide adequate means of control of runoff, as to not detrimentally impact downstream conditions during construction. The Contractor shall plan his operations so that permanent drainage mitigation systems such as detention/retention/infiltration basins and chambers are in place and properly functioning prior to connecting upland drainage flows to these systems. The Contractor shall plan his operations such that downstream drainage

mitigation measures are in place and functioning before attempting to tie in upgradient drainage systems.

- F. In the event that the Contractor is unable to sequence the work so that construction of the permanent drainage mitigation systems precedes the upland work, then the Contractor shall submit a plan indicating his proposed methods of otherwise controlling runoff from the site.
- G. The "Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas" should be consulted as a guide for the selection and installation of Best Management Practices to suit the conditions encountered.

3.2 COMPOST SOCK:

- A. Compost socks shall be Filtrexx SiltSoxx or approved equal.
- B. Stakes for socks shall be one of the following materials. Lengths shall be approximately two feet (2').
 - a. Wood stakes of sound hardwood, one inch by one inch (1" x 1") in size.
 - b. Steel reinforcing bars of at least No. 4 size.

3.3 STABILIZED CONSTRUCTION ENTRANCE AND STONE BERMS

- A. Stone size: Use ASTM designation C-33, size No. 2 (1-1/2" to 2-1/2"). Use crushed stone.
- B. Length: As effective, but not less than 50 feet.
- C. Thickness: Not less than eight inches.
- D. Width: Not less than full width of all points of ingress or egress, but not less than 25 feet.
- E. Washing: When necessary, wheels shall be cleaned to remove sediment prior to entrance onto public right-of-way. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch, or watercourse through the use of sand bags, gravel boards or other approved methods.
- F. Maintenance: The entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spoiled, dropped, washed or tracked onto public rights-of-way must be removed immediately.
- G. Place crushed stone berms in locations required and as directed. Berms shall have side slopes of 1:3 or less.
- H. Inspect stone berms periodically and replace and/or regrade crushed stone as required.

3.4 SILT FENCING

- A. Excavate a 6-inch trench along the upstream side of the desired fence location.
- B. Drive fence posts a minimum of 1'-6" into the ground. Install fence, well-staked at maximum eight-foot intervals in locations as shown on Drawings. Secure fabric to fence and bury fabric end within the six-inch deep trench cut.
- C. Lay lower 12 inches of silt fence into the trench, 6 inches deep and 6 inches wide. Backfill trench and compact.

- D. Overlap joints in fabric at post to prevent leakage of silt at seam.
- E. Inspect siltation fence after major storm events and periodically and remove accumulated sediment and debris. If a breach or failure of the siltation fence occurs, the fence shall immediately be restored.

3.5 EROSION CONTROL GRASSING

- A. Grassing shall be applied according to the Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers and Municipal Officials.

3.6 INLET PROTECTION

- A. Install silt fence or straw bales around inlet as specified herein.
- B. Install temporary covers at drainage structure locations that may be subject to erosion infiltration and as directed by the Engineer.
- C. Inspect drainage structures periodically. Remove sediment accumulation and regrade or replace materials as required.

3.7 DUST CONTROL

- A. Throughout the construction period the Contractor shall carry on an active program for the control of fugitive dust within all site construction zones, or areas disturbed as a result of construction. Control methods shall include the following: Apply calcium chloride at a uniform rate of one and one-half (1 ½) pounds per square yard in areas subject to blowing. For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the contractor.
- B. The frequency and methods of application for fugitive dust control shall be as directed by the Designer with concurrence by the Owner's Representative.

3.8 TEMPORARY PROTECTIVE COVERINGS

- A. Place temporary soil coverings to control erosion and sedimentation on all disturbed or graded areas as required by the construction methods employed and as directed by the Engineer. Erosion control matting shall be installed in all areas seeded or hydroseeded with slopes of one vertical foot to three-foot horizontal, or steeper, immediately after such areas have been seeded and a hay mulch applied as follows:
 - 1. The area to receive matting shall have been recently seeded and shall have a smooth surface free from stones, clods or depressions.
 - 2. Roll out of the matting perpendicular to the slope, do not stretch the fabric. In drainage swales, center the fabric along the flow line. Install the matting in a check slot at the top and bottom of the slope and at the edges of the area to be covered. Check slots shall be six inches deep and six inches wide. Fabric shall extend down one wall of the check slot and across the full width of the base. Overlap edges of matting rolls four (4) inches minimum and overlap the ends eighteen (18) inches minimum.
 - 3. Install staples in check slots, edges, center, and ends of rolls by driving specified steel staples two feet on center over the entire area to be covered except at check slots and ends of rolls, where staples shall be placed six inches on center. All staples shall be driven below finished grade.
 - 4. Fill check slots with loam and tamp firmly.
 - 5. Reseed check slots and all disturbed areas per Specifications.

6. Following matting installation, roll the entire area with a smooth drum roller weighing between fifty and seventy-five (50-75) pounds per linear foot of roller. The finished installation of matting shall be firmly in contact with the seeded area and provide a smooth, finished appearance free from lumps or depressions.
- B. Install erosion control matting as a temporary ground cover in all disturbed or graded areas subject to erosion and as directed by the Engineer. The temporary ground cover shall protect the site from erosion until a full permanent lawn can be installed. Install and anchor in place temporary erosion control matting in accordance with manufacturer's printed instructions or as directed by the Engineer and remove all temporary erosion control matting prior to installation of a permanent lawn.
- C. Inspect protective coverings periodically and reset or replace materials as required.

3.9 TEMPORARY PROTECTIVE COVERINGS (AFTER GROWING SEASON)

- A. Place temporary covering for erosion and sedimentation control on all areas that have been graded and left exposed after October 30. Contractor shall have the choice to use either or both of the methods described herein.
- B. Hay or straw shall be anchored in-place by one of the following methods and as approved by the Designer with concurrence by the Owner's Representative: Mechanical "crimping" with a tractor drawn device specifically devised to cut mulch into top two inches of soil surface or application of non-petroleum based liquid tackifier, applied at a rate and in accordance with manufacturer's instructions for specific mulch material utilized.
- C. Placement of mesh or blanket matting and anchoring in place shall be in accordance with manufacturer's printed instructions.
- D. Inspect protective coverings periodically and reset or replace materials as required.

3.10 REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized against erosion, and with the approval of the Owner's Representative remove sediment control devices and all accumulated silt. Dispose of silt and waste materials offsite. Regrade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated.

End of Section

SECTION 31 60 00 - GROUND IMPROVEMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION OF WORK

- A. The work consists of improving the existing ground by means of aggregate pier soil reinforcement or by means of rigid inclusions as specified herein. Aggregate piers and/or rigid inclusions shall be installed below foundations and slabs.
- B. Work shall consist of designing, furnishing, and installing aggregate pier and/or rigid inclusion ground improvements to the lines and grades designated on the project foundation plan and civil drawings as specified herein.
- C. The installation of the ground improvement shall also include the removal and disposal of excavation spoils as a result of the installation process. The excavated material is all assumed to be unsuitable and shall either be wasted or used in accordance with the Earth Moving Specifications. The cost of installation of the ground improvement shall include the cost of hauling, stockpiling, and disposal of the excavated material.
- D. The aggregate piers and/or rigid inclusions shall be in a columnar-type configuration and shall be used for support of foundations and slabs.

1.03 WORK INCLUDED

- A. Provision of all equipment, material, labor, and supervision to design, furnish, and install aggregate piers and/or rigid inclusions for support foundations and slabs.
- B. The aggregate pier and/or rigid inclusion design and installation shall adhere to all methods and standards described in this Specification.
- C. These ground improvements are installed by driving a mandrel and hammer to the design depth, feeding the backfill material through the hollow mandrel, and compacting the backfill in one-foot lifts using the hammer; thus, generating no spoils. If the aggregate piers are installed in augured holes, the testing, if needed, and disposal of the spoils should be included in the contractor's bid price.
- D. The design of the ground improvement shall be verified with a modulus load test.
- E. The existing fill contained fill contained traces of organic soil, roots, asphalt, and brick and boulders that need to be pre-trenched. The pre-trenching, if required, shall be performed by the Contractor.

1.04 RELATED SECTIONS

- A. Related Sections include the following:
 - 1. Section 02 41 00 – Demolition.
 - 2. Section 02 41 13 – Site Preparation.

3. Section 03 30 00 – Cast-In-Place Concrete.
4. Section 04 01 40 – Stone Masonry Restoration.
5. Section 07 11 13 – Bituminous Damproofing.
6. Section 31 00 00 – Earthwork.
7. Section 31 25 00 – Erosion and Sedimentation Control.

1.05 APPROVED INSTALLERS

- A. The Aggregate Pier and/or rigid inclusion installer (the Installer) shall be approved by the Engineer. Prior to approval, Installers and their Designers are required to submit to the Owner a qualification statement to demonstrate 5 years experience on at least 10 projects of a similar scope and nature. Additionally, prior to approval, Installers and their Designers are required to submit to the Owner a preliminary design document. Without exception, no alternate installer will be accepted unless approved by the Owner.
- B. Installers of aggregate pier and/or rigid inclusion foundation systems shall have a minimum of 5 years of experience with the installation of aggregate pier systems and shall have completed at least 10 projects in New England.
- C. Local installer of aggregate piers include:
 1. Vibro Stone Columns (VSC) (aggregate piers) or Controlled Modulus Column (CMC) (rigid inclusions) by Menard (Phone: (781) 281-0371 or (908) 603-8224).
 2. Vibro Piers (VP) (aggregate piers) or Vibro Concrete Columns (VCC) (rigid inclusions) by Hayward Baker/Keller (Phone: (401) 334-2565).
 3. Aggregate Piers (AP) (aggregate piers) or GeoConcrete Columns (GCC) (rigid inclusion) by Geopier (Phone: (860) 531-9137). The Local installer for Geopier is HDI – (781) 848-2110.
 4. Vibro Stone Columns (VSC) (aggregate Piers) Subsurface Constructors (Phone: (866) 421-2460).
 5. Aggregate Piers by H. B. Fleming (Phone: (207) 799-8514).

1.06 REFERENCE STANDARDS

- A. Design:
 1. "Ground Modification Methods Reference Manual – Volume I, "U.S. Department of Transportation, Federal Highway Administration, FHWA-NHI-16-027, FHWA GEC 013, April 2017.
 2. "Control of Settlement and Uplift of Structures Using Short Aggregate Piers," by Evert C. Lawton (Assoc. Prof., Dept. of Civil Eng., Univ. of Utah), Nathaniel S. Fox (President, Geopier Foundation Co., Inc.), and Richard L. Handy (Distinguished Prof. Emeritus, Iowa State Univ., Dept. of Civil Eng.), reprinted from *IN-SITU DEEP SOIL IMPROVEMENT, Proceedings of sessions sponsored by the Geotechnical Engineering Division/ASCE in conjunction with the ASCE National Convention held October 9-13, 1994, Atlanta, Georgia.*
 3. "Settlement of Structures Supported on Marginal or Inadequate Soils Stiffened with Short Aggregate Piers," by Evert C. Lawton and Nathaniel S. Fox. *Geotechnical Special Publication No. 40: Vertical and Horizontal Deformations of Foundations and Embankments*, ASCE, 2, 962-974.
 4. "Behavior of Geopier®-Supported Foundation Systems during Seismic Events," by Kord Wissmann, Evert C. Lawton, and Tom Farrell. Geopier Foundation Company, Inc. Blacksburg, VA ©1999.
 5. "The design of vibro replacement." H.J. Priebe. *Ground Engineering*, London. Dec 1995.
- B. Modulus Testing:
 1. ASTM D 1143 – Pile Load Test Procedures
 2. ASTM D 1194 – Spread Footing Load Test

- C. Materials and Inspection:
 - 1. ASTM D 1241 – Aggregate Quality
 - 2. ASTM D 422 – Gradation of Soils
 - 3. ASTM C39/C39M-12a – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 4. ASTM C-150-05 – Standard Specification for Portland Cement
 - 5. ASTM D1557 – Moisture Density Relationship for Soils
- D. Where specifications and reference documents conflict, the Owner shall make the final determination of the applicable document.

1.07 DEFINITIONS

- A. Aggregate Piers: VSC, VP, or AP. Rigid Inclusions: CMC, VCC, or GCC.
- B. Test Element: Aggregate pier and/or rigid inclusion element installed as a non-production element for the purpose of performing a modulus test. Test elements shall be installed prior to the start of production elements at a location representative of the subsurface conditions and loading. Where different subsurface conditions are encountered that warrant different types of improvements, a modulus test shall be performed for each type of improvement.

1.08 SUBSURFACE INFORMATION

- A. Subsurface explorations have been performed at the site by the Geotechnical Engineer. The results of the explorations are included in the geotechnical report prepared by Lahlaf Geotechnical Consulting, Inc. (LGCI) 100 Chelmsford Road, Suite 2, Billerica, MA 01862 dated January 14, 2021.
- B. The use and interpretation of these data for purposes of the work shall be the responsibility of the Installer. Subsurface conditions and groundwater levels are not considered as accurate for any times or locations other than the specific time and location of each of the explorations.
- C. The Owner assumes no responsibility for the Installer's failure to make his own site investigation and makes no representation other than the soils reports regarding the character of the soil or subsurface conditions which may be encountered during the performance of the work. The Installer shall refer to the Geotechnical Report. Failure by the Installer to be aware of existing site conditions shall not be cause for additional cost to the Owner.
- D. Use and interpretation of these data for purposes of the work shall be the responsibility of the Installer. Subsurface conditions and groundwater levels are not considered as accurate for any times or locations other than the specific time and location of each of the explorations.
- E. The installer may, at his own expense, conduct additional subsurface testing as required for his own information after approval by the Owner.
- F. No claim for extra cost or extension of time resulting from reliance by the Installer on information presented herein shall be allowed, except as provided in the Contract.

1.09 CERTIFICATIONS AND SUBMITTALS

- A. Shop drawings that include spacing, diameter, length, installation procedure and sequence of construction with sufficient details, planned cut off and tip elevations, material, proposed equipment, aggregate gradation, and mix design. The submittal shall also include a plan showing numbered locations of ground improvements. The design shall conform to the criteria in Part 3.01 of this specification.

- B. Design Submittal: Design Calculations and Shop Drawings - The Installer shall submit detailed design calculations and construction drawings prepared by the ground improvement designer (the Designer) for review and approval by the Owner in accordance with Section 1.09 of these specifications. All plans shall be sealed by a Professional Engineer in the State of Massachusetts.
1. The Installer shall submit detailed design calculations, construction drawings, and shop drawings (the Design Submittal), for approval at least two week(s) prior to the beginning of construction. A detailed explanation of the design parameters for settlement calculations shall be included in the Design Submittal. Additionally, the quality control test program for the aggregate piers, meeting these design requirements, shall be submitted. All computer-generated calculations and drawings shall be prepared and sealed by a Professional Engineer, licensed in the State of Massachusetts.
 2. The following shall be included in the design calculation submittal:
 - a. A written summary report that describes the overall ground improvement design
 - b. Applicable code requirements and design references. Design criteria including, soil shear strengths including friction angle and cohesion, unit weights, aggregate pier and/or rigid inclusion hole diameter, aggregate pier and/or rigid inclusion spacing, aggregate pier and/or rigid inclusion unit weight and friction angle/concrete compressive strength, composite shear strength parameters, and any other design assumptions.
 - c. Design calculation sheets with project number, foundation location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. An index page with the design calculations shall be provided.
 - d. Design notes including an explanation of any symbols and computer programs used in the design.
 - e. Detailed subgrade preparation notes and requirements.
 - f. A complete list of the equipment proposed for use, including a description of the characteristics of each piece of equipment.
 - g. Detailed description of the methods and equipment proposed for loading of the test element during the modulus test and load test. Any deviation from Section 3.04 of this specification shall be specifically noted with explanation for the requested deviation. Without exception, no deviations will be accepted unless approved by the Owner.
 3. Working Drawings: Utility locations, right of way, and other applicable information are available on the plans. Working drawings shall include, but not be limited to the following items:
 - a. A plan view of the aggregate pier ground improvement for identifying:
 - 1) Right of way, permanent or temporary construction easement limits, location of all known active or abandoned existing utilities, adjacent structures, or other potential interferences. Any drainage structure or drainage pipe centerline behind, passing through, or passing under the structure.
 - 2) Limits of the aggregate pier and/or rigid inclusion ground improvement and layout of the numbered individual aggregate piers and/or rigid inclusions.
 - b. Subsurface exploration locations shown on a plan view of the proposed structure alignment with appropriate reference base lines to fix the locations of the explorations relative to the structure.
 - c. Elevation view showing aggregate pier and/or rigid inclusion locations, elevations, and depth of improvement; location of drainage elements and expansion/contraction joints when applicable.
 4. The submittal shall include a plan showing aggregate piers and/or rigid inclusions with aggregate pier and/or rigid inclusion numbers, and a schedule showing aggregate pier and/or rigid inclusion number, aggregate pier and/or rigid inclusion length, aggregate pier and/or rigid inclusion diameter, top and bottom design elevations, and top and bottom as-installed elevations.

C. Qualification Data:

1. For qualified professional engineer licensed in the State of Massachusetts.
 2. For qualified Quality Control Representative.
- D. Professional Liability Insurance Submittal: - The Designer and Installer shall have Errors and Omissions design insurance for the work. The insurance policy should provide a minimum coverage of \$3 million per occurrence.
- E. Modulus/Load Test Reports – A modulus test(s) is performed on a non-production aggregate pier and/or rigid inclusion element as required to verify the design assumptions. The Installer shall furnish the Owner a description of the installation equipment, installation records, complete test data, analysis of the test data, and verification of the design parameter values based on the modulus test results. Test elements shall be installed prior to the start of production elements at a location representative of the subsurface conditions and loading. The report shall be prepared under direction of a Registered Professional Engineer in the State of Massachusetts.
- F. Daily Aggregate Pier and/or Rigid Inclusion Progress Reports – The Installer shall furnish a complete and accurate record of aggregate pier and/or rigid inclusion installation to the Owner. The record shall indicate the aggregate pier and/or rigid inclusion location, length, volume of aggregate/concrete used or number of lifts, densification forces during installation of the aggregate, and final elevations or depths of the base and top of aggregate piers and/or rigid inclusions. The record shall also indicate the type and size of the installation equipment used, and the type of aggregate used. The Installer shall immediately report any unusual conditions encountered during installation to the Designer and to the Owner.
- G. Submit calibration records for the load cells, the hydraulic jacks, the pumps, and the pressure gauges At least two weeks before performing the modulus and load tests.
- H. The Ground Improvement is a subcontractor design. The subcontractor is fully responsible for the adequacy of the design and the performance of the system.
- I. If required, the Installer/Designer shall include in its submittal an instrumentation plan as they own the design of the ground improvement and the performance of the proposed footings and slabs.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS, AGGREGATE PIER AND/OR RIGID INCLUSION DESIGN

- A. The design of the aggregate piers and/or rigid inclusions under the proposed building shall be based on a maximum allowable bearing pressure of 3,000 psf and the allowable total settlement of 3/4 inch or less and an allowable differential settlement of 1/2 inch or less over a distance of 25 feet under static loads for footings, and a maximum of 0.5-inch settlement under slabs.
- B. A load transfer platform (LTP) should be installed on top of the aggregate piers and/or rigid inclusions under the footings and slabs in accordance with the requirements of the specialty subcontractor's designing the aggregate piers and/or rigid inclusions.
- C. The aggregate piers and/or rigid inclusions shall be designed in accordance with generally accepted engineering practice. The design life of the structure shall be 50 years.
- D. The aggregate pier and/or rigid inclusion elements shall be designed using an aggregate pier and/or rigid inclusion stiffness modulus to be verified by the results of the modulus test and/or rigid inclusion load test described in Section 3.04 of these specifications.

2.02 AGGREGATE

- A. Aggregate used by the Installer for aggregate pier construction shall be pre-approved by the Designer and Owner and shall demonstrate suitable performance during modulus testing. Typical aggregate consists of Type 1 Grade B in accordance with ASTM D-1241-68, No. 57 stone, or other graded aggregate approved by the Designer.
- B. Potable water or other suitable source shall be used to increase aggregate moisture content where required. The Owner shall provide such water to the Installer.

2.03 PORTLAND CEMENT

- A. Type I or Type II.

2.04 GROUT MIX

- A. Minimum Compressive Strength:
 - 1. 4,000 psi at 28 days.
 - 2. 2,000 psi at 7 days.

PART 3 - EXECUTION

3.01 APPROVED INSTALLATION PROCEDURES

- A. The following sections provide general criteria for the construction of the aggregate piers. Unless otherwise approved by the Designer, the installation method used for aggregate pier construction shall be that as used in the construction of the successful modulus test.
- B. Aggregate Piers installed using Rammed Aggregate Pier Systems:
 - 1. Aggregate Pier (AP) systems shall be constructed by advancing a specially designed mandrel with a minimum 15-ton static force augmented by dynamic vertical ramming energy to the full design depth. The hollow-shaft mandrel, filled with aggregate, is incrementally raised, permitting the aggregate to be released into the shaft, and then lowered by vertically advancing and/or ramming to densify the aggregate and force it laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated to the top of pier elevation. The cycle distance shall be determined by the Designer. The mandrel shall be raised at a rate determined from the demonstration pier testing or no faster than 1 foot in 5 seconds. The crowd pressure shall be recorded to provide a measure of the vertical densification force as the mandrel is driven on its compaction stroke.
 - 2. At AP element locations, water or compressed air shall be used, if necessary, as determined from the flow test, to enhance free flow of aggregate through the mandrel as determined during the performance of a flow test. Water or air flow shall be discontinued when the mandrel reaches the 3-foot raise height.
 - 3. At the completion of the pier installation, the hammer shall be turned off and the mandrel pushed downward applying full crowd pressure on the top of the pier to provide preloading.
 - 4. At completion of the pier installation, the remaining stone in the mandrel may be emptied outside the pier location to allow for a measure of the remaining volume of aggregate.
 - 5. Special high-energy impact densification apparatus shall be employed to densify the AP elements during installation. The apparatus shall apply direct vertical impact energy to each constructed lift of aggregate.
 - 6. Densification shall be performed using a chained mandrel.
 - 7. Downward crowd pressure shall be constantly applied to the mandrel shaft.

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

C. Aggregate Piers Installed Using Vibrator:

1. If a vibrator is used to construct the aggregate piers, the Installer shall use an electric down-hole vibrator capable of providing at least 80 HP of rated energy and a centrifugal force of 15 tons. The vibrator diameter must be at least 60% of the aggregate pier design diameter. An appropriate metering device should be provided at such a location that inspection of amperage increase may be verified during the operation of the equipment. The metering device may be an ammeter directly indicating the performance of the vibrator. The vibrator shall be a minimum of 16 inches in diameter. Complete equipment specifications should be submitted to the Engineer prior to commencement of the fieldwork.
2. The probe and follower tubes shall be of sufficient length to reach the elevations shown on the Installer's approved construction drawings. The probe, used in combination with the available pressure to the tip jet, shall be capable of penetration to the required tip elevation.
3. The probe shall penetrate into the foundation soil layer to the minimum depths required in the Installer's construction plans. After penetration to the required depth, the probe shall not be withdrawn more than 2 feet at any time unless the stone stops flowing to the bottom of the probe.
4. Redriving the probe into the treated depth shall be attempted at approximately 12 to 18-inch intervals to observe resistance to penetration and amperage build-up. During redriving, the probe tip shall penetrate to within 1 foot of the previous redriving depth.
5. Amperage build-up and backfill quantities will be contingent upon the type of probe used and procedures. Prior to commencement of work, the subcontractor shall discuss the equipment capabilities with the to determine if trial probes will be necessary.
6. The Installer shall provide a full-time Quality Control Representative on-site during the installation process.

- D. The as-built center of each aggregate pier and/or rigid inclusion shall be within 6 inches of the locations indicated on the plans. Aggregate piers and/or rigid inclusions installed outside of the above tolerances and deemed not acceptable shall be rebuilt at no additional expense to the Owner.

E. Rigid Inclusions

1. Install the rigid inclusions in accordance with the sequence detailed in the approved work plan. If adjacent rigid inclusions are observed to be influenced by the installation of a neighboring rigid inclusion, the installation sequence shall be modified to prevent disturbance of rigid inclusions. Modifications to the sequence, or replacement of rigid inclusions deemed unusable due to disturbance, shall be completed by the Contractor at no additional cost to the Owner.
2. Cutoff the rigid inclusions to the top elevation of the first layer of the load transfer pad, or slightly higher to allow any required trimming or removal of low strength material at the butt of the rigid inclusion. The cut-off elevation of each rigid inclusion shall be within +/- 0.1 feet. The cut-off shall be made before the concrete sets.
3. Protect the concrete at the top of rigid inclusions from mixing with surrounding soil.

3.02 REJECTED AGGREGATE PIERS

- A. Aggregate Pier and/or rigid inclusion elements installed beyond the maximum allowable tolerances shall be abandoned and replaced with new aggregate piers and/or rigid inclusions unless the Designer approves the condition or provides other remedial measures. All material

and labor required to replace rejected piers shall be provided at no additional cost to the Owner unless the cause of rejection is due to an obstruction or a mislocation.

3.03 QUALITY CONTROL REPRESENTATIVE

- A. The Installer shall have a full-time, on-site Quality Control Representative to verify and report all installation procedures. The Installer shall immediately report any unusual conditions encountered during installation to the Designer and to the Owner. The quality control procedures shall include the preparation of Aggregate Pier and/or rigid inclusion Progress Reports completed during each day of installation containing the following information.
1. Footing and aggregate pier and/or rigid inclusion location.
 2. Pre-auger diameter and soil conditions encountered during drilling (if required).
 3. Aggregate pier and/or rigid inclusion length.
 4. Planned and actual aggregate pier and/or rigid inclusion elevations at the top and bottom of the aggregate pier and/or rigid inclusion.
 5. Average lift thickness of each aggregate pier and/or rigid inclusion.
 6. Volume of aggregate used in each aggregate pier.
 7. Volume of concrete in each rigid inclusion.
 8. Documentation of any unusual conditions encountered.
 9. Type and size of densification equipment used.

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

- A. A minimum of one (1) Modulus Test is required for this project. When authorized, an Aggregate Pier or Rigid Inclusion Modulus Test(s) shall be performed at locations agreed upon by the Designer and the to verify or modify Aggregate Pier designs. Modulus Test Procedures shall utilize appropriate portions of ASTM D 1143 and ASTM D 1194, as outlined in the aggregate pier and/or rigid inclusion design submittal. Aggregate piers shall be tested to 150 percent of the maximum design stress as shown in the aggregate pier design submittal. The modulus tests shall be of the type and installed in a manner specified herein.
- B. A telltale shall be installed at the bottom of the test pier so that bottom-of-pier deflections may be determined. Acceptable performance is indicated when the bottom of the pier deflection is no more than 30% of the top of pier deflection at the design stress level, the total settlement is less than the design settlement, and the residual movement, i.e., movement after the unloading, is less than 0.5 inch.
- C. ASTM D-1143 general test procedures shall be used as a guide to establishing load increments, load increment duration, and load decrements. As a minimum, the following loading increments, decrements and duration shall be used.

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

12	33	N/A	N/A
13	0	N/A	N/A

- D. With the exception of the load increment representing approximately 117% of the design maximum top of aggregate pier stress, all load increments shall be held for a minimum of 15 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for the maximum of 1 hour, whichever is occurs first.
- E. The load increment that represents approximately 117% of the design maximum stress on the Aggregate Pier shall be held for a minimum of 60 minutes. Loads are then maintained until the rate of deflection reduces to 0.01 inch per hour or for the maximum of 4 hours, whichever is occurs first.
- F. A seating load equal to 5 percent of the total load shall be applied to the loaded steel plate prior to application of load increments and prior to measurement of deflections to compensate for surficial disturbance.
- G. At least one rigid inclusion load test shall be performed on rigid inclusions in accordance with ASTM D 1143 to maximum load test of 200% of the design load at increments of 25% of the design load, when applicable.
- H. The location of the aggregate pier modulus test and the rigid inclusion load test shall be approved by the geotechnical engineer.
- I. Submit as-built plans showing layout, location, and numbers of installed aggregate piers.

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

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

3.06 FIELD QUALITY ASSURANCE

- A. The Owner will retain the geotechnical engineer to provide full-time monitoring of aggregate pier and/or rigid inclusion construction activities, including observing the aggregate pier modulus test and/or the rigid inclusion load test.

3.07 SITE PREPARATION AND PROTECTION

- A. The Site Contractor shall locate and protect underground and aboveground utilities and other structures from damage during installation of the aggregate piers and/or rigid inclusions.
- B. Site grades for aggregate pier and/or rigid inclusion installation shall be a minimum of 2 feet below the finished grade elevation to minimize aggregate pier and/or rigid inclusion installation depths. Ground elevations and bottom of footing elevations shall be provided to the aggregate pier and/or rigid inclusion Installer in sufficient detail to estimate installation depth elevations to within 3 inches.
- C. The Owner's Site Contractor will provide site access to the Installer, after earthwork in the area has been completed. A working surface shall be established and maintained by the Owner's

Site Contractor to provide wet weather protection of the subgrade and to provide access for efficient operation of the aggregate pier and/or rigid inclusion installation.

- D. Prior to, during and following aggregate pier and/or rigid inclusion installation, the Owner's Site Contractor shall provide positive drainage to protect the site from wet weather and surface ponding of water.
- E. If spoils are generated by aggregate pier and/or rigid inclusion installation, spoil removal from the aggregate pier and/or rigid inclusion work area shall occur in a timely manner to reduce the potential for interruption of aggregate pier and/or rigid inclusion installation is required.
- F. The installer shall coordinate with Owner's Site Contractor the installation of support of excavation (SOE) system if required. The purpose of this coordination is to plan the workflow and avoid down time during construction.
- G. The Owner's Site Contractor shall perform test pits within the areas slated for ground improvements to explore for the presence and remove obstructions.
- H. The Owner's Site Contractor shall monitor vibration through installation of seismographs at the nearby buildings during installation of aggregate piers and/or rigid inclusions.

3.08 AGGREGATE PIER AND/OR RIGID INCLUSION LAYOUT

- A. The location of aggregate pier and/or rigid inclusion supported foundations and slabs for this project, including layout of individual aggregate pier and/or rigid inclusion shall be marked in the field using survey stakes or similar means at locations shown on the drawings. The layout of aggregate piers and/or rigid inclusions shall be part of the base bid.

3.09 EXCAVATIONS FOR OBSTRUCTIONS

- A. The existing fill may include below-ground structures and/or obstructions that need to be pre-trenched. Should any obstruction be encountered during aggregate pier and/or rigid inclusion installation, the Owner's Site Contractor shall be responsible for promptly removing such obstruction, or the aggregate pier and/or rigid inclusion shall be relocated or abandoned. Obstructions include, but are not limited to, abandoned utilities, existing and abandoned foundations or concrete structures, asphalt, demolition debris, cobbles, boulders, wood, metals, and other below-ground structures, and underground tanks which shall prevent placing the aggregate piers and/or rigid inclusions to the required depth or shall cause the pier to drift from the required location.
- B. The specialty subcontractor shall mobilize an auger and equipment necessary to spin the auger in the ground to pre-auger and/or remove obstructions as needed.
- C. Dense natural rock or weathered rock layers shall not be deemed obstructions, and aggregate piers and/or rigid inclusions may be terminated short of design lengths on such materials. Dense rock or weathered rock are not anticipated within the proposed depths of the aggregate piers and/or rigid inclusions.
- D. The cost of pre-trenching and/or auguring shall be part of the base bid and there shall be no separate compensation for pre-trenching and/or auguring prior to installing aggregate piers and/or rigid inclusions.

3.10 UTILITY EXCAVATIONS

- A. The Owner's Site Contractor shall coordinate all excavations made prior and subsequent to aggregate pier and/or rigid inclusion installations so that excavations do not encroach on the aggregate piers and/or rigid inclusions as shown in the aggregate pier construction drawings.
- B. Protection of completed aggregate piers and/or rigid inclusions is the responsibility of the Owner's Site Contractor. If utility excavations are required in close proximity to the installed aggregate piers and/or rigid inclusions, the Owner's Site Contractor shall contact the aggregate pier and/or rigid inclusion Designer immediately to develop construction solutions to minimize impacts on the installed aggregate pier and/or rigid inclusion elements.
- C. The Owner's Site Contractor shall repair damaged aggregate piers and/or rigid inclusions in accordance with procedure included in specialty subcontractor's submittal.

3.11 FOOTING BOTTOMS

- A. Excavation and surface compaction of all improved subgrades shall be the responsibility of the Owner's Site Contractor.
- B. Foundation excavations to expose the tops of aggregate pier and/or rigid inclusion shall be performed with a smooth edge bucket in a workman-like manner, and shall be protected, until the LTP is built on top of the aggregate piers and/or rigid inclusions, with procedures and equipment best suited to (1) avoid exposure to water, (2) prevent softening of the matrix soil between and around the aggregate piers and/or rigid inclusions before building the LTP, and (3) achieve direct and firm contact between the dense, undisturbed aggregate piers and/or rigid inclusions and the LTP.
- C. The proposed footings shall be supported on a minimum of 6 inches of Structural Fill or 3/4-inch crushed stone wrapped in a filter fabric placed directly over aggregate piers. The Structural Fill or crushed stone layer shall be thicker if required for the LTP installed in accordance with the requirements of the specialty subcontractor.
- D. All excavations for footing bottoms supported by aggregate pier and/or rigid inclusion improved subgrades shall be prepared in the following manner by the Owner's Site Contractor. Recommended procedures for achieving these goals are to:
 - 1. Limit over-excavation below the bottom of the footing to 3-inches (including disturbance from the teeth of the excavation equipment).
 - 2. Compaction of surface soil and top of Aggregate Piers and/or Rigid Inclusions shall be prepared using a large vibratory plate compactor. Motorized impact compactors ("Wacker Packer," "Jumping Jack," or similar) shall only be used in cohesive soils and when approved by the Designer. Loose or soft surficial soil over the entire footing bottom shall be recompacted or removed, respectively. The surface of the aggregate pier and/or rigid inclusion shall be recompacted prior to completing footing bottom preparation.
 - 3. Place footing concrete immediately after footing excavation is made and approved, preferably the same day as the excavation. Footing concrete must be placed on the same day if the footing is bearing on moisture-sensitive soils. If same day placement of footing concrete is not possible, open excavations shall be protected from surface water accumulation. A lean concrete mud-mat may be used to accomplish this. Other methods must be pre-approved by the Designer.
 - 4. The aggregate piers and/or rigid inclusions shall be visible before placing Structural Fill or crushed stone over the top of the APs and/or RIs. Such Structural Fill or crushed stone shall not be placed until the geotechnical engineer has observed the subgrade.
- E. The following criteria shall apply, and a written inspection report sealed by the Engineer shall be furnished to the Installer to confirm:

1. That water has not been allowed to pond over the aggregate pier and/or rigid inclusion subgrade at any time. This statement shall be provided by the Owner's Site Contractor.
2. That all aggregate piers and/or rigid inclusions designed for each structure have been exposed in the footing excavation or prior to fill placement.
3. That immediately before footing construction or fill placement, the tops of aggregate piers and/or rigid inclusions have been inspected and recompact as necessary with mechanical compaction equipment.
4. That no excavations (elevator, pits, or trenches) have been made after installation of aggregate pier and/or rigid inclusion elements within the excavation limits described in the aggregate pier and/or rigid inclusion construction drawings, without the written approval of the Installer or Designer.

3.12 SLAB SUBGRADES

- A. Slabs-on-grade shall be supported on a minimum of 12 inches of Structural Fill placed directly over aggregate piers. The Structural Fill layer shall be thicker if required for the LTP installed in accordance with the requirements of the specialty subcontractor.
- B. The aggregate piers and/or rigid inclusions shall be visible before placing Structural Fill or crushed stone over the top of the APs or RIs. Such Structural Fill or crushed stone shall not be placed until the geotechnical engineer has observed the subgrade.

3.13 VIBRATION MONITORING

- A. The Owner's Site Contractor shall perform vibration monitoring during installation of aggregate piers. The peak particle velocity should be less than two (2) inches per second (ips) for concrete foundations, 1 ips for masonry foundations, and 0.5 for rubble foundations.

3.14 PAYMENT AND UNIT PRICES

- A. Payment for the design and installation of ground improvements shall be based on a lump sum included in the base bid..
- B. For cost estimating purposes, aggregate piers/rigid inclusions shall be assumed on average to be 15 feet long. For average aggregate piers/rigid inclusions length that are shorter than 15 feet, a credit shall be provided in accordance with item 3.17 C.6. For piers that are on average longer than 15 feet, the Contractor shall be compensated for a portion of the total length of aggregate piers/rigid inclusions in excess of length calculated based on an average length of 15 feet in accordance with item 3.17 C.7.
- C. All unit prices must be coordinated and approved by the Owner
- D. Payment shall include all costs for design and installation of the aggregate piers and in accordance with requirements of the Contract Documents. Payment for the Work of this Section shall be made following approval by the Owner in accordance with requirements of the Contract Documents, and the following Schedule:

1. Unit Price for additional installed aggregate piers or rigid inclusion (w/o remobilization):
\$ _____ Lump Sum
2. Unit Price Credit for aggregate piers or rigid inclusion not installed:
\$ _____ Lump Sum
3. Unit Price for additional Modulus Tests (w/o remobilization):
\$ _____ Lump Sum
4. Credit per foot for difference between actual length and length of aggregate piers/rigid inclusions based on average length of 48 feet and actual length for piers.

5. Unit Price per foot difference between actual length and length of aggregate piers/rigid inclusions based on average length of 48 feet and actual length for piers.
6. Unit Price for additional Mobilizations
\$ _____ Each

END OF SECTION
31 60 00

This Page Intentionally
Not Used

SECTION 32 12 16 – ASPHALT PAVING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Hot-mix asphalt (HMA) paving.
 - a. Hot-mix asphalt shall be composed of mineral aggregate and asphalt binder, mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and conformance to the lines, grades, thickness and typical cross sections shown on the plans or as directed by the Designer.
 - b. Each course shall be constructed to the depth, typical section, or elevation required by the contract and/or plans and shall be rolled, finished, and approved before the placement of the next course. Each course shall be placed to a smooth, dense, and uniform appearance.
 - 2. Sawcutting existing pavements.
 - 3. Asphalt Emulsion for Tack Coat.
 - 4. Hot Poured Joint Sealer.
 - 5. Hot-mix asphalt patching.
 - 6. Hot-mix asphalt overlays, including surface preparation, leveling courses, tack coating and all other associated operations required.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Acceptance: The acceptance of plant produced material for gradation, asphalt content, and air voids shall be determined by the Designer in accordance with the requirements of the section on acceptance criteria, herein specified.
- F. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 312000 – EARTHWORK for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 2. Section 321313 – PORTLAND CEMENT CONCRETE for installation of cement concrete paving for driveways, walkways, and sidewalks.
 - 3. Section 321613 – CURBS AND GUTTERS for resetting granite curb.
 - 4. Section 321723 – PAVEMENT MARKINGS for replacement of pavement markings.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

- B. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
 - 1. Proof of a State or local municipality Department of Transportation's pre-approved Job Mix Formula (JMF).
 - 2. Tack Coat.
 - 3. Hot Applied Joint Sealer.
 - 4. Seal Coat.
 - 5. JMF's for roadways.
- C. Material Certificates: For each paving material, from manufacturer.
 - 1. Submit certified test reports signed by the material producer and Contractor certifying that materials comply with, or exceed, the specification requirements. The Owner reserves the right to employ an independent testing laboratory for testing materials included in the JMF, and the Contractor shall, upon request by the Owner, supply suitable quantities of these materials for testing.

1.4 REFERENCE STANDARDS

- A. The following standards are applicable to the work of this Section to the extent referenced herein:
 - 1. Commonwealth of Massachusetts, Massachusetts Department of Transportation (MassDOT), Highway Division, Standard Specifications for Highways and Bridges, latest English Edition with amendments. All references to method of measurement, basis of payment and payment items in the Standard Specifications are hereby deleted. References made to particular sections or paragraphs in the Standard Specifications shall include all related articles mentioned herein.
 - 2. ASTM: American Society for Testing and Materials
 - 3. AASHTO: American Association of State Highway and Transportation Officials
 - 4. ACI: American Concrete Institute
 - 5. MUTCD: Manual on Uniform Traffic Control Devices
- B. Pavement within public rights-of-way. The construction of all pavements within public rights-of-way shall be in accordance with the rules, regulations and requirements of the City of Worcester Department of Public Works.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by MassDOT, Highway Division.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MassDOT, Highway Division for hot mix asphalt paving work.
 - 1. Comply with requirements of MassDOT, Highway Division, Standard Specifications for Highways and Bridges, including supplemental specifications and special provisions.
 - 2. Comply with requirements of the Americans with Disabilities Act (ADA) and the Massachusetts Architectural Access Board (MAAB). If these requirements cannot be met with the grades and slopes indicated on the plans, notify the Designer immediately.
 - 3. Comply with requirements of the local authority having jurisdiction concerning the location and construction of accessible curb cuts.
- C. The Contractor shall establish, provide, and maintain a Quality Control System (QCS) that will detail the methods and procedures that will be taken to assure that all materials and

completed construction conform to project specifications, plans, technical specifications and other requirements, whether manufactured or processed by the Contractor or procured from subcontractors or vendors. The Contractor will be required to complete daily Quality Control testing for the RAP material for each day of production in accordance with these specifications.

1. The Contractor assumes the responsibility of the quality for all materials and construction incorporated into the work and will control all the processes leading to the final result through this function. Quality Control activities should include:
 - a. Maintain a Contractor Quality Control System.
 - b. Proficiency Testing prior to production with the Independent Testing Agency.
 - c. Inspection and Testing of Hot Mix Asphalt Production.
 - d. Inspection and Testing of Hot Mix Asphalt Placement.
 2. See Section 3.3 "Contractor Quality Control of HMA Pavement" of these specifications for additional information.
- D. The Owner, or their authorized representatives, will perform the Quality Acceptance function for this work. All material will be considered for acceptance through a sampling, testing and inspection program performed by the Independent Testing Agency. Quality Acceptance activities include:
1. Proficiency Testing prior to production with Contractor.
 2. Inspection of HMA Production Plant and Testing Laboratory.
 3. Production Trials of HMA Products Intended for the Project.
 4. Inspection/Testing for Acceptance of Hot Mix Asphalt Production.
 5. Inspection/Testing for Acceptance of Hot Mix Asphalt Placement.
 6. HMA Quality Acceptance Daily Report of Activities.
- E. Preinstallation Conference:
1. Prior to the placing of any HMA, a pre-paving conference shall be held to discuss and approve the paving schedule, source of HMA, Job Mix Formula/Design Mix Formula approvals, type and amount of equipment to be used, sequence of paving pattern, rate of HMA supply, all sampling, testing and reporting procedures to be used, traffic control, safety, and general continuity of the operation. Designers, Contractor's plant, quality control and field representatives and Owner's Independent Testing Agency's testing and inspection agents shall attend this meeting. All equipment used shall be approved on the project site prior to starting up each day.
 2. Conduct conference at Project site to comply with requirements in Division 01.
 3. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review condition of subgrade and preparatory work.
 - c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
 - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Coordination. The Contractor shall coordinate and schedule the Work under this specification with all other work, including underground utility improvement construction, to avoid covering up incomplete, unfinished, and/or uninspected work.

Any repaving required due to uncoordinated and/or improper scheduling shall be done by the Contractor at no cost to Owner.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Weather Limitations.
 - 1. HMA shall only be placed on dry, unfrozen surfaces. The underlying surface shall be approved by the Owner's Representative and/or Designer prior to placement of any HMA. Underlying surfaces shall be cleaned of any foreign materials.
 - 2. The HMA shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture (film of water) or when the air and/or surface temperature is less than the temperature requirements contained in MassDOT Specifications Table 450.42-1. When the surface temperature of the underlying course is less than 50°F the Contractor shall determine the time available for compaction. The Contractor shall also take extra precautions to control the temperature of the materials during placement. The time available for compaction shall be calculated based on the time, date, air temperature, average wind speed, sky conditions, latitude, mix type, PG grade, lift thickness, mix delivery temperature, existing surface type, existing moisture content of surface, existing state of moisture in surface, and surface temperature. The estimated time available for compaction can be calculated with computer programs, e.g., Pave Cool Tool. This program is available at the following web location: <http://www.dot.state.mn.us/app/pavecool/>
 - 3. The information regarding the air temperature, average wind speed, sky conditions, mix delivery temperature, and existing moisture conditions shall be evaluated by the Designer and a Contractor's representative located at the paving operation. The estimated time available for compaction shall be provided by the Contractor to the Designer. The Designer and the Contractor shall determine if there is an adequate amount of time available to compact the mixture. Options can be explored to extend the time available for compaction. If there is an adequate amount of time available to compact the mixture, the temperature requirements may be waived by the Designer; however, all other requirements including compaction shall be met. The Contractor assumes responsibility for constructing the pavement to meet compaction and specification requirements.
 - 4. The Contractor shall not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown will not be placed until the pavement surface shows no signs of free moisture, provided the mixture is within temperature limits as specified.
 - 5. When the air temperature falls below 50°F, extra precautions shall be taken in drying the aggregate, controlling the temperature of the materials, and in placing and compacting the mixtures.
 - 6. The construction of hot mix asphalt concrete pavements shall terminate on November 15 and shall not be resumed prior to April 1 except as determined and directed in writing by the Designer.

1.7 EXAMINATION OF SITE AND DOCUMENTS

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

- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.8 ADA AND MAAB COMPLIANCE

- A. Comply with American with Disabilities Act (ADA) and the requirements of the Massachusetts Architectural Access Board (MAAB).
 - 1. Slopes: Walkways as defined by Section 22.1 of 521 CMR, shall be graded to a maximum of 4.5%. The cross-pitch (perpendicular to travel) for walkways and paths shall be constructed at 1.5%. The slopes of ramps and side slopes on handicap curb cuts as defined by Section 21.1 of 521 CMR shall be constructed at 7.5% maximum. Ramps as defined in Section 24.1 of 521 CMR, shall be constructed to a maximum slope of 7.5%.
 - 2. The Contractor is to assume that sidewalk grades will be verified and checked with a 2-foot long electronic 'smart level'.
 - 3. A 5'-0" minimum level, 1.5% pitch, area shall be provided at entrances to buildings. Puddling or ponding of water at the entrances will not be accepted.
 - 4. Handicap parking spaces and access aisles shall be graded level with the slope not to exceed 1.8% in any direction.
 - 5. The requirements specified hereinabove shall supersede the grades indicated on the Drawings. If these requirements cannot be met with the grades indicated on the Drawings, the Designer shall be notified immediately for direction.

PART 2 – PRODUCTS

2.1 HOT MIX ASPHALT

- A. General
 - 1. Hot Mix Asphalt (HMA) shall conform to MassDOT Standard Sections 450.10, 450.30, and M 3.11.00, and as required herein. All HMA mixtures shall meet the requirements of the Superpave volumetric mix design system.
 - 2. HMA designs shall meet the requirements of MassDOT Standard Specification Section 450.30
 - a. Each HMA pavement course placed shall be comprised of one of the mixtures listed in MassDOT Standard Specifications Table 450.10-1: HMA Pavement Courses & Mixture Types
 - 3. Asphalt mixtures shall be composed of the following:
 - a. Mineral aggregate
 - b. Mineral filler (if required)
 - c. Performance Graded Asphalt Binder (PGAB)
 - 1) All mixes shall be PG 64-28
 - 4. The use of recycled materials shall be at the Contractor's option in accordance with MassDOT Standard Section M3.11.00. As permitted, recycled materials shall be limited to Recycled Asphalt Pavement (RAP). Maximum amount of RAP allowed shall be per MassDOT Standard Table M3.11.2-1.
 - 5. Warm Mix Asphalt. Warm Mix Asphalt shall be HMA modified using a Warm Mix Asphalt Additive. WMA shall be per MassDOT Standard Specifications Section M3.01.4.

- a. Shall meet the requirements of AASHTO R 25 Appendix X2: Special Mixture Design Considerations and Practices for Warm Mix Asphalt (WMA).
- b. Laboratory mixing and compaction temperatures shall be reduced per the WMA Manufacturer's recommendations.
- c. WMA additive equipment shall be fully automated and integrated into the HMA plant controls. No WMA foaming technology which requires the mechanical injection of steam or water into the liquid asphalt will be permitted.

2.2 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

2.3 ASPHALT EMULSION FOR TACK COAT

- A. Asphalt emulsion materials shall be homogeneous and shall show no separation after mixing within 30 days after deliveries. They shall conform to the requirements of AASHTO M 140. Anionic emulsion used for tack coat shall be grade RS-1h.

PART 3 – EXECUTION

3.1 GENERAL

- A. Subbase under paving shall be compacted as described in Section 312000, EARTHWORK. Add material meeting the requirements of ordinary borrow to bring the subgrade to the required grade as necessary before placing base course.
- B. The Contractor shall furnish, set, and maintain all line and grade stakes necessary to guide the automated grade control equipment. Where required these control stakes shall be maintained by the Contractor and used throughout the operations, from the grading of the subbase material up to and including the final layers of the pavement.
- C. The gravel base course shall be spread in layers upon the prepared subgrade conforming to the required line and grade. Gravel shall be placed in compacted layers not more than 4 inches thick compacted to not less than 95 percent of the maximum dry density of the material. Any stone greater than 3 inches in size shall be removed. Compaction shall continue until the surface is even and true to line and grade.
- D. Gravel base course shall be placed on backfilled and compacted trenches to proper grade before placement of pavement.
- E. The edges of existing pavement that is to remain shall be sawcut to an even, straight edge using a power-driver rotary saw; use of a jackhammer is unacceptable. This includes road, parking lot, sidewalk, and utility trench edges.
 1. The pavement shall be sawcut through its full depth at all joints between existing and proposed pavements, and at all utility trenches, to provide a uniform, smooth vertical surface.
 2. Sawcut edges which become broken, ragged or undermined as a result of the Contractor's operations shall be re-cut prior to the placement of abutting proposed pavement at no additional cost to the Owner.
 3. Sawcut surfaces in asphalt pavements shall be sprayed or painted with a uniform, thin coat of asphalt emulsion tack coat immediately before placement of hot mix asphalt against the cut surface.
- F. Asphalt courses shall be spread and compacted to the finished thicknesses as shown on the Contract Drawings. A smooth even surface shall be produced.

- G. Any joints at junctions of old and new pavements shall be sealed with hot poured joint sealer and covered with sand.
- H. All structures must be set flush with base course at areas where the final top course is scheduled for a future phase, and re set/readjusted prior to paving the final course, refer to the Construction Manager's phasing requirements.

3.2 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.3 CONTRACTOR QUALITY CONTROL OF HMA PAVEMENT

- A. General. Contractor Quality Control (QC) shall be in conformance with MassDOT Standard Specifications Section 450.60 through 450.68 and required as indicated. The Contractor assumes the responsibility of the quality for all materials and construction incorporated into the work and will control all the processes leading to the final result through this function. The QC system addresses all elements which affect the quality of the pavement including, but not limited to:
 - 1. Mix Design
 - 2. Aggregate Grading
 - 3. Quality of Materials
 - 4. Stockpile Management
 - 5. Proportioning
 - 6. Mixing and Transportation
 - 7. Placing and Finishing
 - 8. Joints
 - 9. Compaction
 - 10. Surface smoothness and uniformity
 - 11. Thickness and grade
- B. Independent Testing Agency. The Contractor shall cooperate with the Independent Testing Agency engaged by Owner for field quality control activities for the Work of this Section. Refer also to Section 014325 - TESTING AGENCY SERVICES.
- C. The Contractor shall be prepared to discuss and present, at the pre-paving conference, their understanding of quality control for this contract.
- D. Field Quality Control.
 - 1. HMA material placed in the field shall be tested for both joint and mat density on a completed street or public facility basis. The Independent Testing Agency may conduct any necessary testing to monitor that the specified density, uniformity and smoothness is being achieved. A properly correlated nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.
 - a. Sampling.

- 1) Samples shall be neatly cut with a core drill. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be 4 inches. The minimum diameter of the base samples shall be 6 inches. Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. Cores shall be taken within 48-hours of placement of the HMA.
 - 2) The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Pavement cores will be taken upon project pavement completion to determine the average percent density. Cores will be taken randomly by the Independent Testing Agency based on five cores for mat density and three cores for longitudinal joint density per 1000 tons of material placed. A minimum of five core samples for mat and three core samples for joint density will be removed from each course and construction phase or 40,000 square feet of paving. The average density of the core samples will be used to determine the density of the pavement course. The removal and patching of cores shall be paid for by the Owner. Cored holes shall be filled by the Contractor in a manner acceptable to the Owner's Representative and/or Designer and within one day after sampling. Resampling of pavement shall be in accordance with applicable provisions of the Northeast Transportation Training and Certificate Program (NETTCP) Quality Assurance Technologist Manual, latest edition.
- b. Testing.
- 1) The bulk specific gravity of each cored sample will be measured by the Independent Testing Agency in accordance with AASHTO T 166 or AASHTO T 275, whichever is applicable. The theoretical maximum specific gravity shall be the average maximum specific gravity for the project pavement in accordance with the plant-produced material section. The theoretical value used for the percent density of the core samples shall be the average of the measurements for maximum specific gravity for the project pavement course. The percent density of each sample will be determined in accordance with AASHTO T 269, using the bulk specific gravity of each sample and the average theoretical maximum specific gravity. Retesting of pavement shall be in accordance with applicable provisions of the NETTCP Quality Assurance Technologist Manual, latest edition.
 - a) Mat Density. Core locations will be determined by the Independent Testing Agency on a random basis in accordance with procedures contained in ASTM D3665. Cores shall not be taken closer than 1 foot from a longitudinal joint and 10 feet from a transverse joint.
 - b) In place density shall be measured during paving operations by a density gauge. Testing shall be performed randomly throughout the paving operation.
 - c) Joint Density. Three 6-inch diameter cores of finished longitudinal joint, will be taken by the Independent Testing Agency from each course and construction phase. Core locations will be determined by the Independent Testing Agency on a random basis over the joint, not adjacent to the joint.
2. Surface Smoothness.
- a. The finished surfaces of the pavement shall be uniform in appearance, free from irregularities in contour and texture and shall present a smooth-riding surface. Smoothness evaluation applies to all hot mix asphalt concrete roadways and walkways receiving 1.5 inches or more in plan (compacted) thickness of HMA pavement.

- b. The Contractor shall carefully apply the straight edge immediately after the first compaction by rolling, and from then on as may be necessary until and after the final compaction of the material in place. Hold the straightedge in successive positions parallel to the road centerline and in contact with the road surface; check the entire area from one side of the pavement to the other.
 - 1) Tests for conformity with the specified crown and grade shall be made by the Contractor immediately after initial compaction. Any variation shall be corrected by the removal or addition of materials and by continuous rolling.
 - 2) The finished surface of the pavement, when measured with a 10-foot straightedge, shall not vary more than $\frac{1}{4}$ inch for the surface course and $\frac{3}{8}$ inch for the intermediate course measured perpendicular and parallel to the centerline.
 - 3) After the completion of final rolling, the smoothness of the course shall again be tested.
 - c. Humps or depressions exceeding the specified tolerances shall be immediately corrected by removing the defective work and replacing with new material, as directed by the Owner's Representative and/or Designer. This shall be done at the Contractor's expense.
 - d. Skin patching will not be permitted.
 - e. When profile corrections are required, the Contractor shall use one or more of the following corrective methods:
 - 1) Removing and replacing the entire pavement thickness.
 - 2) Diamond grinding or micro milling.
 - 3) Overlaying (not patching) with the specified surface course.
 - 4) Removing the surface by milling and applying a lift(s) of the specified course(s).
 - 5) Use of other methods that will provide the desired results.
 - f. The corrective method(s) chosen by the Contractor shall be performed at the Contractor's expense, including all necessary equipment and traffic control.
 - 1) Areas of removal and replacement shall be removed the full width of the lane or paver pass. The removal areas shall begin and end with a transverse butt joint which shall be constructed with a transverse sawcut perpendicular to the centerline or paver pass.
 - 2) Replacement materials shall be placed in sufficient quantity, so the finished surface will conform to grade and smoothness requirements. The corrective area shall conform to all material and density specification requirements.
 - 3) When the corrective work consists of an overlay, the overlay shall cover the full width of the pavement including shoulders or the paver passes sufficient to correct the defective work. The area overlaid shall begin and end with a transverse butt joint which shall be constructed with a transverse sawcut and asphalt removal.
 - 4) All materials shall meet contract requirements. The overlay shall be placed so the finished surface will conform to grade and smoothness requirements. The overlaid area shall be compacted to the specified density.
 - g. The Owner's Representative and/or Designer can have the Independent Testing Agency retest any sections where corrections were made to verify that the corrections produced a surface that conforms to the grade and smoothness requirements.
3. Uniformity.

- a. The HMA mat shall be smooth, dense, and uniform. Uniformity is generally affected by Thermal and/or Aggregate segregation.
 - b. If segregation is evident and discernable by either the Contractor or the Owner's Representative/Designer, the Contractor shall immediately cease production and take steps to correct and eliminate the cause(s) of the segregation.
 - c. The Contractor shall review all potential causes of segregation as it relates to its operation, including but not limited to HMA Plant issues, loading and transportation issues, placement issues, thermal segregation, and hand work. The Contractor shall employ additional investigation methods and make the necessary changes in their operation such that segregation is eliminated, and mat uniformity is acceptable.
4. Thickness.
 - a. The thickness requirements contained herein shall apply only when each pavement layer is specified to be a uniform compacted thickness of 1 inch or greater. Thickness shall be evaluated for acceptance by the Owner's Representative and/or Designer to the requirements shown on the plans. Measurements of thickness may be checked periodically by the Contractor in following their QC system for field operations. Measurements of thickness for acceptance shall be made by the Independent Testing Agency using 4-inch minimum diameter pavement cores removed also for subsequent density measurement.
 - b. The finished surfaces of each HMA pavement course shall not vary from that specified or cross sections shown on the contract drawings by more than $\frac{1}{4}$ inch. The Contractor shall correct pavement areas varying more than this amount by removing and replacing the defective work or as ordered by the Owner's Representative and/or Designer. Skin patching will not be permitted.
5. Grade.
 - a. The finished surface of the pavement shall not vary from the gradeline elevations as shown on the plans by more than $\frac{1}{2}$ inch. The Contractor shall remove deficient areas and replace with new material. Sufficient material shall be removed to allow at least 1 $\frac{1}{2}$ inches of hot mix asphalt to be placed. Skin patching for correcting low areas shall not be permitted. High points may be ground off.
6. Rejection of Inferior HMA.
 - a. The Owner's Representative and/or Designer may at any time, notwithstanding previous acceptance, reject and require the Contractor to dispose of any batch of hot mix asphalt which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. Similarly, the Owner's Representative and/or Designer may at any time, notwithstanding field acceptance for mat density, reject and require the Contractor to correct any HMA pavement that was placed with unacceptable mat uniformity or paving joints due to low density, segregation, improper elevation, or tearing. In the event of such rejection, the Contractor and the Owner's Representative and/or Designer may take random split samples of the area(s) in question, and if it can demonstrate in the laboratory, in the presence of the Owner's Representative and/or Designer, that such material/pavement was erroneously rejected, payment will be made for the material at the contract unit price.

3.4 PAVEMENT MILLING

- A. This work shall consist of milling and removal of existing asphalt pavement from the project by the Contractor in areas designed on the Contract Drawings. Milling shall be performed in conformity with the limits, line, grade, and typical cross-section shown on the plans. The milling operation shall be categorized as either Standard Milling, Fine Milling, or Micro Milling, as defined MassDOT Standard Specification Table 415.2.1. The milled material shall become the property of the Contractor to be properly removed and disposed.
- B. Milling Equipment Requirements. The milling equipment shall be self-propelled with sufficient power, traction, and stability to remove the existing asphalt pavement to the specified depth and cross-slope. The milling machine shall be capable of operating as a minimum speed of 10 feet per minute, designed so that the operator can always observe the milling operation without leaving the control area of the machine, and be equipped with the following:
1. A built-in automatic grade control system that can control the longitudinal profile and the transverse cross-slope to produce the specified results.
 2. Longitudinal controls capable of operating from any longitudinal grade reference, including string line, 30-ft ski minimum, 30-ft mobile string line minimum, or a matching shoe.
 3. The transverse controls shall have an automatic system for controlling cross-slope at a given rate.
 4. Cutting heads able to provide a minimum 6 ft cutting width and a 0 to 4 in. 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.
 5. 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.
 6. Safety devices such as reflectors, headlights, taillights, flashing lights and back up signals so as to operate safely in both day and night.
 7. 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.
 8. Whenever the milling operations are being conducted between the hours of sunset and sunrise, the Contractor shall provide mobile lighting system(s).

When milling smaller areas or area 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 Owner's Representative and/or the Designer.

- C. Sweeper Equipment. 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.
- D. Mobile Lighting for Milling and Sweeping Equipment. Whenever milling operations are being conducted between the hours of sunset and sunrise, the Contractor shall provide mobile lighting system(s) attached to each piece of mobile milling equipment, including milling machines and mechanical sweepers but shall not include trucks used to transport materials and/or personnel to the work zone or other vehicles that are continually moving in and out of the work zone.
1. Mobile lighting systems attached to milling equipment shall be in addition to Contractor's construction work zone lighting required for the Project.

2. Lighting attached to each machine shall be capable of providing a minimum of 1 fc measured 60 ft in front of and behind the equipment. Light fixtures shall be balloon-style or otherwise diffused to minimize glare. Flood lights without diffusers shall not be permitted.
 3. No part of the mobile lighting system shall exceed a height 13 ft above the pavement. In areas with constrained vertical clearances the height may further be limited to accommodate the constraint.
 4. Existing street, highway, or site lighting shall not eliminate the requirement for the Contractor to provide lighting.
- E. Milling Operations. 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 paved 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 Owner's Representative and/or the Designer at the Contractor's expense.
1. Under no circumstances shall the milled surface be left exposed to traffic for a period exceeding 7 calendar days. The Owner's Representative and/or the Designer may allow the Contractor to adjust the limits of milling production when necessary.
 2. 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-ft 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, and typical cross-section shown on the plans. The requirement for automatic grade or slope controls may be waived by the Owner's Representative and/or the Designer in locations warranted by the situation, including intersections and closely confined areas.
 3. The Owner's Representative and/or the Designer may adjust the average milling depth specified on the plans by $\frac{3}{4}$ in. 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 pavement, the Contractor shall cease milling operations and consult the Owner's Representative and/or the Designer to determine whether to reduce the milling depth or make other adjustments to the operation.
- F. 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.
- G. 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.

- H. 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 Contract Documents.
- I. Contractor Quality Control. The Contractor shall provide a Quality Control (QC) System adequate to ensure that all workmanship meets the quality requirements herein. The Contractor shall provide qualified QC personnel and perform QC inspection, data analysis, corrective action (when necessary), and documentation as outlined further below.
 - 1. 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 re-milling at the Contractor's expense.
 - 2. The Contractor shall perform QC inspection of all work items as specified in MassDOT Standard Specifications Table 415.61-1. Inspection activities during milling of asphalt 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 the Owner's Acceptance inspection for QC purposes. The Owner's Representative and/or Designer shall be provided the opportunity to monitor and witness all QC inspection.
 - 3. The quality of each milled pavement surface will be inspected and evaluated on the basis of Lots and Sublots. A Lot is defined as an isolated quantity of work which is assumed to be produced by the same controlled process. A Lot shall constitute no greater than the entire milled surface area on the project completed within the same construction season using the same milling process.
 - 4. The milled surface of each travel lane and/or parking aisle shall be divided into longitudinal Sublots of 500 ft. The Contractor shall perform a minimum of 1 random QC measurement within each Sublot with a 10-ft 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 IRFs.
 - 5. The milled surface shall have a texture such that the variation from the edge of the straightedge to the top of ridges between any 2 ridge contact points shall not exceed $\frac{1}{8}$ in. The difference in height from the top of any ridge to the bottom of the valley adjacent to that ridge shall not exceed the values specified in MassDOT Standard Specification Table 415.61-1. Any point in the surface not meeting these requirements shall be corrected as directed by the Owner's Representative and/or the Designer at the Contractor's expense.
 - 6. 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 by the Owner's Representative and/or the Designer.

3.5 PATCHING

- A. Areas of existing HMA pavement courses that are significantly distressed or unsound shall be removed and replaced with patches using new HMA. The location and limits of patching

will be as identified in the plans or as directed by the Owner's Representative and/or the Designer.

- B. Each existing pavement course determined to be unsound shall be removed to the full depth of the pavement course within a rectangular area. For each patch location equal to or greater than 50 ft² (and having a minimum dimension of 4 ft) where the existing pavement courses are removed down to subbase, the subbase shall be compacted by mechanical means to not less than 95% of the maximum dry density of the subbase material as determined by AASHTO T 99 Method C at optimum moisture content. Each edge of the patch area shall be sawcut or otherwise neatly cut by mechanical means to provide a clean and sound vertical face. The vertical face of each edge shall be thoroughly coated with a hot poured joint sealer immediately prior to placing the HMA patching mixture.
- C. Delaminated areas of existing pavement courses resulting from pavement milling shall be cut back neatly by mechanical means to the limits of any unsound material. After removing all unsound material, the underlying pavement surface within the patch limits shall receive a thorough tack coat at a rate of application in accordance Section 3.7 prior to placing the HMA patching mixture.
- D. HMA patching mixture shall be the same mixture type as the existing pavement course being patched or as specified on the plans or as directed by the Owner's Representative and/or the Designer. The lift thickness of the patching mixture shall not exceed 4 times the nominal maximum aggregate size of the mixture. The patching mixture will be placed by hand or by mechanical means and shall match the thickness, grade, and cross-slope of the surrounding pavement. The HMA patching mixture shall be compacted using a steel wheel roller. For patch areas not large enough to permit use of a roller, compaction shall be accomplished using a mechanical tamper capable of achieving the required in-place density. The in- place density of the HMA patching mixture shall be not less than 90% of the maximum theoretical density of the mixture as determined by AASHTO T 209 (Method A). When the Contractor and Owner's Representative and/or Designer elect to test the in-place density of a patched area using a calibrated density gauge, the test data for the patched area shall be recorded on NETTCP TRFs.

3.6 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving. The Contractor shall ensure that it is in conformance with the required grade, cross-section, and in-place density. The compacted subbase shall not be frozen or have standing water.
- B. Proof roll prepared base material surface, if applicable, to identify areas requiring removal and re-compaction, and to provide a uniform degree of compaction over the entire pavement area.
- C. Do not begin paving work until deficient base material areas and utility trenches have been corrected and are ready to receive paving. Paving shall not be applied until the Designer inspects and approves the finished base.
- D. When an existing surface or new base upon which the bottom course is to be placed contains unsatisfactory irregularities, in the Designer's judgment, such irregularities may be eliminated by an adequate placing and compaction of HMA mixture to furnish a surface with true contour and grade before placing any specified course of mixture.
- E. When indicated on the plans, existing HMA pavement courses shall be milled and removed from the project by the Contractor in accordance with Section 3.5 and with Section 415 of the MassDOT Standard Specifications for Pavement Milling. Adjustments to milling depth shall be approved by the Designer and shall be used for consideration of the HMA pavement

thickness measurements. Each vertical face of the milled pavement that meets new/existing pavement shall be thorough coats with a hot poured joint sealer.

- F. Check all frames, covers, grates, water valve boxes and other miscellaneous castings that are located in the proposed pavement areas to ensure that all have been correctly positioned and set to the proper slope and elevation. All covers and grates shall be set flush with the required finished surface. All adjustments shall be made prior to placement of the surface course. No depressions or mounds will be permitted in the pavement to accommodate inaccuracies in the setting of castings. Hand placement of HMA along curbs, edging, or utilities after placement and compaction of the surface course shall not be permitted.
- G. Leveling Course. Any HMA used for truing and leveling shall meet the requirements of the mix design methods and the requirements of MassDOT Standard Section 450.10 for the applicable mixtures. Leveling courses shall not be subject to density requirements. The thickness of the Leveling Course shall be measured off the interface with the existing milled or un-milled pavement surface. The leveling course shall be compacted with the same effort used to achieve placement and density of the test section. The truing and leveling course shall not exceed a nominal thickness of 1.5 inches.
- H. Immediately before placing the hot mix asphalt, the underlying course shall be thoroughly cleaned of all dust and debris by a self-propelled sweeper. Areas inaccessible by power sweepers shall be broom swept until the pavement surface is clean. Extra care shall be required during fall leaf fall.
- I. Tack Coat. Apply uniformly to surfaces to be paved.
 - 1. Contact surfaces of manholes, structures, vertical pavement edges, etc. shall be painted with a thin, uniform tack coat just before the material is placed against them.
 - 2. Tack coat is required on all surfaces to be paved; this includes leveling, base, or intermediate layers of HMA. Particular attention should be made during the application that the longitudinal joint areas be treated with no bare spots. Missing areas on the longitudinal joint area will require either re-application or localized hand work application. The existing surface shall be swept clean of all foreign matter and loose material using a mechanical sweeper and shall be dry before the tack coat is applied.
 - 3. Tack Coat shall be applied by a pressure distributor. All nozzles on the distributor shall be open and functioning. All nozzles shall be turned at the same angle to the spray bar. The nozzles shall be offset at an angle from the spray bar to prevent the fan from one nozzle from interfering with the fan from another. Proper nozzle angle shall be as determined by the Manufacturer of the distributor spray bar. The spray bar shall be adjusted so that it is at the proper height above the pavement surface to provide a triple overlap spray for a uniform coverage of the pavement surface. A triple lap application requires that the nozzle spray patterns overlap one another such that every portion of the pavement receives spray from exactly three nozzles.
 - 4. The tack distributor system shall be equipped with the following to control and monitor the application:
 - a. System for heating the asphalt emulsion uniformly to specified temperature.
 - b. Thermometer for measuring the asphalt emulsion temperature.
 - c. Adjustable full circulation spray bar.
 - d. Positive controls including tachometer, pressure gauge, and volume measuring device.
 - 5. Tack coat application rates for specific surface conditions shall be in accordance with the following:
 - a. On a new HMA surface, not opened to traffic, the emulsion application rate shall equal 0.06 to 0.08 gal/yd².

- b. On an existing tight smooth pavement, the emulsion application rate shall equal 0.06 to 0.08 gal/yd².
 - c. On a milled surface the emulsion application rate shall equal 0.07 to 0.09 gal/yd².
 - d. On cement concrete base course, the emulsion application rate shall be equal to spray application for adjacent surface.
 - e. On new HMA patches the emulsion application rate shall equal 0.06 to 0.09 gal/yd². Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
6. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
7. Tack Coat shall be applied to cover a minimum of 95% of the pavement surface.

3.7 HOT-MIX ASPHALT TRANSPORTING, PLACING AND FINISHING

- A. The trucks used to transport HMA to the field placement site shall have tight, clean, smooth metal beds. When necessary to maintain the required HMA temperature, trucks shall be equipped with insulated beds. The truck beds shall be evenly and lightly coated with an approved release agent meeting the requirements of MassDOT Standard Specification Section M3.01.6. Truck beds shall be free of kerosene, gasoline, fuel oil, solvent, or any other materials negatively impacting the HMA. The HMA shall be protected from foreign debris during transport.
- B. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
- C. HMA deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver.
- D. Upon arrival, the mixture shall be placed to the full width by a hot mix asphalt paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the hot mix asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet except where edge lanes require less width to complete the area. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 6 inches however, the joint in the top layer shall be at the centerline of the pavement. Transverse joints in one layer shall be offset by at least 2 feet from transverse joints in the previous layer. The placement of the material along the longitudinal joint may be performed by setting the screed to overlap the first mat. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. The overlapped material shall be bumped by the lutes, if necessary, to optimize the density along the longitudinal joint. Under no circumstances should the overlapped material be broadcast across the mat. Excess material should be removed by hand. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.
- E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.
- F. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by

hand tools. When hand spreading is permitted, the mixture shall be distributed into place by means of hot shovels and spread with lutes in a loose layer of uniform density and correct depth. The use of rakes to spread the hot mix asphalt shall not be permitted. Loads shall not be dumped any faster than they can be properly handled by the shovelers and the shovelers shall not distribute the dumped load any faster than it can properly be handled by the luters. The luting shall be carefully and skillfully done to avoid segregation and so that, after the first passage of the roller over the luted mixture, no back patching will be necessary. Compaction must immediately follow hand spreading such that specification density is achieved while the mixture temperature is above the manufacturers recommended compaction temperature for the performance graded binder.

- G. The mixtures shall be placed and compacted only at such times as to permit the proper inspection and checking by the Owner's Independent Testing Agency.
- H. The mixtures shall only be placed in the work when they can be efficiently and satisfactorily placed, compacted, smoothed, and made uniform in accordance with these specifications. Unless otherwise permitted by the Owner's Representative and/or Designer for special particular conditions, only machine methods of placing shall be used.
- I. No mixture shall be placed unless the breakdown, and intermediate rolling can be completed by the time the material has cooled to 195°F, or that minimum compaction temperature specified by the binder manufacturer and provided that the density and uniformity of the completed pavement attains specification compliance.
- J. No traffic of any kind shall be permitted on the HMA intermediate or HMA base when dirt or any other foreign substance may be tracked thereon.
- K. Immediately after any course is screeded and before roller compaction is started, the surface shall be checked, any irregularities adjusted, any accumulation from the screed removed by rake or lute, and all fat spots in any course removed and replaced with satisfactory materials. Irregularities in alignment and grade along outside edges shall be corrected by the addition or removal of mixture before the edges are rolled. Indiscriminate casting of mix on the new screeded surface, where irregularities are not evident, shall not be permitted.
- L. All hot mix shall be placed and compacted in such a manner as to ensure a continuous bond between the tacked hot mix pavement surfaces and obtain the required density.
- M. No vehicular traffic or loads shall be permitted on newly completed HMA until adequate stability has been attained and the material has cooled to a temperature of 140°F or less.

3.8 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections and to obtain the required density. Construct joints free of depressions, with same texture and smoothness and grade as other sections of hot-mix asphalt course. When abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure.
 - 1. Clean contact surfaces and apply hot poured joint sealer to joints.
 - 2. Longitudinal Joints.
 - a. All longitudinal joints shall be constructed with the first paver pass in a neat straight line. Deviation from trueness will negate the ability to form a properly compacted longitudinal joint.
 - b. The paver screed may be equipped with a Longitudinal Notched - Wedge Joint or Straight Wedge Joint paver attachment and screed mounted roller attachment when placing HMA pavement courses. Use the Notched Wedge Joint for thicknesses of 1.5 inches or greater and use the Straight Wedge Joint for

thicknesses less than 1.5 inches. The notched wedge joint shall include a variable notched vertical edge (the notch vertical height to be equal to the mixture's maximum aggregate size). The sloped surface of the diagonal wedge joint shall not exceed a 6:1 slope. Prior to placing the adjacent paver pass, all joint contact surfaces shall be given a coat of hot poured joint sealer prior to placing any fresh mixture against the joint. Hot applied joint filler shall not be applied when a wedge joint is used. A tack coat shall be applied to the entire surface of the wedge joint.

- c. Vertical butt joints which are not constructed straight, are not constructed with an edge restraining device (either a commercial paver screed attachment or by dropping the end gate down to the surface) or are damaged (or otherwise defective) shall be cut back 3 inches to expose a clean, sound surface for the full depth of the course and all contact surfaces shall be given a coat of hot poured joint sealant prior to placing any fresh mixture against the joint.
 - d. Offset longitudinal joints, in successive courses, a minimum of 12 inches.
 - e. All longitudinal joint edges on surface courses shall be treated with hot applied joint filler, regardless of location.
 - f. When longitudinal joints abut edges such as curbs, gutters, manholes, etc., a tack coat surface shall be applied over the entire joint.
3. Transverse Joints.
- a. The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical face. In both methods, all contact surfaces shall be given a coat of hot poured joint sealer before placing any fresh mixture against the joint.
 - b. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Longitudinal and transverse joints shall have an in-place density when measured by the average of three 6-inch cores of between 90% to 98% of maximum theoretical.
5. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
6. At the start/end of new HMA meeting existing HMA, the existing pavement shall be sawcut. Sawcut faces shall be coated with hot applied joint sealer prior to HMA placement.
7. If traffic is to be carried over any traverse joints before HMA completion, a temporary pavement joint of a maximum 12:1 slope shall be constructed. Reheating of the joint will not be permitted.

3.9 COMPACTION

- A. The mixture shall be thoroughly and uniformly compacted by rolling. Equipment may include steel wheeled rollers, vibratory rollers, oscillation rollers, or pneumatic-tired rollers. The surface shall be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor so that the required compaction and surface texture are consistently attained while the mixture is in a workable condition. When possible, the Contractor is encouraged to use pneumatic or oscillation rollers. Rolling shall be initiated with the drive roll or wheel towards the paving machine. When rolling on steep grades, the

previous procedure may need to be altered. The Contractor shall provide the proper number of rollers to achieve the target in-place density and course thickness.

- B. The speed of the roller shall, at all times, be sufficiently slow and of uniform speed to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring because of reversing the direction of the roller, or from any other cause, shall be corrected at once. Rollers shall not be permitted to stop on the mat except to reverse direction or refill water.
- C. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. The number of rollers and passes required shall be governed by the compaction results; however, at least two rollers shall be provided for each paver employed on the paving operation. Each roller shall be operated by a competent, experienced roller operator and shall be kept in as nearly continuous operation as practicable while work is underway. A plate shall be attached to each roller showing the ballasted and unballasted weight per length-width of tread.
- D. To prevent adhesion of the mixture to the steel roller, the drums or shall be kept properly moistened, cocoa mats kept clean and scrapers used, but excessive water will not be permitted. Pneumatic rollers shall be operated on adjacent pavement surfaces to get the tires warm to hot from friction, then moved to the fresh mat.
- E. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers and vibratory plate compactors.
- F. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.
- G. Along any adjoining edge such as curb, gutter or an adjoining pavement, and after the HMA is placed by the paver, just enough of the hot HMA shall be placed by hand method to fill any space left open. These joints shall be properly 'set up' with the back of a lute at the proper height and level to receive the maximum compaction. Any areas where the rollers cannot access shall be hand tamped or plate compacted.
- H. Breakdown Rolling. Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- I. Intermediate Rolling. Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the required field density.
- J. Finish Rolling. Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- K. Edge Shaping. While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to the proper alignment. Edges so formed shall be beveled while still hot with the back of a lute or smoothing iron and thoroughly compacted by tampers or by other satisfactory methods.
- L. Protection. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

- M. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 INSTALLATION TOLERANCES

- A. Accessibility: Comply with requirements of Massachusetts Architectural Access Board and ADAAG requirements. Remove and replace paving that does not meet required tolerances when measured with a 2 foot straight edge.
- B. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 3/8 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- C. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within MHD Specification tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas.

3.11 OPENING TO TRAFFIC

- A. No vehicular traffic or loads shall be permitted on the newly completed pavement until all of the following conditions are met:
 - 1. Adequate stability has been attained.
 - 2. The material has cooled sufficiently to prevent distortion or loss of fines.
 - 3. The pavement has cooled sufficiently to an internal temperature of 140 degrees F or less.
- B. If the climatic or other conditions warrant, or if the PGAB manufacturer recommends, the period of time before opening to traffic may be extended at the discretion of the Owner's Representative and/or Designer.

3.12 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from the Project site, and legally dispose of them in an EPA-approved landfill.

End of Section

SECTION 32 12 42- PERVIOUS CONCRETE

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Provide all equipment and materials, and do all work necessary to complete the work which includes, but is not limited to the following:
 - 1. Furnishing, placing, curing and finishing of pervious concrete pavement as shown on the Contract Documents

1.3 RELATED WORK

- A. Section 02 41 13 – SITE PREPARATION.
- B. Section 04 01 40 – STONE MASONRY RESTORATION.
- C. Section 31 20 00 – EARTHWORK.
- D. Section 32 13 13 – CONCRETE PAVEMENT.

1.4 REFERENCES

- A. The following standards shall apply to the work of this Section.
 - 1. American Concrete Institute (ACI):
 - 306.1 Cold Weather Concreting
 - 316R Recommendations for Construction of Concrete Pavements and Concrete Bases.
 - 2. American Society for Testing and Materials (ASTM):
 - A 185 Specification for Steel Welded Wire Fabric. Plain, for Concrete Reinforcement
 - A 615 Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
 - C 33 Specifications for Concrete Aggregates
 - C 94 Specifications for Ready-Mixed Concrete
 - C140 Test Method for Sampling and Testing
 - C 150 Specification for Portland Cement
 - C 171 Specification for Sheet Materials for Curing Concrete
 - C 172 Standard Practice for Sampling Freshly Mixed Concrete
 - C 174 Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
 - C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - C 494 Specification for Chemical Admixtures for Concrete
 - C 595 Specification for Blended Hydraulic Cements
 - C 1077 Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
 - C1688 Test Method for Density and Void Content of Freshly Mixed Pervious Concrete
 - D 226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
 - D 545 Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types)

- D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft³ (2,700 kN-m/m³)]
- D 1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- 3. Commonwealth of Massachusetts Highway Department (MHD):
Specifications Standard Specifications for Highways and Bridges

1.5 PROJECT CONDITIONS

- A. The Contractor, before commencing work, shall examine all adjoining work on which this work is in any way dependent for proper installation and workmanship according to the intent of this specification, and shall report to the Owner's Representative any condition that prevents this contractor from performing first class work.
- B. Protection of Footings against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.
- C. Protect adjacent finish materials against spatter during concrete placement.
- D. Provide all barricades and safeguards at all pits and holes etc. to prevent injury to workmen and others within and about the premises. Also provide all safeguards as required by the Building Code, OSHA, or any other departments having jurisdiction. Contractor shall take full responsibility for all safety precautions and methods.
- E. Procedure of Work: The Contractor shall keep himself constantly informed as to the progress of the work in the field, materials and men ready to start work immediately when conditions of preceding work are available or ready, wholly or in part, so as not to delay the progress of building work or to interfere with the progress of work of other contractors, and in any event he shall, within 24 hours after notice from the Owner, proceed with such work as directed to maintain the uninterrupted progress of the work.

1.6 QUALITY ASSURANCE

- A. Unless otherwise specified, work and materials for construction of the reinforced porous cement concrete paving shall conform to ACI 316R, and applicable portions of the following:
 - 1. MHD Specifications Section 403 Cement Concrete Base Course and 476 Cement Concrete Pavement.
- B. Place two test panels on the project site, on a subgrade, and subbase prepared as specified, using the material and construction requirements for the slab in this specification. Each panel must have a area of least 150 square feet, and a width and thickness as specified for the for the slab in the Contract Documents.
- C. Paving installation shall be done only after excavation and construction work which might injure them have been completed. Damage caused during construction shall be repaired before acceptance.
- D. Existing paving areas shall, if damaged or removed during course of this project, be repaired or replaced under this Section. Workmanship and materials for such repair and replacement, except as otherwise noted, shall match as closely as possible those employed in existing work installed under this Contract.
- E. Pavement base shall not be placed on a muddy or frozen subgrade.

1.7 SUBMITTALS

- A. Description of Methods and Sequence of Placement. For each type of specially-finished concrete provide description of methods and sequence of placement.
- B. Proposed concrete mixture proportions with density and void contents of freshly mixed pervious concrete per ASTM C1688.C1688M.
- C. In-place test results from previous work, completed in the last 24 months, including density and void content freshly mixed pervious concrete, mixture proportions, thickness, density, and content of cores extracted from the slab, if tested when required by Owner's Representative.
- D. Reports covering the source and quality of concrete materials.
- E. Advise designated Testing agency at least 48 hours before concrete placement.
- F. Two test panels as described in 1.6 shall be placed, jointed and cured; a minimum of 150 square feet and being in tolerance of the required thickness defined by Contract Documents. The required information to be submitted for the test panels shall be density of the fresh concrete, length of cores and density of cores. The accepted sample, upon approval, shall be maintained as the standard of minimal quality for approval of all proposed pervious concrete work required for the project. Unacceptable sample panels shall immediately be removed from the site.
- G. Jointing plan and placing sequence, if proposed alternative to the Contract Documents
- H. When hot and or cold weather is anticipated, submit detailed procedures for the production, transportation, placement, protection, curing and temperature monitoring of the concrete

1.8 TESTING AND INSPECTION

- A. The testing laboratory will be responsible for conducting and interpreting tests. Each report shall state whether or not the test specimens conform to all requirements of the Contract Documents and will specifically note any deviation there from if any. Specific test and inspection requirements shall be as specified herein.
- B. The Owner reserves the right to retain an independent testing laboratory to perform inspection and testing of paving and associated work.

PART 2 – PRODUCTS

2.1 AGGREGATE BASE COURSE

- A. Base course and structural fill shall meet the size, quality and grading requirements of Contract Documents and Section 31 00 00, EARTHWORK.

2.2 CONCRETE FORMWORK

- A. The dimensions of the lumber used to form concrete pavements shall not be less than 2 inches nominal thickness by the required pavement depth of pavement, base or pad.
- B. Use forms clean and free of debris, non-adherent rust and hardened concrete.

2.3 STEEL REINFORCEMENT

Ray Dunetz Landscape Architecture, Inc.

PERVIOUS CONCRETE
32 12 42-3

- A. Welded wire fabric (WWF) reinforcement shall conform to the applicable requirements of ASTM A 185.
 - 1. Provide mat of #4 rebar at 12 inch center to center spacing both ways.
- B. Expansion dowel system shall consist of a 3/8 inch by 4 1/2 inch square smooth steel plate cut from hot-rolled plate steel conforming to the requirements of ASTM A36 and compatible pocket former sleeve or approved product or contractor-fabricated item.
 - 1. Dowels and sleeves shall be Diamond Dowel System as furnished by PNA Construction Technologies, Atlanta, GA; phone: (770) 455-6800, (800) 542-0214; fax: (770) 455-6803, or approved equal.

2.4 PERVIOUS CONCRETE BASE SLAB

- A. Cast-in-place pervious concrete shall meet the following acceptable standards and conform to the requirements and applicable provisions of MHD Specifications Section M4.02. Any portion of the pervious concrete paving that does not meet the required acceptance shall be removed at the direction of the Owner's Representative.
 - 1. Water permeability rate shall be no less than 3 gallons/minute/square foot.
 - 2. Interconnected pores shall range in size from 0.10 to 0.30 inches.
 - 3. The effective void content shall be 20% to 25%.
 - 4. Compressive strength shall be minimum 4,000 psi.
 - 5. Air content shall be 14% to 16%.
 - 6. Pavement surfaces shall be free of cracking.
 - 7. Pavement surfaces shall not pond water.
 - 8. Pavement surfaces shall be free of visible high and low spots.
 - 9. Tooled joints and all expansion joints shall be straight, true, uniform in width and free from twists, bends, kinks and misalignments.
 - 10. All tooled joints and expansion joints shall be flush.
- B. Cement and/or Cementitious Content: ASTM C150 Type I or Type II, the total cementitious material shall not be less than 600 pounds per cubic yard. The aggregate to cement ratio (by mass) shall range between 4:1 and 4.5:1.
- C. Fly ash conforming to ASTM C618 may be used in amounts not exceeding 20 percent by weight of the total cementitious material.
- D. Water to cement ratio (by mass) shall range between 0.27 and 0.34.
- E. Aggregate gradation shall conform to M2.01.4. The volume of aggregate shall be equal to approximately 25 cubic feet by cubic yard when calculated as a function of the unit weight determined in accordance with ASTM C 29 jigging procedure. Final aggregate content will depend upon the specific gravity of the aggregate to be used, and the desired void content to be obtained in the hardened pervious concrete. A hardened void content range of 20-25% is assumed when using approximately 25 cubic feet of aggregate per cubic yard of pervious concrete.

2.5 CURING MATERIALS FOR CONCRETE

- A. Curing shall be by moist curing or by use of curing compound.
- B. Curing paper shall be nonstaining, fiber reinforced laminated kraft bituminous product conforming to ASTM C 171. Four mil polyethylene sheeting may be substituted for curing paper.

- C. Curing compound shall be a resin-base, white pigmented compound conforming to ASTM C 309, Type 2.

2.6 CONTROL JOINTS

- A. Control joints indicated on the Drawings to be sawn, shall be made by saw cutting concrete slab after concrete is finished and when the surface is stiff enough to support the weight of the workmen without damage to the slab. Saw blade shall cut into slab at least 1 in., but in no case less than 25% of slab depth.

2.7 EXPANSION JOINTS

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

2.8 JOINT SEALANT

- A. Joint sealant and primer shall be polyurethane-based, one component, elastomeric sealants, complying with Fed. Spec. TT-S-00230C, Class A Type 1. Color shall be as selected by the Owner's Representative. Sealants shall be self-leveling pour grade type.
 - 1. Vulkem 45, as manufactured by Mameko International, 4475 East 175th Street, Cleveland Ohio 44182, (800) 321-6412.
 - 2. Urexpan NR-210, as manufactured by Pecora Corporation, 165 Wambold Road, Harleysville, PA 10348, (215) 723-6051
 - 3. PSI 951, as manufactured by Polymeric Systems Inc., Phoenixville, PA, (800) 228-5548.
- B. Provide only materials which are known to be fully compatible with the actual installation condition, as shown by the manufacturer's published data or certification. Use manufacturer's recommended joint primer.

2.9 BOND BREAKER

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

2.10 BONDING AGENT

- A. High strength bond coat shall be a mixture of the following ingredients:
 - 1. Laticrete 211 Crete Powder manufactured by Laticrete International, Inc., Bethany, CT 06524.
 - 2. Laticrete 4237 manufactured by Laticrete International, Inc., Bethany, CT 06524.

PART 3 – EXECUTION

3.1 PREPARATION OF SUBGRADE

- A. Areas to be paved shall be compacted and brought to subgrade elevation and all said work specified, performed and paid under Section 31 00 00, EARTHWORK, before work of this Section is performed. Final fine grading, filling, and compaction of areas to receive paving, as

Ray Dunetz Landscape Architecture, Inc.

PERVIOUS CONCRETE
32 12 42-5

required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be as specified, performed and paid under Section 31 00 00, EARTHWORK, of this Specification.

- B. Existing subgrade material that will not readily compact as required shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material purchased, installed and paid for under the work of Section 31 00 00, EARTHWORK.
- C. Subgrade of areas to be paved shall be recompacted as required to bring top 8 inches of material immediately below aggregate base course to a compaction at optimum moisture of at least 95 percent of maximum density, as determined by ASTM D 1557. Subgrade compaction shall extend for a distance of at least 12 inches beyond pavement edge.
- D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subbase, base, or pavement, subsequent backfill and compaction shall be performed as directed by the Owner's Representative as specified, performed and paid for in Section 31 00 00, EARTHWORK, of this Specification. Uniformly and properly grade all such completed subgrade areas after filling.
- E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 inches deep in subgrade, shall be graded out, reshaped as required, and recompacted before placing pavement as specified, performed and paid for under Section 31 00 00, EARTHWORK, of this Specification.
- F. Materials shall not be stored or stockpiled on subgrade.
- G. Disposal of debris and other material excavated under Section 31 00 00, EARTHWORK, of this Specification, and material unsuitable for or in excess of requirements for completing work of Section 31 00 00, EARTHWORK, of this Specification shall be disposed of off-site as specified, performed and paid for under Division 2 Section, EARTHWORK, of this Specification.
- H. Prepared subgrade will be inspected by the Owner's Representative. Contractor shall arrange to have the Owner's Representative visit the site to inspect and approve subgrade. Disturbance to subgrade caused by inspection procedures shall be repaired as specified, performed and paid for under Section 31 00 00, EARTHWORK, of this Specification.

3.2 AGGREGATE BASE COURSE

- A. Aggregate base course for concrete paving shall be provided, installed and paid for under the Section 31 00 00, EARTHWORK, of this Specification.

3.3 FORMWORK

- A. All forms shall be joined neatly and tightly, shall be set true to line and grade, well staked and braced, and shall have uniform bearing throughout their length. Remove all forms and miscellaneous appurtenances from pavement edges and dispose of all formwork and appurtenances at the end of the construction project.
 - 1. Forms shall not be moved for 72 hours after the concrete has been placed, or for a longer period if directed by the Owner's Representative.
 - 2. Remove all forms. Extreme care shall be taken in removing forms in order that no damage will be done to the concrete.
 - 3. Under no condition shall any bar, pick or other tool be used which depends upon leverage on the concrete for removal of the forms.

3.4 STEEL REINFORCEMENT

Ray Dunetz Landscape Architecture, Inc.

PERVIOUS CONCRETE
32 12 42-6

- A. Before being placed in position, reinforcing for reinforced concrete shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material which may reduce the bond between the concrete and reinforcing. Where there is delay in placing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.
- B. Reinforcement shall be held firmly in place against vertical or transverse movement by means of satisfactory devices. Where reinforcement is spliced, it shall be lapped at least 12 inches.
 - 1. Unless designated otherwise on the Contract Documents, reinforcement shall be placed midway within the depth, and parallel to the finished surface of concrete pavements.
 - 2. Do not pour concrete over top of reinforcement unless it is supported underneath.
 - 3. Contractor shall pull reinforcement up immediately after pouring concrete to make sure that the reinforcement is in the middle of the slab and not sitting on the bottom.
- C. Unless otherwise indicated on the Contract Documents, reinforcing shall not extend within 2 inches of formwork and expansion joints.
 - 1. Reinforcing shall continue through control joints.
- D. The Owner may do core testing to make sure that reinforcement is in the proper position. If testing shows otherwise concrete will be rejected and the Contractor shall remove all rejected slabs and re-pour new slabs at no additional cost. Contractor shall repair cored holes as directed by the Owner's Representative.

3.5 EXPANSION JOINTS

- A. Expansion joints (isolation joints) shall be 1/2 inches wide and unless otherwise indicated on the Drawings, shall be located 30 ft. o.c. and at places where pavement meets other structures. Expansion joint shall be formed in the concrete to required width with preformed joint filler in place. Joint filler shall extend the full depth of the slab. Joint filler shall extend the full length of the expansion joint.
 - 1. Depth of joint filler shall be as required to form a 1-1/4 in. deep sealant and backer rod recess below finished concrete surface.
 - 2. Doweled joint: Install sleeves and dowel bars at expansion joints as indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete from bonding to one side of joint.
- B. Where the expansion dowel system is used in the expansion joints, steel plates and pocket former sleeves shall be set parallel with the top and bottom surfaces of the concrete slab and installed according to the manufacturer's installation instructions.

3.6 CONTROL JOINTS

- A. Control joints indicated shall be sawn by using a diamond blade concrete power saw. Joint shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab. Saw shall cut into slab at least 1 in., but in no case less than 25% of slab depth.

3.7 TRANSPORTATION AND DISCHARGE

- A. The porous concrete can be transported by either a ready-mix truck or a dump truck. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed 90 minutes, unless otherwise approved by the Owner's Representative. This time may be increased to 120 minutes when utilizing an approved retarding admixture or the hydration stabilizer specified herein.

- B. The porous concrete contractor or his qualified agent shall inspect each batch for appearance of concrete uniformity. A slight adjustment of water may be required at the work site to achieve the proper consistency. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following any such adjustment. Mixture discharge shall be as rapid as and continuous as possible. Concrete shall be deposited as close to its final position as practicable and at a point so that fresh concrete enters and adheres to the mass of previously placed unhardened concrete. As deposited, the mixture shall be placed where it will require as little re-handling as possible.

3.9 PORTLAND CEMENT CONCRETE PAVING

- A. Paving mix, equipment, methods of mixing and placing, and precautions to be observed as to weather, condition of base and the like, shall meet the requirements of ACI 316R. Pavement shall be constructed in accordance with the Contract Documents.
- B. The Owner's Representative shall be notified of concrete placement sufficiently in advance of start of operation to allow his representative to complete preliminary inspection of the work, including subgrade, forms, and reinforcing steel, if used.
1. No concrete shall be deposited until the Owner's Representative has inspected the placing of reinforcement and given permission to place concrete.
- C. Normal concrete placement procedures shall be followed. Concrete shall arrive at the job site so that no additional water will be required to produce the desired slump. When conditions develop that required addition of water to produce the desired slump, permission of the Owner's Representative must be obtained. The concrete shall be transported from the mixer to its place of deposit by a method that will prevent segregation or loss of material.
1. Concrete pavement shall be placed in a series of alternate pours such that every other panel bounded by expansion joints shall be poured first.
 2. The intervening panels shall then be poured as a secondary operation only after the first panels have hardened sufficiently to allow the removal of all temporary transverse forming supports.
 3. Concrete shall be placed in one course, to full depth, as detailed on the Contract Documents.
- D. Apply bonding agent to vertical surfaces of galvanized steel trench drain boxes as specified and installed under the work of Section 32 40 00, SITE IMPROVEMENTS, of this Specification. Apply bonding agent immediately prior to the spreading of concrete for pavement surfaces.
- E. Work shall not be performed during rainy weather or when temperature is less than 40 degrees Fahrenheit. In the event that unforeseen rain occurs, cover all broom finished concrete surfaces with plastic sheet covering to prevent alteration of texture. Concrete slabs with textured concrete surfaces altered by rain shall be removed from the site as directed by the Owner's Representative.
- F. Adjacent work shall be protected from stain and damage during entire operation. Damaged and stained areas shall be replaced or repaired to equal their original conditions.
- G. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed shall thoroughly damp when concrete is placed. There shall be no free water on surface.
- H. Concrete which has set or partially set before placing shall not be employed. Retempering of concrete will not be permitted.
- I. Concrete shall be thoroughly spaded and tamped to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms.

- J. When joining fresh concrete to concrete which has attained full set, latter shall be cleaned of foreign matter, and mortar scum and laitance shall be removed by chipping and washing. Laitance is the accumulation of fine particles on the surface of freshly poured concrete caused by an upward movement of water through the concrete. This can be caused by too much mixing water, by excessive tamping, or by vibration of the concrete. Clean, roughened base surface shall be saturated with water, but shall have no free water on surface. A coat of 1:1 cement-sand grout, approximately 1/8 inches thick, shall be well scrubbed into thoroughly dampened concrete base. New concrete shall be placed immediately, before grout has dried or set.

3.10 FINISHING

- A. Compact concrete to a dense, open-textured surface to match the appearance of the test panel and true to line and grade, and free of hollows and bumps and at exact level and slope required.
- B. Where finishing is performed before end of curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.
- C. Immediately following finishing operations, arrises at edges and both sides of expansion joints shall be rounded to a 1/4 inches radius.
- D. Control Joints:
1. Control joints shall be saw cut joints as specified below.
- E. All finishing of the concrete shall be subject to the review and approval of the Owner's Representative at any time during the construction project. The Contractor shall remove and replace, at no additional cost to the Owner, all concrete which is not acceptable to the Owner's Representative.
- F. Where finishing is performed before end of curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.

3.11 CURING

- A. It is essential that concrete be kept continuously damp from time of placement until end of specified curing period. It is equally essential that water is not added to surface during floating and troweling operations, and not earlier than 24 hours after concrete placement. Between finishing operations surface shall be protected from rapid drying by a covering of waterproofing paper. Surface shall be damp when the covering is placed over it and shall be kept damp by means of a fog spray of water, applied as often as necessary to prevent drying, but not sooner than 24 hours after placing concrete. None of the water so applied shall be troweled or floated into surface.
- B. Concrete surfaces shall be cured by completely covering with curing paper or application of a curing compound.
1. Concrete cured using waterproof paper shall be completely covered with paper with seams lapped and sealed with tape. Concrete surface shall not be allowed to become moistened between 24 and 36 hours after placing concrete. During curing period surface shall be checked frequently, and sprayed with water as often as necessary to prevent drying, but not earlier than 24 hours after placing concrete.

2. If concrete is cured with a curing compound, compound shall be applied at a rate of 200 square feet per gallon, in two applications perpendicular to each other.
3. Curing period shall be seven days minimum.

3.11 COLD WEATHER CONCRETING

- A. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40 degree Fahrenheit or is expected to fall to below 40 degree Fahrenheit within 72 hours, and the concrete after placing shall be protected by covering, heat, or both.
- B. Details of handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Owner's Representative. Procedures shall be in accordance with provisions of ACI 306R.

3.12 HOT WEATHER CONCRETING

- A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. Every effort shall be made to minimize delays which will result in excessive mixing of the concrete after arrival on the job.
- B. During periods of excessively hot weather (95 degree Fahrenheit., or above), ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of ACI 305. Any concrete with a temperature above 95 degree Fahrenheit., when ready for placement will not be acceptable, and will be rejected.
- C. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, and the like.) and relative humidity. Records shall include checks on temperature of concrete as delivered and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.

3.13 SEALING OF JOINTS

- A. Where indicated on the Contract Documents, expansion joints in concrete walkways shall be sealed with joint sealant.

3.14 PROTECTION OF CONCRETE SURFACES

- A. Concrete surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently. If necessary 1/2 inches, thick plywood sheets shall be used to protect the exposed surface.
- B. The Contractor shall provide adequate surveillance for all poured-in-place concrete pavements until concrete has set firmly, to prevent unwarranted markings of the concrete surface. Any unauthorized marking or graffiti in the finished surfaces shall be a cause for rejection by the Owner's Representative and replacement by the Contractor.

3.17 ACCEPTANCE STANDARDS

- A. The following acceptance standards shall be applied to this Contract. These standards are considered superior to typical industry standards. Any portion of the concrete paving that does not come up to these required acceptance standards shall be removed at the direction of the Owner's Representative.

1. Pavement surfaces shall be free of all cracking.
2. Pavement surfaces shall not pond water.
3. Pavement surfaces shall be free of visible high and low spots.
4. Steel mesh reinforcing shall not penetrate the surfaces or sides of the concrete slab.
5. Sawn joints and all expansion joints shall be straight, true, uniform in width and free from twists, bends, kinks and misalignments.
6. Expansion joints and score joints shall be placed as required by the Contract Documents.
7. Concrete surfaces shall be free of all stains, including those created during the course of the construction by the Contractor, caused by natural events, or caused by vandalism.
8. All expansion joints shall be flush.
9. Stains from construction or from natural causes
10. Pours different in color as determined by the Owner's Representative.
11. Pours without expansion joints cast into them.
12. Pours not conforming to the Contract Documents.
13. All forms shall be removed from the site.

END OF SECTION
32 12 42

This Page Intentionally
Not Used

SECTION 32 13 13 - CONCRETE PAVING

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- A. The work of this Section consists of providing all labor, equipment, materials, incidental work, and construction methods necessary to furnish and install reinforced concrete pavement, concrete pads for utilities specified elsewhere, concrete base for stone paving, concrete paving, as indicated on the Contract Documents and as specified herein.

1.2 SECTION INCLUDES

- A. Provide all equipment and materials, and do all work necessary to complete the work which includes, but is not limited to the following:

- 1. Furnishing, placing, curing and finishing of all concrete paving.

1.3 RELATED WORK

- A. Section 02 41 13 – SITE PREPARATION.
- B. Section 04 01 40 – STONE MASONRY RESTORATION.
- C. Section 31 20 00 – EARTHWORK.
- D. Section 32 30 00 – SITE IMPROVEMENTS.

1.4 REFERENCES

- A. The following standards shall apply to the work of this Section.

- 1. American Concrete Institute (ACI):
 - 306R Cold Weather Concreting
 - 316R Recommendations for Construction of Concrete Pavements and Concrete Bases.
 - 2. American Society for Testing and Materials (ASTM):
 - A 185 Specification for Steel Welded Wire Fabric. Plain, for Concrete Reinforcement
 - A 615 Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
 - C 33 Specifications for Concrete Aggregates
 - C 94 Specifications for Ready-Mixed Concrete
 - C 143 Test Method for Slump of Hydraulic Cement Concrete
 - C 150 Specification for Portland Cement
 - C 171 Specification for Sheet Materials for Curing Concrete
 - C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - C 494 Specification for Chemical Admixtures for Concrete
 - D 226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing
 - D 545 Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types)
 - D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft³ (2,700 kN-m/m³)]
 - D 1752 Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
 - 3. Commonwealth of Massachusetts Highway Department (MHD):

Specifications Standard Specifications for Highways and Bridges

1.5 PROJECT CONDITIONS

- A. The Contractor, before commencing work, shall examine all adjoining work on which this work is in any way dependent for proper installation and workmanship according to the intent of this specification, and shall report to the Owner's Representative any condition that prevents this contractor from performing first class work.
- B. Protection of Footings against Freezing: Cover completed work at footing level with sufficient temporary or permanent cover as required to protect footings and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary.
- C. Protect adjacent finish materials against spatter during concrete placement.
- D. Provide all barricades and safeguards at all pits and holes etc. to prevent injury to workmen and others within and about the premises. Also provide all safeguards as required by the Building Code, OSHA, or any other departments having jurisdiction. Contractor shall take full responsibility for all safety precautions and methods.
- E. Procedure of Work: The Contractor shall keep himself constantly informed as to the progress of the work in the field, materials and men ready to start work immediately when conditions of preceding work are available or ready, wholly or in part, so as not to delay the progress of building work or to interfere with the progress of work of other contractors, and in any event he shall, within 24 hours after notice from the Owner, proceed with such work as directed to maintain the uninterrupted progress of the work.

1.6 QUALITY ASSURANCE

- A. Unless otherwise specified, work and materials for construction of the reinforced Portland cement concrete paving shall conform to ACI 316R, and applicable portions of the following:
 - 1. MHD Specifications Section 476 Cement Concrete Pavement.
- B. Surfaces of curb ramps and handicapped access ramps shall be stable, firm and slip resistant. Construct ramps so that water does not accumulate on ramp surfaces. While grading plans anticipate cross slopes, Contractor shall be responsible to ensure all surfaces drain while meeting Federal and Commonwealth standards for handicapped access.
- C. Paving work, base course installation, top course installation, and the like, shall be done only after excavation and construction work which might injure them have been completed. Damage caused during construction shall be repaired before acceptance.
- D. Existing paving areas shall, if damaged or removed during course of this project, be repaired or replaced under this Section. Workmanship and materials for such repair and replacement, except as otherwise noted, shall match as closely as possible those employed in existing work installed under this Contract.
- E. Pavement, base, or subbase shall not be placed on a muddy or frozen subgrade.

1.7 SUBMITTALS

- A. Description of Methods and Sequence of Placement. For each type of specially-finished concrete provide description of methods and sequence of placement.

B. Submit manufacturer's product data for the following:

1. Form release agent.
2. Concrete coloring additive.
3. Preformed joint filler.
4. Sealants.
5. Detectable Warning Tile.

C. Construct Concrete Sample Panels:

1. Construct a minimum of four 6 foot x 6 foot sample panels of finished 6 inch concrete pavement, for approval, at least 15 days prior to final concrete paving work. Samples shall be constructed within the vicinity of the proposed finish work to facilitate comparisons during construction. Samples shall not be constructed in an area of proposed finish work. The samples shall demonstrate the typical installation of concrete, including score lines, expansion joint and sealant, curing and finishing material, surface texture, color, and edge treatment. The accepted sample, upon approval, shall be maintained as the standard of minimal quality for approval of all proposed colored concrete pavement work required for the project. Unacceptable sample panels shall immediately be removed from the site.
2. Contractor shall be responsible to consult with a representative of the Manufacturer of integral color admixture to ensure compliance with the Manufacturer's product literature and installation instructions and directives.

1.8 TESTING AND INSPECTION

- A. The testing laboratory will be responsible for conducting and interpreting tests. Each report shall state whether or not the test specimens conform to all requirements of the Contract Documents and will specifically note any deviation there from if any. Specific test and inspection requirements shall be as specified herein.
- B. The Owner reserves the right to retain an independent testing laboratory to perform inspection and testing of paving and associated work.

PART 2 – PRODUCTS

2.1 AGGREGATE BASE COURSE

- A. Base course shall be gravel borrow and shall be specified, provided, installed and paid for under the work of Section 31 00 00, EARTHWORK, of this Specification

2.2 CONCRETE FORMWORK

- A. The dimensions of the lumber used to form concrete pavements shall not be less than 2 inches nominal thickness by the required pavement depth of pavement, base or pad.

2.3 STEEL REINFORCEMENT

- A. Welded wire fabric (WWF) reinforcement shall conform to the applicable requirements of ASTM A 185. Fabric reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.
1. Provide 6 inches x 6 inches W2.9 x W2.9 WWM for pavements, base and pads.
- B. Expansion dowel system shall consist of a 3/8 inch by 4 ½ inch square smooth steel plate cut from hot-rolled plate steel conforming to the requirements of ASTM A36 and compatible pocket former sleeve or approved product or contractor-fabricated item.

1. Dowels and sleeves shall be Diamond Dowel System as furnished by PNA Construction Technologies, Atlanta, GA; phone: (770) 455-6800, (800) 542-0214; fax: (770) 455-6803, or approved equal.

2.4 PORTLAND CEMENT CONCRETE

- A. Cast-in-place concrete shall be air-entrained concrete with minimum 28-day compressive strength of 4,000 pounds per square inch, conforming to the requirements and applicable provisions of MHD Specifications Section M4.02.

1. Air Entrainment: Concrete shall be air-entrained 7 percent minimum +/-1 percent, by volume.
2. Slump: Concrete shall have a slump of 2 inches to 4 inches slump.
3. Maximum Aggregate Size: Aggregate size shall be a maximum of 3/4 inches.
4. Thickness of Concrete: Depths shall be as noted on the Contract Documents.

2.5 CURING MATERIALS FOR CONCRETE

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

2.6 CONTROL JOINTS

- A. Control joints indicated on the Drawings to be sawn, shall be made by saw cutting concrete slab after concrete is finished and when the surface is stiff enough to support the weight of the workmen without damage to the slab. Saw blade shall cut into slab at least 1 in., but in no case less than 25% of slab depth.

2.7 EXPANSION JOINT MATERIALS

- A. Expansion Joint Filler:
1. Closed cell polymer foam meeting requirements of ASTM D 1752, Sections 3.1 to 3.4, based on compression requirement of 10 pounds per square inch minimum and 25 pounds per square inch maximum. Recovery rate following 50 percent compression shall exceed 99 percent recovery, per ASTM D 545. Foam shall be equal to Ceramar Foam Filler, manufactured by W.R. Meadows, Inc., or an approved equal.
- B. Backer Rod: The backer rod shall be expanded, closed cell polyethylene foam. The backer rod shall be approximately 25 percent larger in diameter than the width of the joint or crack to be sealed. Other back-up materials (paper, rope and open cell foam) are unacceptable. The backer rod shall be compatible with the sealant, and no bond or reaction shall occur between the backer rod and sealant.

2.8 EXPANSION JOINTS

- A. Transverse construction joints shall be placed whenever placing of concrete is suspended for more than 30 minutes.

1. Butt joint with dowels or thickened edge joint shall be used if construction joints occurs at location of control joint. Submit sketch to Landscape Architect for review and acceptance of proposed system.
2. Keyed joints with tiebars shall be used if the joint occurs at any other location.

2.9 JOINT SEALANT

- A. Joint sealant and primer shall be polyurethane-based, one component, elastomeric sealants, complying with Fed. Spec. TT-S-00230C, Class A Type 1. Color shall be as selected by the Landscape Architect. Sealants shall be self-leveling pour grade type.
1. Vulkem 45, as manufactured by Mameko International, 4475 East 175th Street, Cleveland Ohio 44182, (800) 321-6412.
 2. Urexpan NR-210, as manufactured by Pecora Corporation, 165 Wambold Road, Harleysville, PA 10348, (215) 723-6051
 3. PSI 951, as manufactured by Polymeric Systems Inc., Phoenixville, PA, (800) 228-5548.
- B. Provide only materials which are known to be fully compatible with the actual installation condition, as shown by the manufacturer's published data or certification. Use manufacturer's recommended joint primer.

2.10 BOND BREAKER

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

2.11 BONDING AGENT

- A. High strength bond coat shall be a mixture of the following ingredients:
1. Laticrete 211 Crete Powder manufactured by Laticrete International, Inc., Bethany, CT 06524.
 2. Laticrete 4237 manufactured by Laticrete International, Inc., Bethany, CT 06524.

2.12 SURFACE SEALANT

- A. Surface sealant shall be a penetrating sealer that is absorbed into the surface of the concrete and reacts with the concrete to form a hydrophobic surface. It shall be deep penetrating, ultraviolet light resistant, silane sealer specifically designed to seal cement concrete pavement against salt and moisture damage. Sealant shall be non-discoloring, non-gloss product designed to reduce chloride and water absorption, bridge cracks, and improve deicer scaling resistance of the concrete.

2.13 DETECTABLE WARNING PANELS

- A. Detectable warning panels shall be gray cast iron panels in dimensions shown on the drawings and meet all applicable codes. Panels shall be heavy-duty and have an underside bolting for embedment in concrete pavement. Panels shall be undipped with no coating.
1. Panels shall meet the following requirements:
 - a. Slip resistance ASTM C-1028
 - b. Wear resistance ASTM C-501-84
 - c. Impact resistance ASTM D-1709
 - d. Adhesion to concrete ASTM D-482
 - e. Tensile strength ASTM A-48
 - f. Design Compliance AASHTO M333-16 and ADA
- B. Panels shall be one of the following:
1. "Duralast" as manufactured by EJ, 800-626-4653, ejco.com.

2. "Interlaken" as manufactured by Iron Age Designs, 877-418-3568, ironagegrates.com
3. Detectable Warning Plate as manufactured by Reliance Foundry, 877-789-3245, reliance-foundry.com
4. Or Approved Equal.

C. Provide all necessary hardware and materials necessary for complete installations of panels.

PART 3 – EXECUTION

3.1 PREPARATION OF SUBGRADE

- A. Areas to be paved shall be compacted and brought to subgrade elevation and all said work specified, performed and paid under Section 31 00 00, EARTHWORK, before work of this Section is performed. Final fine grading, filling, and compaction of areas to receive paving, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be as specified, performed and paid under Section 31 00 00, EARTHWORK, of this Specification.
- B. Existing subgrade material that will not readily compact as required shall be removed and replaced with satisfactory materials. Additional materials needed to bring subgrade to required line and grade and to replace unsuitable material removed shall be material purchased, installed and paid for under the work of the Section 31 00 00, EARTHWORK.
- C. Subgrade of areas to be paved shall be recompacted as required to bring top 8 inches of material immediately below aggregate base course to a compaction at optimum moisture of at least 95 percent of maximum density, as determined by ASTM D 1557. Subgrade compaction shall extend for a distance of at least 12 inches beyond pavement edge.
- D. Excavation required in pavement subgrade shall be completed before fine grading and final compaction of subgrade are performed. Where excavation must be performed in completed subgrade, subbase, base, or pavement, subsequent backfill and compaction shall be performed as directed by the Landscape Architect as specified, performed and paid for in Section 31 00 00, EARTHWORK, of this Specification. Uniformly and properly grade all such completed subgrade areas after filling.
- E. Areas being graded or compacted shall be kept shaped and drained during construction. Ruts greater than or equal to 2 inches deep in subgrade, shall be graded out, reshaped as required, and recompacted before placing pavement as specified, performed and paid for under the Section 31 00 00, EARTHWORK, of this Specification..
- F. Materials shall not be stored or stockpiled on subgrade.
- G. Disposal of debris and other material excavated under Section 31 00 00, EARTHWORK, of this Specification, and material unsuitable for or in excess of requirements for completing work of Section 31 00 00, EARTHWORK, of this Specification shall be disposed of off-site as specified, performed and paid for under Division 2 Section, EARTHWORK, of this Specification.
- H. Prepared subgrade will be inspected by the Landscape Architect. Contractor shall arrange to have the Landscape Architect visit the site to inspect and approve subgrade. Disturbance to subgrade caused by inspection procedures shall be repaired as specified, performed and paid for under Section 31 00 00, EARTHWORK, of this Specification.

3.2 AGGREGATE BASE COURSE

- A. Aggregate base course for concrete paving shall be provided, installed and paid for under the Section 31 00 00, EARTHWORK, of this Specification.

3.3 FORMWORK

- A. All forms shall be joined neatly and tightly, shall be set true to line and grade, well staked and braced, and shall have uniform bearing throughout their length. Remove all forms and miscellaneous appurtenances from pavement edges and dispose of all formwork and appurtenances at the end of the construction project.
 - 1. Forms shall not be moved for 72 hours after the concrete has been placed, or for a longer period if directed by the Landscape Architect.
 - 2. Remove all forms. Extreme care shall be taken in removing forms in order that no damage will be done to the concrete.
 - 3. Under no condition shall any bar, pick or other tool be used which depends upon leverage on the concrete for removal of the forms.

3.4 STEEL REINFORCEMENT

- A. Before being placed in position, reinforcing for reinforced concrete shall be thoroughly cleaned of loose mill and rust scale, dirt, ice, and other foreign material which may reduce the bond between the concrete and reinforcing. Where there is delay in placing concrete after reinforcement is in place, bars shall be re-inspected and cleaned when necessary.
 - B. Welded Wire Mesh: Wire mesh used for reinforcement shall be spread flat before placing concrete. Mesh reinforcement shall be held firmly in place against vertical or transverse movement by means of satisfactory devices. Where mesh reinforcement is spliced, it shall be lapped at least 12 inches.
 - 1. Unless designated otherwise on the Contract Documents, wire mesh shall be placed midway within the depth, and parallel to the finished surface of concrete pavements.
 - 2. Do not pour concrete over top of reinforcement unless it is supported underneath.
 - 3. Contractor shall pull reinforcement up immediately after pouring concrete to make sure that the reinforcement is in the middle of the slab and not sitting on the bottom.
 - C. Unless otherwise indicated on the Contract Documents, reinforcing shall not extend within 2 inches of formwork and expansion joints.
1. Reinforcing shall continue through control joints.
- D. The Owner may do core testing to make sure that reinforcement is in the proper position. If testing shows otherwise concrete will be rejected and the Contractor shall remove all rejected slabs and re-pour new slabs at no additional cost. Contractor shall repair cored holes as directed by the Landscape Architect.

3.5 EXPANSION JOINTS

- A. Expansion joints (isolation joints) shall be 1/2 inches wide and unless otherwise indicated on the Drawings, shall be located 30 ft. o.c. and at places where pavement meets other structures. Expansion joint shall be formed in the concrete to required width with preformed joint filler in place. Joint filler shall extend the full depth of the slab. Joint filler shall extend the full length of the expansion joint.
 - 1. Depth of joint filler shall be as required to form a 1-1/4 in. deep sealant and backer rod recess below finished concrete surface.
 - 2. Doweled joint: Install sleeves and dowel bars at expansion joints as indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete from bonding to one side of joint.
- CB Where the expansion dowel system is used in the expansion joints, steel plates and pocket former sleeves shall be set parallel with the top and bottom surfaces of the concrete slab and installed according to the manufacturer's installation instructions.

3.6 CONTROL JOINTS

- A. Control joints indicated shall be sawn by using a diamond blade concrete power saw. Joint shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab. Saw shall cut into slab at least 1 in., but in no case less than 25% of slab depth.

3.7 DECORATIVE SAW CUT JOINTS

- A. Unless otherwise indicated, decorative saw cut joints shall be sawn into the concrete slab at intervals and patterns indicated on the Drawings. Joint shall be made after concrete is finished and when the surface is stiff enough to support the weight of workmen without damage to the slab, but before slab has achieved its final set. Saw cut joints shall be straight and accurate to line.
 - 1. Saw cut joints shall be sawn flush to vertical surfaces.
- B. Decorative saw cut joints shall be located each way to create scoring patterns indicated on the Drawings.
- C. Depth of decorative saw cut joint shall be 3/4 inch.

3.8 PORTLAND CEMENT CONCRETE PAVING

- A. Paving mix, equipment, methods of mixing and placing, and precautions to be observed as to weather, condition of base and the like, shall meet the requirements of ACI 316R. Pavement shall be constructed in accordance with the Contract Documents.
- B. The Landscape Architect shall be notified of concrete placement sufficiently in advance of start of operation to allow his representative to complete preliminary inspection of the work, including subgrade, forms, and reinforcing steel, if used.
 - 1. No concrete shall be deposited until the Landscape Architect has inspected the placing of reinforcement and given permission to place concrete.
- C. Normal concrete placement procedures shall be followed. Concrete shall arrive at the job site so that no additional water will be required to produce the desired slump. When conditions develop that required addition of water to produce the desired slump, permission of the Landscape Architect must be obtained. The concrete shall be transported from the mixer to its place of deposit by a method that will prevent segregation or loss of material.
 - 1. Concrete pavement shall be placed in a series of alternate pours such that every other panel bounded by expansion joints shall be poured first.
 - 2. The intervening panels shall then be poured as a secondary operation only after the first panels have hardened sufficiently to allow the removal of all temporary transverse forming supports.
 - 3. Concrete shall be placed in one course, to full depth, as detailed on the Contract Documents.
- D. Apply bonding agent to vertical surfaces of galvanized steel trench drain boxes as specified and installed under the work of Section 32 40 00, SITE IMPROVEMENTS, of this Specification. Apply bonding agent immediately prior to the spreading of concrete for pavement surfaces.
- E. Work shall not be performed during rainy weather or when temperature is less than 40 degrees Fahrenheit. In the event that unforeseen rain occurs, cover all broom finished concrete surfaces with plastic sheet covering to prevent alteration of texture. Concrete slabs with textured concrete surfaces altered by rain shall be removed from the site as directed by the Landscape Architect.

- F. Adjacent work shall be protected from stain and damage during entire operation. Damaged and stained areas shall be replaced or repaired to equal their original conditions.
- G. Existing concrete, earth, and other water-permeable material against which new concrete is to be placed shall thoroughly damp when concrete is placed. There shall be no free water on surface.
- H. Concrete which has set or partially set before placing shall not be employed. Retempering of concrete will not be permitted.
- I. Concrete shall be thoroughly spaded and tamped to secure a solid and homogeneous mass, thoroughly worked around reinforcement and into corners of forms.
- J. When joining fresh concrete to concrete which has attained full set, latter shall be cleaned of foreign matter, and mortar scum and laitance shall be removed by chipping and washing. Laitance is the accumulation of fine particles on the surface of freshly poured concrete caused by an upward movement of water through the concrete. This can be caused by too much mixing water, by excessive tamping, or by vibration of the concrete. Clean, roughened base surface shall be saturated with water, but shall have no free water on surface. A coat of 1:1 cement-sand grout, approximately 1/8 inches thick, shall be well scrubbed into thoroughly dampened concrete base. New concrete shall be placed immediately, before grout has dried or set.

3.9 DETECTABLE WARNING PANELS

- A. Install detectable warning panels in locations specified in the Drawings. All edges of panels shall be flush with adjacent pavement. No lips, rises, or rough edges shall be allowed. Panels shall be installed in accordance with manufacturer's instructions while meeting ADA, Massachusetts Access Board, and all other applicable standards.

3.10 FINISHING

- A. Concrete flatwork surfaces shall be screeded off and hand floated and finished true to line and grade, and free of hollows and bumps. Surface shall be dense, smooth, and at exact level and slope required.
 - 1. Finished concrete surface for subbases for unit pavement systems shall be woodfloated to a slightly rough surface. Surface shall not deviate more than 1/4 inches in 10 feet.
- B. Unless otherwise indicated, horizontal surfaces of concrete pavement which will be exposed shall be given a light broomed finish, with direction of grooves in concrete surface approximately 45 degrees from the long axis of the concrete pavement at the 500-foot elevation plaza. At all other locations, broom finish shall be set 90 degrees to the long axis of the pavement. After concrete has set sufficiently to prevent coarse aggregate from being torn from surface, but before it has completely set, brooms shall be drawn across it to produce a pattern of small parallel grooves. Broomed surface shall be uniform, with no smooth, unduly rough or porous spots, or other irregularities. Coarse aggregate shall not be dislodged by brooming operation.
- C. Where finishing is performed before end of curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.
- D. Immediately following finishing operations, arrises at edges and both sides of expansion joints shall be rounded to a 1/4 inches radius.

E. Control Joints:

1. Control joints shall be saw cut joints as specified below.

F. All scoring, tooling and finishing of the concrete shall be subject to the review and approval of the Landscape Architect at any time during the construction project. The Contractor shall remove and replace, at no additional cost to the Owner, all concrete which is not acceptable to the Landscape Architect.

G. Where finishing is performed before end of curing period, concrete shall not be permitted to dry out, and shall be kept continuously moist from time of placing until end of curing period, or until curing membrane is applied.

3.11 CURING

A. It is essential that concrete be kept continuously damp from time of placement until end of specified curing period. It is equally essential that water is not added to surface during floating and troweling operations, and not earlier than 24 hours after concrete placement. Between finishing operations surface shall be protected from rapid drying by a covering of waterproofing paper. Surface shall be damp when the covering is placed over it and shall be kept damp by means of a fog spray of water, applied as often as necessary to prevent drying, but not sooner than 24 hours after placing concrete. None of the water so applied shall be troweled or floated into surface.

B. Concrete surfaces shall be cured by completely covering with curing paper or application of a curing compound.

1. Concrete cured using waterproof paper shall be completely covered with paper with seams lapped and sealed with tape. Concrete surface shall not be allowed to become moistened between 24 and 36 hours after placing concrete. During curing period surface shall be checked frequently, and sprayed with water as often as necessary to prevent drying, but not earlier than 24 hours after placing concrete.
2. If concrete is cured with a curing compound, compound shall be applied at a rate of 200 square feet per gallon, in two applications perpendicular to each other.
3. Curing period shall be seven days minimum.

3.12 COLD WEATHER CONCRETING

A. Materials for concrete shall be heated when concrete is mixed, placed, or cured when the mean daily temperature is below 40 degree Fahrenheit or is expected to fall to below 40 degree Fahrenheit within 72 hours, and the concrete after placing shall be protected by covering, heat, or both.

B. Details of handling and protecting of concrete during freezing weather shall be subject to the approval and direction of the Landscape Architect. Procedures shall be in accordance with provisions of ACI 306R.

3.13 HOT WEATHER CONCRETING

A. Concrete just placed shall be protected from the direct rays of the sun and the forms and reinforcement just prior to placing shall be sprinkled with cold water. Every effort shall be made to minimize delays which will result in excessive mixing of the concrete after arrival on the job.

B. During periods of excessively hot weather (95 degree Fahrenheit, or above), ingredients in the concrete shall be cooled insofar as possible and cold mixing water shall be used to maintain the temperature of the concrete at permissible levels all in accordance with the provisions of

ACI 305. Any concrete with a temperature above 95 degree Fahrenheit., when ready for placement will not be acceptable, and will be rejected.

- C. Temperature records shall be maintained throughout the period of hot weather giving air temperature, general weather conditions (calm, windy, clear, cloudy, and the like.) and relative humidity. Records shall include checks on temperature of concrete as delivered and after placing in forms. Data should be correlated with the progress of the work so that conditions surrounding the construction of any part of the structure can be ascertained.

3.14 SEALING OF JOINTS

- A. Where indicated on the Contract Documents, expansion joints in concrete walkways shall be sealed with joint sealant.

3.15 PROTECTION OF CONCRETE SURFACES

- A. Concrete surfaces shall be protected from traffic or damage until surfaces have hardened sufficiently. If necessary 1/2 inches, thick plywood sheets shall be used to protect the exposed surface.
- B. The Contractor shall provide adequate surveillance for all poured-in-place concrete pavements until concrete has set firmly, to prevent unwarranted markings of the concrete surface. Any unauthorized marking or graffiti in the finished surfaces shall be a cause for rejection by the Landscape Architect and replacement by the Contractor.

3.16 SURFACE SEALANT

- A. After the concrete pavement has cured and reached full strength, remove all dirt, sand, clay, stains, grease, oils and debris from the concrete surface by power sweeping, power washing or other approved method. After cleaning, allow no foot or vehicle traffic on the concrete pavement prior to sealing. Schedule cleaning and sealing to reduce wait times.
- B. If a wet clean method is used to clean concrete pavement surfaces then allow pavement surfaces to dry thoroughly. Allow no dust to collect on concrete surfaces after cleaning. Timing of cleaning and sealing is a critical aspect of this work.
- C. Follow manufacturer's application rates for surface sealant except that application rates shall be increased by 25% to accommodate variable concrete conditions.
- D. Method of application shall be spray application.
- E. Keep sealers in airtight drums. Use sealer product within manufacturer's specified shelf life.

3.16 ACCEPTANCE STANDARDS

- A. The following acceptance standards shall be applied to this Contract. These standards are considered superior to typical industry standards. Any portion of the concrete paving that does not come up to these required acceptance standards shall be removed at the direction of the Landscape Architect. Saw cut pavement at nearest adjacent tooled joint, remove concrete pavement and discard off site in a legal manner and replace with new concrete pavement meeting the requirements of this Section.
 - 1. Pavement surfaces shall be free of all cracking.
 - 2. Pavement surfaces shall not pond water.
 - 3. Pavement surfaces shall be free of visible high and low spots.
 - 4. Steel mesh reinforcing shall not penetrate the surfaces or sides of the concrete slab.

5. Sawn joints and all expansion joints shall be straight, true, uniform in width and free from twists, bends, kinks and misalignments.
6. Saw cut joints shall be free of chips and spauling at joint edges.
7. Tooled edges and the associated edging patterns shall be consistent, true, crisp and complete.
8. Broom finish shall not be too coarse in the opinion of the Landscape Architect.
9. Broom finish shall be constant and complete between joints without bare spots, lifts or disconnections in broom pattern.
10. Pavement shall show no graffiti. Pavement shall show no rubbed surfaces indicative of attempts to erase graffiti.
11. Expansion joints and score joints shall be placed as required by the Contract Documents.
12. Concrete surfaces shall be free of all stains, including those created during the course of the construction by the Contractor, caused by natural events, or caused by vandalism.
13. All tooled joints and expansion joints shall be flush.
14. Stains from construction or from natural causes
15. Pours different in color as determined by the Landscape Architect.
16. Pours without expansion joints cast into them.
17. Pours not conforming to the Contract Documents.
18. All forms shall be removed from the site.

END OF SECTION
32 13 13

SECTION 32 14 00 - UNIT PAVING

PART 1 – GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Precast Concrete Unit Pavers for Pedestrian Paving set on stone setting bed over pervious concrete slab.

1.3 RELATED WORK

- A. Section 31 20 00 – EARTHWORK.
- B. Section 32 12 42 – PERVIOUS CONCRETE.
- C. Section 32 30 00 – SITE IMPROVEMENTS.

1.4 QUALITY ASSURANCE

- A. HANDICAP ACCESSIBILITY: When installed, all paving shall be handicap accessible and will comply with the Civil Rights Restoration Act of 1987 and the Americans with Disabilities Act of 1990, latest version, and the Massachusetts Architectural Access Board (MAAB), Section 521 of the Code of Massachusetts Regulations.

1.5 REFERENCES

- A. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.
- B. Work operations shall meet American National Standards Institute [ANSI] Standard Z-133.1.
- C. The following standards shall apply to the work of this Section.
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - M 43 Standard Size of Coarse Aggregate for Highway Construction
 - M 140 Emulsified Asphalt
 - M 208 Cationic Emulsified Asphalt
 - 2. American Society for Testing and Materials (ASTM):
 - C67 Test Method for max. absorption of 5% or less, Absorption, 24 hr. submersion in cold water, max. saturation coefficient, Initial rate of absorption (suction), Abrasion index, Freeze-thaw and Efflorescence.
 - C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
 - C936-82 Test Method compressive strength of 8000 psi min.
 - D 1557 Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft³ (2,700 kN-m/m³)]

1.6 SUBMITTALS

- A. Samples: Samples shall be submitted for the following items:
 - 1. Furnish not less than three full size individual pavers, size, color thickness and finish required to Landscape Architect for approval. Samples shall exhibit the full color range of pavers to be provided. Final color and finish to be selected by owner.
 - 2. Furnish not less than 5lbs. Bedding Course and Void Filler Aggregate.
- B. Manufacturer's Product Data: Manufacturer's product data shall be submitted for the following items:
 - 1. Permeable concrete rectangular paver consisting of Portland cement, fine and coarse aggregates. High density, hydraulically pressed concrete paving units with 1/16" tolerance.
- C. Test Report:
 - 1. Test report of precast concrete unit paver shall be submitted.
 - 2. Testing shall be done by an independent testing laboratory. Test procedures shall conform to ASTM C 936 methods, where applicable.
 - 3. Test report shall indicate, as a minimum, the following:
 - a. Compressive strength, pounds per square inch.
 - b. Absorption, 5 hr. submersion in cold water.
 - c. Absorption, 24 hr. submersion in cold water.
 - d. Maximum saturation coefficient.
 - e. Initial rate of absorption (suction).
 - f. Abrasion index.
 - g. Freeze-thaw.

1.7 QUALITY ASSURANCE

- A. Installer must review installation procedures of all permeable precast concrete unit paving and sequence of work with General Contractor to ensure proper coordination with other subcontractors and suppliers whose work is affected by the delivery schedule and installation of paving work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Precast concrete paver units shall be packaged by strapping to manufacturer's standard and delivered on pallets. Pavers damaged in any manner will be rejected and shall be replaced with new material at no additional cost to the Owner.
- B. Store all paving units on raised platforms. Storage piles or stacks shall be located to avoid or be protected from heavy or unnecessary traffic. Store paving units on wood skids or pallets. Place and stack skids and units to distribute weight evenly and to prevent breakage or cracking of units. Materials shall be stored under an approved roof or covered with non-staining waterproof tarpaulins, at all times, except when materials are being installed. Protect paving units during storage and construction against moisture, soiling, staining and physical damage.
- C. Handle paving units to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges of units with wood or other rigid materials. Lift with

wide-belt type slings or vacuum lifts wherever possible; do not use wire cable or ropes containing tar or other substances which might cause staining. If required, use wood rollers and provide cushion at end of wood slides. Any paving unit chipped during delivery, storage, or handling will be rejected and replaced by the Contractor at no additional cost to the Owner.

1.9 PROTECTION OF ADJACENT SURFACES

- A. Finished surfaces adjacent to the precast concrete unit paving shall be adequately protected from soiling, staining, and other damage during construction.

PART 2 – PRODUCTS

2.1 BEDDING COURSE AND VOID FILLER AGGREGATE

- A. The bedding course shall be 1/4" open graded stone to the requirements of AASHTO #8.
- B. The course and joint void filler aggregate shall be washed, crusher run, free of organics and soluble salts, or other contaminants likely to cause efflorescence. The grading requirement shall be in compliance with the following gradation chart.

<u>ASTM Sieve Size</u>	<u>Percent Passing (by weight)</u>
1/2 inch	100 - 100
3/8 inch	94 - 100
1/4 inch	39 - 94
No. 4	23 - 39
No. 8	8 - 23
No. 16	0 - 8

2.2 PAVERS

- A. Pavers shall be 4"x8" (actual dimensions 3-7/8" x 7-7/8" x 3/4") permeable unit paver, manufactured by Hanover Architectural Products, Inc., Hanover, PA 17331 or equal
 - 1. Pavers shall be gauged in order to fit the setting bed.
 - 2. Water absorption shall be less than 1 percent.
 - 3. No laminated units will be accepted. Color matrix must be fully integrated throughout the paver units.
 - 4. Pavers shall be provided in standard color as shown below:
 - a. Limestone Gray with Tudor finish.

2.3 WATER

- A. Water shall be potable and shall be free of injurious contaminants.

PART 3- EXECUTION

3.1 ACCEPTABILITY OF CONCRETE BASE

- A. Contractor shall examine the concrete base slab provided, installed and paid for under the work of Section 32 12 42 PERVIOUS CONCRETE of these Specifications to determine its adequacy to receive concrete unit pavers and bituminous setting bed. Concrete shall have fully set prior to the work of installing pavers. Evidence of inadequate base shall be brought to the immediate

attention of the Owner's Representative and shall be corrected by the Contractor as directed by the Owner's Representative at no additional cost to the Owner.

3.2 BEDDING COURSE

- A. Aggregate material for base beneath precast concrete pavers shall be to the depth indicated on the Contract Documents. Base shall be compacted to 95 percent of maximum dry density at optimum moisture content, as determined by ASTM D1557.
- B. Contractor shall examine the concrete base to determine its adequacy to receive granite, pavers, granite bands, and mortar setting bed. Evidence of inadequate base shall be brought to the immediate attention of the Landscape Architect.

3.3 SETTING PERMABLE CONCRETE PAVERS

- A. Do not use unit pavers with chips, cracks, voids, discolorations or other defects which might be visible or cause staining in the finished work. Keep exposed surfaces deleterious substances at all times. No cracked, broken or chipped pavers will be allowed in the finished work.
- B. The pavers shall be installed in approximately the order in which they were manufactured. No cluster shall be installed next to a cluster that was manufactured more than 2,500 cycles before or after.
- C. Lay pavers in the pattern as shown on the Contract Drawings. Lay pavers away from the existing laying face or edge restraint in such a manner as to ensure that the pattern remains square. Chalk lines shall be used upon the bedding course to maintain straight joint lines. Lines and grades shown on the plans shall be established and maintained during the installation of the wearing course. Lay out coursing so that at end conditions no paver will have to be cut to a width of less than 2 inches. Cut as required to provide pattern shown and to fit adjoining work neatly. Place pavers in the pattern indicated on the Drawings and with uniform top surface and alignment. Protect newly laid pavers at all times from damage or stain with clean plywood.
- D. Pavers shall be cut using a high-speed table-mounted masonry saw. Block splitting shall not be permitted. All cut faces shall be vertical. Dry cutting of the pavers shall be performed utilizing a dust collection system. Cut pavers shall be no less than one-third in length of a full-size paver.
- E. Once the pavers have been placed upon the bedding course and all cut pavers have been inserted to provide a full and complete surface, inspect the pavers for damaged units and remove and replace those units. Once all pattern lines have been straightened, the void filler shall then be placed into the paver openings to the top of the chamfer on the pavers and the surface swept broom clean.
- F. The pavement surface shall be compacted to achieve consolidation of the bedding course and paving stones and brought to design levels and profiles by two passes of a suitable plate compactor. Compaction of the pavers shall be accomplished by the use of a vibratory plate compactor with a neoprene pad as to not mar or damage the pavers capable of a minimum of 4,500 pounds of compaction force. After compaction inspect the pavers and remove and replace any damaged units.

- G. On completion of vibration after void filling, the surface tolerances shall be plus or minus $\frac{1}{2}$ " from finish levels. The pavers shall be flush to $\frac{1}{4}$ inch above adjacent paving. Additional void filler material shall be swept in the paver voids, as required, to within $\frac{1}{2}$ inch from the bottom of the chamfer on the paving stones. Upon completion, the wearing course surface shall be swept clean of all excess materials. Remove from the site all surplus materials, equipment and debris resulting from these operations.
 - H. After a sufficient area of pavers has been installed, joints of pavers shall be filled by sweeping $\frac{1}{4}$ " open graded stone, as specified by manufacturer.
 - I. Completed surface shall be compacted by running a medium plate vibrator with a neoprene pad across the top of the pavers. Additional joint filler material shall be swept in the joints during vibration to completely fill joint space.
 - J. Newly laid pavers shall be protected at all times by panels of plywood. These panels may be advanced as work progresses; however, the plywood protection shall be kept in areas which will be subjected to continued movement of materials and equipment. All necessary precautions shall be taken in order to avoid depressions and protect paver alignment.
 - K. Prior to acceptance, the paved area shall be flooded with water to assure that there are no depressions. Pavers with top surfaces greater than $\frac{1}{16}$ inch above or below adjacent pavers shall be removed and reset. Remove and reset pavers as required until surface is true to line and grade.
 - L. Refill $\frac{1}{4}$ " open graded stone joints as necessary until all joints are filled to finish grade.
- 3.4 CLEANING OF PAVER SURFACES
- A. After completion of unit paving, surfaces shall be carefully cleaned, removing all dirt, bitumen, sand and stains using an approved masonry cleaner and soft bristle brush.

END OF SECTION 32 14 00

This Page Intentionally
Not Used

SECTION 32 14 40 – STONE PAVING

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 DESCRIPTION OF WORK:

- A. Work of this Section includes, but is not limited to:
 - 1. Resetting of existing and new stone paving.
 - 2. All other items of stone work shown or reasonably inferred to make the work of this Section complete.

1.3 RELATED WORK

- A. Section 02 41 13 – SITE PREPARATION
- B. Section 03 30 00 – CAST-IN-PLACE CONCRETE
- C. Section 04 01 10 – MASONRY CLEANING
- D. Section 04 01 40 – STONE MASONRY RESTORATION.
- E. Section 04 05 13 – MASONRY POINTING.
- F. Section 31 20 00 – EARTHWORK.
- G. Section 32 13 13 - CONCRETE PAVEMENT.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Provide all labor, materials, equipment, services and transportation required to complete the stone paving as shown on Drawings and specified herein.

1.5 DEFECTIVE MATERIALS

- A. Do not install defective materials. No patching or hiding of defects will be permitted. Refer to Owner's Representative for decision on all materials showing flaws or imperfections upon delivery to the job site. The Owner's Representative's decision as to rejection of materials shall be understood to be final. Remove rejected material from the site and replace with new material at no additional cost to Owner.

1.6 QUALITY ASSURANCE

- A. Construction Tolerances:
 - 1. Variations from plumb: 1/4 inch in 10 feet.
 - 2. Variations from level: 1/4 inch in 20 feet.
 - 3. Variation of linear line: 1/2 inch in 20 feet.
- B. Quality Control
 - 1. All finishes, dimensions and tolerances shall meet both industry standards and those indicated on approved shop drawings and samples.
 - 2. All stone used shall be sound and free from cracks, seams or starts that might impair its structural integrity or function.

3. No patching shall be permitted except with the written approval of the Owner's Representative.

1.7 SUBMITTALS

- A. Submit 3 physical samples each of the following:
 1. Stone Samples as required: 12 inches by 12 inches by 0.5 inches thick tile for each type of granite specified in this Section.
 2. Cobble stone samples: Provide three full size units displaying full range of color and veining with specified finish.
 2. Colored masonry mortar showing full range of colors available.
- B. Submit shop drawings for new stone paving work. Include in the drawings sizes, shapes, finishes and location of all materials, bedding, bonding, anchoring and jointing of all dimension work, relations to adjacent construction, relations to work of other trades, and all other details required for the proper installation of the work with due reference to all related work.

1.8 STORAGE AND HANDLING

- A. Storage of Existing Masonry Materials: Salvaged stone shall be stored on site or off site in a protected location. Stack the stone on timber platforms at least 4" above the ground. Take extreme care to prevent staining during storage. Place polyethylene or other suitable plastic film between any wood and finished surfaces if storage will be for a prolonged period. Use also as an overall protective covering. Plug Lewis holes during freezing weather to prevent the accumulation of water. Do not use salt for the melting of ice formed in Lewis holes or on pieces, or for any purpose involving its contact with the stone.
- B. Store and handle stone units to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.
- C. Protect stone units during storage and construction against moisture, soiling, staining and physical damage.
 1. Handle to prevent chipping, breakage, soiling or other damage. Do not use pinch or wrecking bars without protecting edges with wood or other rigid materials. Lift with wide-belt type slings wherever possible. Do not use wire rope or ropes containing tar or other substances which might cause staining. If required use wood rollers and provide cushion at end of wood slides.
- D. Deliver masonry materials in undamaged condition. Deliver cleaning materials to site in manufacturer's original unopened containers and packaging, bearing labels as to type and names of products and manufacturers.
- E. Store cementitious materials off the ground, under cover and in dry location.
- F. Protect mortar materials and stone accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.9 PROJECT CONDITIONS

- A. Remove all stone determined to be frozen or damaged by freezing conditions.

- C. During cleaning of stone, protect persons, motor vehicles, construction site and surrounding buildings from injury resulting from cleaning work.

1.10 COLD WEATHER PROTECTION

- A. Do not erect or clean any masonry when temperature of surrounding area is below 40 degrees F., or below 45 degrees F. and falling, or forecast by public news media to fall to or below 35 degrees F. within 24 hours without temporary heated enclosures or without heating materials or other precautions necessary to prevent freezing. Minimum temperature within heated enclosure shall be 40 degrees F. Do not use masonry materials which are likely to contain frost. Do not use accelerating ingredients with any mortar. Do not use anti-freeze compounds to lower the freezing point of mortar. Mortar shall harden without freezing and with no damage from frost. Protect all masonry against freezing for not less than 48 hours after installation.
- B. Do not lay stone units which are wet or frozen. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen setting beds. Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch. Remove and replace masonry work damaged by frost or freezing.
- C. Comply with requirements of International Masonry All-Weather Council's "Guide Specification for Cold-Weather Masonry Construction". Heat materials and provide temporary protection of completed portions of masonry work.

1.11 HOT WEATHER PROTECTION

- A. Protect masonry work in hot weather to prevent excessive evaporation of mortar setting beds. Provide artificial shade, wind breaks and use cooled materials as required. Use fresh mortar. Discard mortar which has stiffened due to hydration.

PART 2 – MATERIALS

2.1 GRANITE MATERIALS

- A. GRANITE FOR NEW PAVING: shall be new granite, color to match existing granite treads and wall caps reset at paving.
 - 1. GRANITE PAVERS shall be new granite units as required conforming to the physical requirements and properties of ASTM C615 and with "Specifications for Building Granite" National Building Quarries Association, Inc. All stone shall be of structural granite, hard and durable, and the color as approved. Granite shall be sound, durable stone, free from imperfections such as knot formations, starts, cracks or seams which may impair its structural integrity. Granite shall be free of minerals that may cause objectionable staining under normal environments of use.
 - a. Granite Cobble Stones shall be 4" x 8" x 6" in size.
 - b. Edges shall be Tumbled.
 - 2. GRANITE FINISHES [as defined by the National Building Quarries Association, Inc.]:
 - a. All beds, joints and other concealed surfaces shall be sawn.
 - b. Top face of pavers shall be thermal finished and/or match existing reset granite paving.
 - 3. Granite Fabrication Requirements

- a. Fabricate granite in accordance with the tolerances specified in NBGQA Specifications and as indicated.
- b. All faces shall be at right angles unless otherwise noted on the plans and detailed drawings.
- c. Granite shall be cut accurately to required shapes and dimensions.
- d. Flatness Tolerance: Variation from true plane, or flat surfaces, shall be determined by use of a 4-foot long straightedge, applied in any direction on the surface. Such variation on surfaces at the bed and joint arris lines shall not exceed 1/4" of the specified joint width.
- e. Thermal finish shall not exceed 3/16-inch variations from true plane to other parts of the face surfaces.

B. Dimensional Tolerance:

1. Face Dimensions: Maximum variation in the dimension of any piece shall be 1/4 of the specified bed joint width, however, in any case not less than +/- 1/16".

C. Flatness Tolerances: Variation from true plane, or flat surfaces shall be determined by a 4 foot dimension in any direction on the surface. The maximum variation from true plane shall not exceed the tolerance listed below or 1/2 of the specified joint width whichever is greater.

D. Beds and Joints: Pieces shall be bedded and jointed with bed and joint surfaces cut as follows:

1. 3/16" minimum joints.
2. Beds and joints shall be cut or sawn full square for the specified minimum thickness of the piece. If the thickness is greater, the remainder shall fall under square not more than 3" in 12".

2.2 SALVAGED GRANITE TREADS FOR USE AS PAVING

- A. Existing granite treads and retaining wall caps from the site as noted in Section 02 41 13, shall be reset as described in this Section.
- B. Where salvaged granite treads abut other granite treads, edges shall not be rough, contain divets, or be uneven. Edges shall be square. Saw-cut existing granite treads where necessary to achieve desired installation.
- C. Salvaged materials shall be cleaned of all dirt and old mortar prior to resetting.
- D. Owner's representative shall have sole responsibility to determine whether salvaged granite treads are acceptable for use as paving. Contractor shall provide concrete pavement in lieu of any salvaged granite treads deemed unacceptable for reuse as determined by the Owner's Representative. Any salvaged stone not determined acceptable shall be set aside for Owner's use.

2.2 SALVAGED GRANITE PAVING AT BASE OF FLAGPOLE

- A. Stone paving at the base of the flagpole shall be salvaged and restored in accordance with Section 02 42 91, REMOVAL AND SALVAGE OF HISTORIC MATERIALS.

2.3 MORTAR MATERIALS

- A. MATERIALS

1. Portland cement shall conform to ASTM C150, Type II for use with fieldstone. Provide natural color or white cement as required to produce mortar color to match existing work in one or more areas.
2. Lime: ASTM C207 type S, special finishing hydrated lime.
3. Aggregate for Mortar: Non-staining sand, ASTM C144, or ASTM C404, Size No. 2 except for joints 1/4 inch and less (if any) use aggregate graded with 100 percent passing No. 16 sieve. Provide well-graded bagged mason's mortar sand or other clean washed sand or crushed stone of size and color to match or blend visually with existing historic work as required.
4. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for used in mortar mixes. Use only sunfast, limeproof pigments with record of satisfactory performance in masonry mortars. Owner's Representative will not be limited to "standard" colors. Provide custom colors when color selected is not available as one of the following products:
 - a. "Spectrum Custom Colors": S.B. Green & Co., Inc., Watertown, MA.
 - b. "SGS Mortar Colors": Solomon Grind-Chem Services, Inc.
 - c. Iron oxide pigments: Lander-Segal.
5. Calcium chloride and accelerators: NOT PERMITTED.
6. Water: Clean, potable, non-alkaline and free of deleterious materials which would impair strength or bond.

2.4 STONE ACCESSORIES

- A. Anchors, dowels and other accessories shall be stainless steel, type 302/304 of the sizes and shapes indicated on the Drawings and as specified herein, or if not indicated, as required to securely anchor and fasten stonework in place.
- B. EPOXY GROUT: Equal to Sikadur 35, Hi-Mod LV as manufactured by Sika Corporation, Lyndhurst NJ, or approved equal.
- C. METAL EDGING: StructurEdge Aluminum Restraint in 8'-0" sections as manufactured by Permaloc Corporation, Holland, MI or approved equal. Anchor using 10" x 3/8" spiral steel spikes, 12" on center.

2.5 WATER

- A. Water shall be potable and shall be free of injurious contaminants.

2.6 CONCRETE FOR COBBLE STONES.

- A. Concrete for concrete cradles for Cobble Stones shall be in accordance with Section 32 13 13, CONCRETE PAVEMENT.

2.7 CONCRETE FOR SALVAGED GRANITE PAVING.

- A. Concrete for concrete cradles for salvaged granite paving shall be in accordance with Section 32 13 13, CONCRETE PAVEMENT.

2.8 CONCRETE PAVING IN LIEU OF UNACCEPTABLE SALVAGED GRANITE PAVING

- A. Concrete pavement to be provided in lieu of unacceptable granite paving shall be in accordance with Section 32 13 13, CONCRETE PAVEMENT.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Execute stone work by skilled and competent stone setters in accordance with the approved shop drawings. Do necessary field cutting as stone is set. Cut stone as required with high speed masonry saw to provide clean, sharp edges and as required to fit neatly around all projections.
- B. Clean stone before setting by thoroughly scrubbing with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh fillers or abrasives.

3.2 INSTALLATION OF GRANITE TREADS AND GRANITE PAVING

- A. Spread a layer of mortar setting bed as shown in Drawings. Continually check the surface for line and grade with a straight edge and correct any deficiencies.
- B. Salvaged granite paving and treads for use as pavers shall be carefully placed in positions as shown on the Drawings with hand tight joints and uniform top surface. Good alignment shall be kept, and the pattern shall be that as shown on the plans. The Owner's Representative will approve the start of paving layouts.
 - 1. Joints for existing treads shall be a maximum of 3/16 inch.
 - 2. Joints for salvaged granite paving at the flagpole shall be per existing conditions.
- C. There shall be no deviation from a true grade greater than one-quarter inch (1/4") in ten feet (10').
- D. Newly laid granite pavers and treads shall be protected at all times by panels of plywood. These panels may be advanced as work progresses; however, the plywood protection shall be kept in areas which will be subjected to continued movement of materials and equipment. All necessary precautions shall be taken in order to avoid depressions and protect paver alignment.
- E. After setting all pavers, use a low amplitude, high frequency plate vibrator capable of 3,000 to 5,000 pounds centrifugal compaction force to vibrate the pavers into the setting bed
- F. Prior to acceptance, the granite paved areas shall be flooded with water to assure there are no depressions. Remove and reset pavers as required until surface is true to line and grade.

3.3 INSTALLATION OF NEW GRANITE COBBLE STONE EDGING

- A. Set all cobblestones accurately in strict accordance with the Drawings.
- B. New cobblestones shall be set in accordance with MassDOT Specifications Sections 500 and 501, except as indicated below.

1. Following placement and compaction of gravel subbase provide zero slump concrete foundation, to depths indicated on the Contract Documents, completely supporting cobblestones throughout their entire length.
 2. Vertical, exposed faces of cobblestone shall be plumb, with edging top parallel to adjacent surface.
 3. Cobblestone Edge shall be set accurately to line and grade. Edge alignment shall be uniform, with smooth and continuous arris lines. Cobblestones shall be fitted together as closely as possible.
 4. After proper alignment of edging and concrete foundation have been established, place additional concrete surround, of wetter consistency, to extend concrete up each face of curbing as detailed on the Contract Documents.
 5. Joints between stone units shall be carefully filled with a cement mortar, and neatly pointed on the top and front exposed portions. After pointing, excess mortar shall be cleaned from curb surface.
 6. Backfill material on each side of cobblestone edging shall be as specified for adjacent surface and shall be thoroughly compacted by means of power tampers. Extreme care shall be taken not to destroy curb alignment. Cobblestone edging disturbed during backfilling or otherwise shall be reset to line and grade, and properly backfilled.
- C. Remove and replace cobblestone units that have been broken, chipped, stained, or otherwise damaged. Remove and replace units which are misaligned or not to grade or do not match adjoining granite work. Provide new matching cobblestone units, install as specified and fill joints to eliminate evidence of replacement.
- D. After completion of cobblestone edging installation, stone surfaces shall be carefully cleaned, removing all dirt, excess mortar, filler, and stains using the approved masonry cleaner. Follow the manufacturer's directions for use. Apply masonry cleaner within the time frame noted in the manufacturer's literature.
- 3.4 CLEANING AND PROTECTION
- A. After installation is completed, carefully clean all work, removing all dirt, excess mortar, stains and/or other site incidental defacements. Clean soiled masonry surfaces using a nonacidic solution which will not harm masonry or adjacent materials. Consult masonry manufacturer for acceptable cleaners. Do not use wire brushes, acid or other solutions which may cause discoloration. Use nonmetallic tools in cleaning operation. Apply in accordance with cleaner manufacturer recommendations.
- B. Protect work in progress and after completion. Keep the premises neat and clean at all times.

END OF SECTION
32 14 00

This Page Intentionally
Not Used

SECTION 321613
CURBS AND GUTTERS

PART 1-GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Furnishing and installing granite curb, granite edging, curb inlets, and curb corners, precast concrete curb and cast-in-place concrete curb.
 - 2. All associated items and operations required to complete the installations, including surface preparation, concrete support, jointing and finishing.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 033000 – CAST-IN-PLACE CONCRETE for general construction applications of concrete.
 - 2. Section 312000 – EARTHWORK for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 3. Section 321313 – PORTLAND CEMENT CONCRTE for installation of cement concrete paving for, walkways, and sidewalks.
 - 4. Section 321216 – ASPHALT PAVING for hot-mix asphalt pavement for roadways, parking lots, walkways, berms, and curbs.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract.
 - 1. Submit Shop Drawings and Manufacturer's literature for granite and precast curb, edging, corners and inlets, indicating size, shape and dimensions, finish and setting method.
 - 2. Copies of tests on representative samples of the concrete used in the manufacture of precast units showing a compressive strength of 5,000 psi.

1.4 REFERENCE STANDARDS

- A. The following standards are applicable to the work of this Section to the extent referenced herein:
 - 1. Commonwealth of Massachusetts, Massachusetts Department of Transportation (MassDOT), Highway Division, Standard Specifications for Highways and Bridges, latest English Edition with amendments. All references to method of measurement, basis of payment and payment items in the Standard Specifications are hereby deleted.

References made to particular sections or paragraphs in the Standard Specifications shall include all related articles mentioned herein.

2. ANSI: American National Standards Institute
 3. ASTM: American Society for Testing and Materials
 4. AASHTO: American Association of State Highway and Transportation Officials
 5. References herein are made in accordance with the following abbreviations and, all work under this Section shall conform to the latest editions as applicable.
 - a. ACI 304-Recommended Practice for measuring, mixing, transporting and placing concrete.
 - b. ANSI/ASTM D1751-Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types).
 - c. ANSI/ASTM D1752-Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- B. Curbing within public rights-of-way: The construction of all curbing within public rights-of-way shall be in accordance with the rules, regulations and requirements of the public agency having control and ownership of such rights-of-way.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Granite and precast curb units shall be adequately protected from damage during transit to the site.
- B. Curbing shall be protected against staining, chipping, and other damage. Cracked, badly chipped, or stained units will be rejected and shall not be employed in the work.

1.6 SAMPLES

- A. The Contractor shall supply to the site three samples of all curb types for approval prior to ordering materials. Approved sample material may be used in the work.

1.7 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Construction Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

PART 2-PRODUCTS

2.1 GRANITE CURB

- A. Replace granite curb damaged during construction operations as directed by the Owner.
- B. Granite curb shall conform to MassDOT Standard Specification Section M9.04.0: Curb and Edging.
- C. Granite curb shall be basically light gray in color, free from seams and other structural imperfections or flaws which would impair its structural integrity, and of a smooth splitting

appearance. Natural color variation characteristic of the deposit from which the curb is obtained will be permitted.

- D. Whenever curbing is sawed, all surfaces that are to be exposed shall be thoroughly cleaned and any iron rust or iron particles removed by sand blasting or other methods satisfactory to the Owner's Representative and/or Designer and any saw mark in excess of 1/8 inch shall be removed.
- E. Granite Curb. The stones for the granite curb shall be cut to the dimensions and curvature hereinafter stated:

Type	Minimum Length	Width at Top	Depth	Minimum Width at Bottom
VA4	6 ft	6 in.	17 in. to 19 in.	4 in. (for 2/3 length)

- 1. Stones used in making closures may be as much as one-third shorter than specified.
- 2. On curves with radii greater than 100 ft but less than 500 ft, VA stone may be 4 ft to not more than 6 ft in length.
- 3. Type VA stones to be set on a radius of 100 ft or less shall be cut to the required curvature unless otherwise directed and except for making closures shall be of minimum lengths as follows:

Radius	Minimum Length
50 ft to 100 ft	6 ft
25 ft to less than 50 ft	4.5 ft
Less than 25 ft	3 ft

- 4. The ends of all curved stones shall be cut on radial lines.

F. Finish

- 1. Granite curb shall have a top surface free from wind, shall be peen hammered or sawed to an approximately true plane, and shall have no projections or depressions greater than 1/8 inch. The front and back arris lines shall be pitched straight and true and there shall be no projection on the back surface for 3 inches down from the top which would exceed a batter of 4 inches to 1 foot.
- 2. The front face shall be at right angles to the planes of the top and ends and shall be smooth quarry split, free from drill holes and with no projection of more than 1 inch and no depression of more than 1/2 inch measured from the vertical plane of the face through the arris or pitch line for a distance down from the top of 8 inches. For the remaining distance, there shall be no projection or depression greater than 1 inch measured in the same manner.
- 3. The ends of all stones shall be square with the planes of the top and face so that when the stones are placed end to end as closely as possible, no space shall show in the joint at the top and face of more than 1/2 inch for the full width of the top and for 8 inches down on the face, after which the end may break back not over 8 inches from the plane of the joint. The arris formed by the intersection of the plane of the joint with the planes of the top and exposed faces shall have no variation from the plane of the top and exposed faces greater than 1/8 inch.

4. The ends of all transition curb shall be cut with a power-driven saw to provide a flush vertical joint with adjacent curbing.

2.2 CEMENT MORTAR

- A. Cement mortar shall be composed of one (1) part Portland Cement and two (2) parts sand by volume with sufficient water to form a workable mix. Cement shall be Portland Cement Type II.

PART 3-EXECUTION

3.1 GENERAL

- A. Curb, edging, curb inlet and curb corner units delivered to the site shall be inspected for damage, unloaded and placed along the prepared curb trench, or other designated location, with the minimum amount of handling.
 1. Materials shall be handled in a manner that prevents damage to the units.
 2. All individual pieces of curved curbing shall be marked to correspond to the radius and location where curbing is to be set.
- B. Trenching, excavation, backfilling, and compaction shall be completed in accordance with Section 312000, EARTHWORK.

3.2 CURB INSTALLATION

- A. Excavating Trench.
 1. The trench for curb shall be excavated to a width of 18 inches.
 2. The subgrade of the trench shall be a depth below the proposed finished grade of the curb equal to 6 inches plus the depth of the curb unit.
 3. Existing pavements shall be sawcut in
- B. Preparing Foundation.
 1. The foundation for the curb shall consist of gravel spread upon the subgrade and after being thoroughly compacted by tamping shall be 6 inches in depth.
 2. The gravel foundation for edging shall be as shown on the plans and shall be thoroughly rammed or tamped until firm and unyielding.
 3. The foundation for curb inlets shall consist of a full bed of Portland cement mortar on the supporting back wall of the catch basin or gutter inlet and sufficient gravel on each side to support the overhang. The trench for the gravel foundation shall be at least 6 inches in depth and 18 inches in width. This trench shall be filled with gravel thoroughly tamped to the required grade.
 4. The trench for curb corners shall be excavated so that there shall be constructed a foundation of gravel which when thoroughly compacted will be 6 inches in depth and extending 6 inches beyond the front and back of curb corner to the full depths of foundation. Other acceptable material may be used for backing.
- C. Setting Curb
 1. Curbing shall be set on additional gravel spread upon the foundation.
 2. All spaces under the curb, curb corners or edging shall be filled with gravel thoroughly compacted so that the curb, curb corners or edging will be completely supported throughout their length. The curb shall be set at the line and grade required as shown on the plans unless otherwise directed by the Owner's Representative and/or the Designer.

3. The curbing shall be set on edge and settled into place with a heavy wooden hand-rammer, to the line and grade required, straight and true for the full depth.
4. Curb, curb corners or edging shall be fitted together as closely as possible.
5. If granite curb, curb corners, curb inlets or edging of different quarries is used on the same project, curbing of each particular quarry shall be segregated and set to give uniform appearance.
6. The ends of the granite curb at driveways and intersections shall be cut at a bevel or rounded, as indicated on the Contract Drawings.
7. Pedestrian ramps and flush curb sections shall be constructed with transition sections, as indicated on the Contract Drawings.
8. Precast concrete curb units shall be doweled together continuously to the line and grade indicated on the Contract Drawings.

D. Filling About Trench.

1. After the curb, curb corners, curb inlets, and edging is set, the space between it and the wall of the trench shall be filled with cement concrete as indicated on the Contract Drawings. Care shall be taken in placing the concrete to avoid disturbing the line or grade of the curb.
2. After the concrete has sufficiently cured, the space between the back of curb and the wall of the trench shall be filled with gravel borrow compacted to the depth indicated on Contract Drawings.

E. Pointing

1. The joints between curbstones (both front and back) or edging shall be carefully filled with cement mortar and neatly pointed on the top and front exposed portions. After pointing, the curbstones and edging shall be satisfactorily cleaned of all excess mortar.

3.3 REMOVAL AND RESETTING OF CURB

- A. Procedures for removal and resetting of existing granite curb, and new granite curb, in existing pavements shall include the following:
1. Prior to excavation for existing granite curb removal, the pavement surface shall be cut a minimum of one foot from the face of curb with appropriate pavement cutting equipment.
 2. Existing curb shall be carefully excavated and removed in a manner that protects the curb and existing pavement to remain from damage.
 3. Existing granite curb shall be cleaned by sandblasting as required to remove of bituminous material, paint and concrete from exposed surfaces prior to resetting in the proposed work.
 4. New granite curb shall be set to match the top of existing granite curb remaining in place at abutting sections and, if required, transitioned to the typical section shown on the Contract Drawings within the first section of curb.

3.4 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from the Project site, and legally dispose of them in an EPA-approved landfill.

End of Section

31 23 00

SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Furnishing and placing of the pavement markings as indicated on the Contract Drawings and as herein specified.
 - 2. All associated items and operations required to complete the installations, including layout of work, surface preparation, application of markings, protection of markings, and accommodations for traffic.
- B. Alternates: Not Applicable.
- C. Items To Be Installed Only: Not Applicable.
- D. Items To Be Furnished Only: Not Applicable.
- E. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 321313 – CONCRETE PAVING for installation of cement concrete paving for driveways, walkways, and sidewalks.
 - 2. Section 321216 – ASPHALT PAVING for hot-mix asphalt pavement for roadways and parking lots.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product Data: For each type of traffic and zone marking paint product. Include technical data and tested physical and performance properties.
 - 2. Shop Drawings: Indicate pavement markings, lane separation, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.

1.4 REFERENCE STANDARDS

- A. The following standards are applicable to the work of this Section to the extent referenced herein:
 - 1. Commonwealth of Massachusetts, Massachusetts Department of Transportation (MassDOT), Highway Division, Standard Specifications for Highways and Bridges, latest English Edition with amendments. All references to method of measurement, basis of payment and payment items in the Standard Specifications are hereby deleted.

References made to particular sections or paragraphs in the Standard Specifications shall include all related articles mentioned herein.

2. MUTCD: Manual on Uniform Traffic Control Devices.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.6 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Construction Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified pavement marking installer whose work has resulted in successful establishment pavement markings.
 - 1. Installer's Field Supervisions: Require Installer to maintain an experienced full-time supervisor on Project Site when work is in progress.
- B. Pavement markings shall be in accordance with the MUTCD.

1.8 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Weather Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 – PRODUCTS

2.1 FAST DRYING WATER-BORNE TRAFFIC PAINT

- A. Fast Drying White Water-borne Traffic Paint and Fast Drying Yellow Water-borne Traffic Paint as specified in the MassDOT Standard Specification Sections M7.01.23 and M7.01.24, respectively. Traffic paint shall be lead free, VOC compliant, fast drying, 100% acrylic waterborne traffic paint. Traffic paint shall conform to the performance specifications referenced in Federal Specification TT-P-1952E Type I & II, Federal Specification TT-P-195F Type I & II.

- B. Pavement markings shall be “white” or “yellow” in color, unless otherwise noted on Contract Drawings.
- C. General pavement marking delineation for parking stalls shall measure 4 inches in width. All other pavement-marking widths are shown in detail on the Contract Drawings.

PART 3 – EXECUTION

3.1 GENERAL

- A. Pavement markings shall be applied in accordance with MassDOT Standard Specification Section 860 and in accordance with the manufacturer’s specifications and requirements.
- B. Do not apply pavement-parking paint until layout, colors, and placement have been verified with the Owner’s Representative and/or the Designer.

3.2 SURFACE CONDITION AND PREPARATION

- A. Asphalt and concrete surfaces shall be cured, clean, dry, and sound. The surface shall be free of sand, grease, oil or other foreign substances.
- B. Prior to application of traffic paint the Contractor shall:
 - 1. Sweep and clean pavement surface to eliminate loose material and dust.
 - 2. Remove loose and lifting paint.
 - 3. Remove by etching or abrasive blasting concrete pavement with sealers containing silicone, having a smooth finish, efflorescence or other conditions that may interfere with adhesion.
- C. Allow new asphalt surfaces to cure for one (1) to two (2) weeks before application of traffic paint.

3.3 APPLICATION

- A. Pavement markings shall be applied only in seasonable weather and in accordance with good painting practices. Apply when air and surface temperatures are above 50°F and relative humidity is below 85%. If work has started and air temperatures fall below 50°F and continuous cooling is forecasted, work shall be stopped. Starting work at air temperatures lower than 50°F shall not be allowed.
- B. Contractor shall apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer’s recommended rates to provide a minimum wet film thickness of 15 mils. When the paint must be applied on new asphalt, apply two thin coats 7-8 mils each, allowing 24 hours between coats.
- C. No thinners shall be used for pavement marking applications.
- D. To improve spraying, Contractor may heat paint to the optimum temperature specified by the manufacturer. No paint material shall be heated above the temperature specified by the manufacturer.
- E. If for any reason material is spilled or tracked on the pavement, or any markings applied by the Contractor fail to conform to the Contract Documents because of a deviation from the required pattern, the Contractor shall remove such material by a method that is not injurious

to the roadway surface and is acceptable to the Owner's Representative and/or the Designer, clean the pavement surface and prepare the surface for a reapplication of markings and reapply the markings as indicated on the Contract Documents without additional compensation for any of the foregoing corrective operations.

- F. Contractor shall protect pavement markings until sufficiently dry to bear traffic.

3.4 INSPECTION

- A. All materials and each part or detail of the work shall be subject to observation by the Owner's Representative and/or the Designer. The Owner's Representative and/or the Designer shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection, (such assistance may include furnishing labor, tools, and equipment, at no expense to the Owner).
- B. Any work done or materials used without authorization by the Owner's Representative and/or the Designer may be ordered removed and replaced at the Contractor's expense. The Contractor shall furnish written information to the Owner's Representative and/or the Designer stating the original sources of supply of the materials manufactured away from the actual site of the work. In order to ensure a proper time sequence for required inspection and approval this information shall be furnished at least two weeks (or as otherwise directed by the Owner's Representative and/or the Designer) in advance of the incorporation in the work of any such materials.
- C. For the purpose of observing work that affects their respective properties, inspectors for the municipalities, public agencies and the utility companies shall be permitted access to the work, but all official orders and directives to the Contractor will be issued by the Owner's Representative and/or the Designer.
- D. The observation of the work shall not relieve the Contractor of any of his obligations to fulfill the terms of the Contract as herein prescribed by the Contract Documents.
- E. Failure to reject any defective work or materials shall not in any way prevent later rejection when such defect is discovered or obligate the Owner's Representative and/or the Designer to make final acceptance.

End of Section

SECTION 32 30 00 - SITE IMPROVEMENTS

PART 1 - GENERAL

1.1 REFERENCE

- A. Attention is directed to the printed form of the Contract, General Conditions, Supplementary General Conditions and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

- A. Furnish and install the following site improvements:
 - 1. Interpretive Sign Panel and Metal Base
 - 2. Trash Receptacle
 - 3. Bench
 - 4. Flagpole Restoration + Reinstallation
- B. Furnish and install all accessory items including hardware, connecting angles, clip angles, bolts, bracing members, etc. necessary for a complete installation.

1.3 RELATED WORK

- A. Section 03 30 00 – CAST-IN-PLACE CONCRETE.
- B. Section 05 01 70 – CONSERVATION AND MAINTENANCE OF DECORATIVE METALS.
- C. Section 05 50 01 – METAL FABRICATIONS.
- D. Section 09 91 13 – EXTERIOR PAINTING.
- E. Section 26 00 00 – ELECTRICAL.
- F. Section 31 20 00 – EARTHWORK.
- G. Section 32 13 13 – CONCRETE PAVEMENT.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect and handle materials, during loading, shipping, unloading at the site, storage and erection as required to prevent damage to finish surfaces, section contours, squareness, straightness and flatness of fabricated members

1.5 DEFECTIVE MATERIALS

- A. Do not install defective materials. No patching or hiding of defects will be permitted. Refer to Owner's Representative for decision on all materials showing flaws or imperfections upon delivery to the job site. The Owner's Representative's decision as to rejection of materials shall be understood to be final. Remove rejected material from the site and replace with new material.

1.6 REFERENCES

- A. ADA: Americans with Disability Act.
- B. Massachusetts Architectural Access Board (MAAB), Section 521 of the Code of Massachusetts Regulations, Latest Edition.
- C. Standard Specification: MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, Commonwealth of Massachusetts, latest edition.

- D. The National Association of Architectural Metal Manufacturers (NAAMM): Manual Metal Flagpole Manual
- E. National Fire Protection Association (NFPA): 70 - National Electrical Code and 78 - Lightning Protection Code

1.7 SUBMITTALS

- A. Manufacturer's catalog data and specification sheets for each type of manufactured product, including certification that each product complies with specified requirements. Include instructions for handling, storage, installation and protection.
- B. Shop Drawings for all signs shall be submitted for approval prior to start of fabrication.
 - 1. Manufacturer's technical data and installation instructions for each type of sign required.
 - 2. Shop drawing for signs enumerating the various dimensions of all sign sections to be constructed as well as letter font and letter heights, and typical post, hardware and footing details.
 - 3. Samples for signage material:
 - a. All materials to be used, approximately 6 inches square, showing finish.
 - 4. Full size positive of artwork for a camera-ready graphic including sign layout with typography.
- C. Flagpole Shop Drawings:
 - A. Showing the method of attachment of the salvaged eagle to the top of the post showing method of attachment, flanges, brackets, or the like.
 - B. Showing the repair or replacement of the internal halyard system and door closure to ensure operation equals a new installation.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Handle and ship all items to prevent damage in transit. Use only material that is not subject to staining or discoloration for blocking and packing. Deliver materials to site in manufacturer's original containers with labels intact and seals unbroken.
- B. Unload and handle all items carefully so as to prevent chipping and breakage. Protect all items during handling, storage and construction against moisture, soiling, staining and physical damage. Store on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack to distribute weight evenly and to prevent breakage or cracking. Protect stored materials from weather with waterproof, non-staining covers or enclosures, but allow air to circulate around materials. Replace materials damaged in any manner.

PART 2 - MATERIALS

2.1 INTERPRETIVE SIGN PANEL

- A. SIGN shall be a custom high pressure laminate (CHPL) graphic panel that is graffiti proof and guaranteed for 10 years against fading and weather deterioration. The CHPL sign material is composed of layers of FSC Certified phenolic resin impregnated brown or black kraft filler paper to produce specified thicknesses, surfaced by a layer of melamine overlay, graphics imaged on saturation grade paper with UV resistant pigment based process color inks, and with an optically clear UV overlay that will resist no less than 99% of all sunlight and UV rays, as well as provides a graffiti resistant surface that allows for removal with standard cleaners.
1. CHPL thickness shall be a minimum 1/2" thick.
 2. Sign shall have threaded holes for mounting positioned on the back side of the board.
 3. Sign shall have the standard Matte finish.
 4. Sign shall be 24" x 36".
 5. Sign mounted shall come with a 5 year warranty.
- B. Sign shall be composed of layers of material which are assembled and heat / pressure consolidated at approximately 1,200 PSI at temperatures exceeding 275° Fahrenheit at manufacturer's prescribed time frames. All manufacturing processes of printing, pressing, machining, finishing and crating to be accomplished within a single standalone manufacturing facility to ensure consistent quality control and providing standard product delivery times of three weeks.
- C. The graphic material and images for the sign are to be supplied by the Owner's Representative and shall be produced under the supervision of the sign manufacturer. CHPL manufacturer must supply project specific electronic PDF proofs for content approval and minimum 8" x 10" x .060" actual material lab samples for color and finish approval from production ready digital art work and specifications as provided by Owner's Representative.
- D. Sign Board shall be manufactured by one of the following:
1. iZone Imaging, 2526 Charter Oak Dr., Temple, TX 76503; tel: 888.464.9663; email: info@izoneimaging.com.
 2. Folia Signs by SH Immersive Environments, 110 Wellington Street, Huntingdon, Quebec Canada, J0S 1H0, tel: 800-363-5304; e-mail: info@theshgroup.
 3. Fossil Signs by Fossil Industries, 44 Jeffryn Blvd., Deer Park, NY 11729; tel: 631-254-9200; email: Info@FossilGraphics.com.

2.2 METAL SIGN BASE

- A. METAL SIGN BASE shall be equal to # NPSC3624IN as manufactured by iZone Imaging, PO Box 368, Temple, TX or approved equal.
1. Frame shall be the 'Cantilever' with two post base supports, as shown on Drawings.
 2. Aluminum frame and exhibit base will be finished in powdercoat.
 3. Exhibit base supports shall be surface mounted onto pavement.
 4. Color of powdercoat finish shall be selected by the Owner's Representative.

2.3 MISCELLANEOUS MATERIALS

- A. FASTENERS: Provide all nuts, bolts, fasteners and fittings of AISI Type 304 stainless steel with vandal resistant design as required for a complete and secure installation of sign elements.
- B. EPOXY GROUT shall conform to ASTM C-881 and equal to "Sikadur 32, Hi-Mod" high strength adhesive as manufactured by Sika Corporation, Lyndhurst NJ.

2.4 NEW SITE FURNISHINGS

- A. New site furnishings shall be provided by Dumor, Inc., Mifflintown, PA, or approved equal.
 - 1. TRASH RECEPTACLE shall be Model # 157-32 with 14 gauge spun cover # CVB-30-BT. The unit is a 32 gallon receptacle fabricated with epoxy coated steel slats which are powdercoated. Receptacle comes with anchor bolts for surface mounting and a 32 gallon plastic liner.
 - 2. BENCH shall be Model # 117-60 with center armrest, 72" length x 28" depth. Anchor bolts are provided by manufacturer.
 - 3. Steel members of all site furnishings shall be factory coated with zinc rich epoxy coating and finished with powdercoating. Finish colors shall be selected by Owner's Representative.

2.4 SALVAGED FLAGPOLE

- A. Restoration
 - 1. Provide and install all necessary elements, materials, and components to rehabilitate the internal halyard, enclosure, and other operational workings of the existing steel flagpole such that it is in new-condition. Acceptable halyard system shall meet the following requirements:
 - a. Revolving, non-fouling, internal halyard truck.
 - b. Stainless steel aircraft cable.
 - c. Connection points for two flags.
 - d. Neoprene coated steel counterweight
 - e. Nylon beaded retainer ring.
 - f. Neoprene covers for carabiners or rubber-coated carabiners.
 - g. Gearless, self-locating direct drive winch with six-tumbler cylinder lock.
 - 2. Paint existing flagpole in accordance with Section 09 00 00 – EXTERIOR PAINTING.
- B. Reinstallation
 - 1. See Section 03 30 00 – CAST-IN-PLACE CONCRETE and Contract Drawings for footing information.
- C. Provide necessary flanges, brackets, and/or hardware for attachment of salvaged eagle to the top of the flagpole. All metal components shall be galvanized metal and appropriate for attachment to the materials of the flagpole and eagle.

PART 3 - EXECUTION

3.1 INSTALLATION OF SITE IMPROVEMENTS – GENERAL

- A. Assemble and install site improvements in accordance with the Drawings and manufacturer's written instructions as required.
- B. Fasten items securely together by anchoring and fastening as shown and as required by recognized standards. Make tight connections between members. Discard units of material

with defects which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.

- C. Repair damaged surfaces and finishes after completion of installation, or replace damaged members as directed where damage is beyond satisfactory repair.
- D. Perform all work by workmen skilled and experienced in the trade in a neat and clean fashion. Install all work in accordance with the Drawings in straight and true lines, plumb and true to line and grade. Fasten items securely together.

3.2 INSTALLATION OF INTERPRETIVE SIGN

- A. Posts of new sign base shall be surface mounted with new tamper-proof anchor bolts drilled and epoxy grouted into new concrete pavement. Sign base shall be vertical when viewed from all directions. New sign panel shall be positioned and fastened within aluminum frame according to manufacturer's instructions.
- B. Repair damaged surfaces and finishes after completion of installation, or replace damaged members as directed where damage is beyond satisfactory repair.

3.3 INSTALLATION OF SITE FURNISHINGS

- A. Assemble and install site furnishings in accordance with the Drawings and manufacturer's recommendations in a neat and clean fashion. Install benches in straight and true lines. Secure in place. Install furnishings with the top of benches horizontal and square to paving unless otherwise shown on the Drawings.
- B. Benches and trash receptacles shall be surface-mounted firmly to new concrete walk paving with tamper proof stainless steel fasteners. Neatly drill or core into pavement and set anchor in epoxy grout. Affix anchors to each bench leg with vandal resistant fasteners.
 - 1. Install epoxy and sealants in strict accordance with manufacturer's written instructions.
- C. Repair damaged surfaces and finishes after completion of installation, or replace damaged members as directed where damage is beyond satisfactory repair.

3.4 INSTALLATION OF FLAGPOLE

- A. See Section 03 30 00, CAST-IN-PLACE CONCRETE for concrete flagpole footing.
- B. Secure the salvaged eagle to the top of the flagpole per approved shop drawings.

3.5 CLEANING AND PROTECTION

- A. Protect work in progress and after completion. Keep the premises neat and clean at all times.

End of Section
32 30 00

This Page Intentionally
Not Used

SECTION 32 31 19 – ORNAMENTAL METAL FENCE

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Perform all work required to complete the work of the Section, as indicated. Such work includes, but is not limited to, the following:
 - 1. Decorative metal picket fence.

1.3 RELATED WORK

- A. Section 03 30 00 – CAST-IN-PLACE CONCRETE.
- B. Section 05 50 01 – METAL FABRICATIONS.
- C. Section 31 20 00 – EARTHWORK.
- D. Section 32 13 13 – CONCRETE PAVEMENT.

1.4 REFERENCES

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
- C. ASTM D523 - Test Method for Specular Gloss.
- D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
- E. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
- F. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
- G. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
- H. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- I. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
- J. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.
- K. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.
- L. Work operations shall meet American National Standards Institute [ANSI] Standard Z-133.1.

1.5 EXAMINATION OF SITE AND DOCUMENTS

- A. By submitting a bid the Contractor affirms that he has carefully examined the project documents site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of lack of full knowledge of existing conditions.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period, as no additional compensation will be made for errors or inaccuracies that may be found therein.

1.6 SUBMITTALS

- A. Shop Drawings: Supply shop drawings at an approved scale for location, installation and erection of all parts of the work under this Section including but not limited to the following:
 - 1. Product data in the form of manufacturer's technical data, specifications, and installation instructions for fences and gates.
 - 2. Drawings showing location of fence, including each post including allowable spacing in accordance with this Section, details of post installation, hardware, and accessories. Show sizes and thicknesses of all members, types of materials, methods of connection and assembly, complete dimensions, clearances, anchorage, relationship to surrounding work, and other pertinent details of fabrication and installation. Provide information on all hardware required for complete operation of gates. Drawing shall show length of each panel and location of the weep channel at the raised concrete curb. Curb and fence post spacing shall be in accordance with the Contract Drawings.
- B. Samples for Verification: Submit samples for each profile and pattern of fabricated metal and for each type of metal finish required, prepared on metal of same thickness and alloy indicated for the Work. Include samples of the following:
 - 1. Post cap including 12 inch (300-mm) long section of post.
 - 2. Full-size sample of fence, 2 feet wide by full height.
- C. Qualification Data: Submit qualification data for fabricator.

1.7 QUALITY ASSURANCE

- A. Source: For each type of product required for the work of this Section, provide products of one manufacturer and source for consistency.
- B. Codes and Standards: Perform ornamental metal fence and gate 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.
- C. 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.
- D. The work of this Section shall be completely coordinated with the work of other Sections. Verify dimensions and work of other trades that adjoin materials of this Section before installing items specified.

1.8 LAWS, ORDINANCES, PERMITS AND FEES

- A. The Contractor shall:
 - 1. Give necessary notices, obtain all permits and pay all Governmental taxes, fees and other costs in connection with this work, file all necessary plans, prepare documents and obtain all necessary approvals of the local Building Departments having jurisdiction.
 - 2. Obtain all required certificates of inspection for this work and deliver same to the Architect before request for acceptance and final payment for the work.

3. Include in the work, without extra cost to the Owner, any labor, materials, services, apparatus, drawings (in addition to Contract Drawings and Documents) in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on the Drawings and/or specified.

1.12 PRODUCT WARRANTY

- A. All structural fence components (i.e. rails, pickets, and posts) shall be warranted within specified limitations, by the manufacturer for a period of 20 years from date of original purchase. Warranty shall cover any defects in material finish, including cracking, peeling, chipping, blistering or corroding.
- B. Reimbursement for labor necessary to restore or replace components that have been found to be defective under the terms of manufacturer's warranty shall be guaranteed for five (5) years from date of original purchase.

1.8 PUBLIC SAFETY

- A. The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site.
- B. All equipment to be used and all work to be performed shall be in full compliance with all OSHA standards including, but not limited to, those regulations concerning noise levels, protective devices and operator safety. Immediately discontinue any obviously hazardous practice.
- C. Contractor shall coordinate for any police details required by the City as a result of the work related to this project. Adhere to all applicable timeframes and requirements of the responsible agency/agencies.

1.9 STORAGE AND HANDLING

- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.10 DIG SAFE

- A. Contractor is required to contact Dig Safe, tel: 811, a minimum of 3 business days, or 72 hours, prior to start of construction.
- B. Contractor will be given a Dig Safe ticket number as proof of notification. Provide Owner's Representative with number.

1.11 SPECIAL PROTECTION FOR MAINTAINING STREETS AND PUBLIC WAYS

- A. Do not close or obstruct streets or sidewalks within the public right of way without a permit. Do not place or store material in streets or sidewalks.
- B. Conduct operations with minimum interference to the abutting streets.

PART 2 - PRODUCTS

2.1 DECORATIVE METAL FENCE

- A. The basis of design for the decorative metal fence shall be the "Montage II" as manufactured by Ameristar Fence Products, Tulsa, OK, ameristarperimeter.com, or approved equal. Fence shall be 3'-0" height, with three rails and a "Majestic" top. Posts shall be embedded in concrete footings. Color of all components shall be black.
- B. Fence shall meet the following requirements:
1. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa) and a minimum zinc (hot-dip galvanized) coating weight of 0.90 oz/ft² (276 g/m²), Coating Designation G-90.
 2. Material for pickets shall be 1" square x 14 Ga. tubing. The rails shall be steel channel, 1.75" x 1.75" x .105". Picket holes in the rail shall be spaced 4.715" o.c. Fence posts and gate posts shall be 2-1/2" x 12 ga. minimum.
 - a. Fence posts shall be maximum 8'-0" o.c. and a minimum of 2'-6" o.c. Where maximum fence post spacing cannot be achieved, fence posts shall be space equally to achieve a consistent aesthetic.
 3. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
 4. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by the manufacturer's fusion welding process, thus completing the rigid panel assembly.
 5. The manufactured panels and posts shall be subjected to an inline electrodeposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

Table 1 – Coating Performance Requirements		
<u>Quality Characteristics</u>	<u>ASTM Test Method</u>	<u>Performance Requirements</u>
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 1,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

6. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Industrial weight fences under ASTM F2408 and all applicable building codes.

2.2 CONCRETE FOOTINGS AND RAISED CONCRETE CURB.

- A. See Section 03 30 00 – CAST-IN-PLACE CONCRETE for round fiber forms for footings and for Concrete for footings and the raised concrete curb.

PART 3 – EXECUTION

3.1 GENERAL

- A. Fence and accessories shall be installed in strict accordance with plans, specifications, approved shop drawings and as recommended by the manufacturer.
- B. Excavation: Drill or hand-excavate (using post-hole digger) holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.
- C. Posts shall be set in concrete footers to depths indicated on the Drawings. Excavate earth in locations indicated on approved shop drawings in accordance with procedures outlined in Section 31 00 00 – EARTHWORK.
- D. Place fiber concrete forms and concrete in accordance with Section 03 30 00 – CAST-IN-PLACE CONCRETE. The “Earthwork” and “Concrete” sections of this specification shall govern material requirements for the concrete footer. Posts setting by other methods such as plated posts or grouted core-drilled footers are permissible only if shown by engineering analysis to be sufficient in strength for the intended application.
- E. Setting Posts in Earth: Center and align posts in holes, space as required by manufacturer. Brace terminal post against structure as required.
- F. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
- G. Unless otherwise indicated, set top of concrete footings 6 inches below finish grade.
- H. Set forms for raised concrete curb and place concrete in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.2 FENCE INSTALLATION

- A. Fence posts shall be spaced according to the Drawings with a maximum distance of 96” o.c. and in accordance with approved shop drawings.
- B. Fence panels shall be attached to posts with brackets supplied by the manufacturer.

3.3 FENCE INSTALLATION MAINTENANCE

- A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove all metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Manufacturer spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-manufacturer parts or components will negate the manufacturer’s warranty.

3.4 CLEAN-UP AND PROTECTION

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material.

- B. Clean fences of all stains or marks and protect from damage. Replace any materials that are part of the final work that are broken or cannot be cleaned to the satisfaction of the Landscape Architect.
- C. After the fence work is installed, it shall be the responsibility of the Contractor to see that the fences are properly and adequately protected from damage.

END OF SECTION
32 31 16

SECTION 32 84 00 - IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide materials, labor, equipment, technical service, and testing to complete construction of automatic irrigation system, with two-wire, and internet weather-based irrigation controller as defined in Construction Documents.
- B. Work items include:
 - 1. Submitting qualifications and product cut sheets as specified below.
 - 2. Procurement of applicable licenses, permits, and fees.
 - 3. Coordination of utilities and verification of existing and proposed site conditions.
 - 4. Connection of electrical power supply to irrigation control system and the irrigation control system to earth ground; coordinating with Electrical.
 - 5. Connection of domestic water supply to irrigation system; coordinating with Civil.
 - 6. Adherence to safety protocols in place during construction, including:
 - a. Occupational Safety and Health Administration (OSHA)
 - b. Local and State Plumbing Boards
 - c. Local and State Health Departments
 - 7. Demonstration of completed irrigation installation and irrigation components operating within specified Sequence of Operation as determined by specified Commissioning Procedure prior to request for final payment (see Part 3 – Execution).
- C. After date of approval of completion by Owner's Representative, guarantee entire system with parts and labor for one (1) year, including first-year winterization and spring startup.

1.2 QUALIFICATIONS

- A. Qualified irrigation system installers must have experience of five (5) years with work and products specified herein, including:
 - 1. Two-Wire Controller and Valve Installation
 - 2. Soil Moisture or Weather-Based Smart Controllers
 - 3. Solvent Weld and/or Gasket Joint PVC Pipe 2-inches and Greater
 - 4. Commercial/Municipal/Institutional Irrigation Systems
- B. Attest qualifications below for three (3) recent projects of similar scope and size in previous five (5) years.

1. Contact Name
2. Company Name
3. Contact Phone number
4. Project Name and Location
5. Brief Project Description

1.3 WORK NOT INCLUDED (PROVIDED BY OTHERS/TRADES)

A. Water Service Point of Connection

1. One (1) new 1-inch domestic water service provided by Civil. Approximate Irrigation System point of connection location is noted on Drawings.
2. Equipment requirements, meeting applicable codes:
 - a. 1-inch Water Meter
 - b. 1-inch Backflow Preventer
 - c. 1-inch Domestic Water Supply.
 - 1) Requirements at Irrigation System points of connection
 - a) Type: Domestic Water
 - b) Flow: Maximum 12 gallons per minute
 - c) Pressure (dynamic): 60 pounds per square inch (psi) at the point of connection in landscape.

B. Electrical Power Source to Controller

1. New electrical circuits to be provided by Electrical.
 - a. Power Requirements for Irrigation Controller
 - 1) 120-Volt, 1-Phase, 60-Hz, 20-Amp
2. Conduits to landscape.
 - a. Coordinate with Electrical to provide conduit through enclosure pad to landscape for:
 - 1) Valve Wire
 - 2) Earth Ground Wire

C. Communications to Controller

1. Cellular Card compatible with and offered by Irrigation Controller Manufacturer.

1.4 RELATED REQUIREMENTS

- A. Plans and general provisions of the Drawings, including but not limited to the Agreement and General Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Coordinate with other project trades and refer to overall project Construction Documents, including, but not limited to:
 - 1. Division 01 – General Requirements
 - 2. Division 02 – Existing Conditions
 - 3. Division 03 – Concrete
 - 4. Division 26 – Electrical
 - 5. Division 32 – Exterior Improvements
 - 6. Division 33 – Utilities
 - 7. Drawings
 - a. Drawings IR-1.0 - IR-2.1
 - b. Review other Project Construction Documents for coordination.

1.5 APPLICABLE STANDARDS AND CODES

- A. Comply with following standards and codes:
 - 1. American Society for Testing and Materials (ASTM)
 - 2. National Standard Plumbing Code (NSPC)
 - 3. National Electric Code (NEC)
 - 4. National Sanitary Foundation (NSF)
 - 5. Underwriters Laboratories, Inc. (UL)
 - 6. Occupational Safety and Health Administration (OSHA)
- B. Comply with applicable laws, standards, and regulations of local governing authority. Local laws more stringent than those referenced above shall take precedent.

1.6 SUBMITTALS

- A. Submit following under provisions of Section 01 33 00 - Submittal Procedures:
 - 1. Literature: Manufacturer's product data sheets, specifications and installation instructions for materials listed in this Specification (Part 2 – Products).
 - a. Product submittals shall be concise (no extraneous pages or sections) and clearly marked to show submitted product model, type, and size.

- b. Substitute Product Submittal
 - 1) Provide specified product submittals for “an approved equal” to Owner’s Representative for approval.
 - 2) Alternate products are acceptable when products of equal or better quality and performance are submitted and approved by Owner’s Representative.
 - 3) Substitute Product Submittals constitute representation that:
 - a) Substitute products have been thoroughly investigated and have been determined to be equal or superior in all respects to that specified.
 - b) Substitute products shall provide same warranties as specified products, at a minimum.
 - c) Substitute products are compatible with interfacing items.
 - d) Assume responsibility and guarantee of system performance as result of product substitution, including making all subsequent changes to meet design specifications.
- c. All product installed shall be new, without defects, and of quality and performance as specified.
- d. Work shall not commence until all products specified are submitted and approved by written notification by Owner’s Representative.
- e. Products to be submitted for approval include, but not be limited to:
 - 1) Automatic Irrigation Controllers
 - 2) Communications Connection for Irrigation Controller
 - 3) Wire and Connectors
 - 4) Conduit and Fittings
 - 5) Manual, Self-Regulating, and Electric Valves
 - 6) Valve Boxes
 - 7) Grounding Equipment
 - 8) Valves (Isolation, Winterization)
 - 9) Flow Sensors and Master Valves
 - 10) Backflow Preventer, Meter, Disc Filter
 - 11) Irrigation Enclosure
- 2. Schedule: Submit Schedule of all products to be furnished hereunder, indicating manufacturer, size, and model.

- a. Ensure that all types/styles of products and installation equipment specified herein can be furnished by manufacturer submitted.
- b. Provide all spare parts as noted here within
- c. Prior to submitting schedule, confirm current site conditions are as provided in Drawings.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Do not deliver materials to Site, until all specified submittals have been submitted to, and approved by Owner's Representative.
- B. Coordinate with Owner's Representative for temporary storage and staging areas.
- C. Protect materials from damage from construction traffic, weather, corrosion, and other causes while stored on-site. Minimize on-site storage as possible.
- D. Store and handle all products and materials in compliance with manufacturer's instructions and recommendations.

1.8 GUARANTEE AND REPLACEMENT

- A. Guarantee entire irrigation system, parts, and labor, for one (1) year from official written date of substantial completion by Owner's Representative.
- B. System malfunctions occurring during guarantee period due to defective materials, poor workmanship, or improper adjustment shall be corrected to satisfaction of Owner's Representative at no additional cost to Owner.
 1. Repair all defects within 10 days of notification from Owner's Representative.
 2. Repair defects with approved products.
- C. First-year spring system start-up and winterization shall be included in system guarantee.
- D. Manufacturer warranties shall be provided for all products and materials where such warranties are offered in published product data. Copies of manufacturer warranties are to be included in Operations & Maintenance Manual (See Operation and Maintenance).
 1. Provide written warranty showing date of completion and period of warranty prior to request for final payment.

PART 2 - PRODUCTS

2.1 AUTOMATIC IRRIGATION CONTROLLER

- A. Controller
 1. Quantity: 1
 2. Size: Approximately 14.5 inches (tall) x 13 inches (wide) x 5.5 inches (deep)
 3. Construction: Electronic with 120-Volt Input and 24-28 Volt Output, Stainless Steel Unistrut-Mounted Enclosure

4. Standards: UL-Listed
5. Features: Manual and Automatic Control, Water Budgeting, Cycle-Soak, Sensor Input Terminals, Internal Transformer, Flow Monitoring Capability, Lightning Protection, Remote Control, Two-Wire System
6. Manufacturer/Model:
 - a. RainBird ESP-LXD (per Owner, compatible with existing internet based central control system) with the following Accessories:
 - 1) LSP1TURF: Two-Wire Line Surge Protection
 - 2) SD210TURF: Two-Wire Decoder Sensor Decoder
 - b. Approved Equal

B. External Devices

1. Flow Sensor
 - a. Quantity: 1
 - b. Flow Range 2 – 40 gpm
 - c. Manufacturer/Model:
 - 1) RainBird 1-inch Flow Sensor – Model FS100B
 - 2) Approved Equal
2. Pressure Reducing Normally Open (NO) Master Valve
 - a. Quantity: 1
 - b. Size: 1-Inch
 - c. Construction: Brass Globe Valve
 - d. Ratings: 220 psi
 - e. Features: Manual Bleed Screw, Flow Control, Pressure Regulation, Pressure Reducing
 - f. Manufacturer/Model:
 - 1) Griswold Controls, 2260 Pressure Reducing, Normally Open
 - 2) Approved Equal
 - g. Note: Demonstrate master valve closing within 3 minutes by simulating broken pipe through unexpected flows through drain valves or multiple zones operating manually and simultaneously.
3. Remote Management

- a. Enroll and configure Irrigation Controller web application for remote management of irrigation system with web-enabled devices.
- b. Purchase Tablet and Stylus for explicit use by irrigation system manager/operator.
- c. Manufacturer/Model:
 - 1) RainBird IQ4
 - 2) Basis of Design per Owner

2.2 WIRE

A. Two-Wire

1. Size: 14/2 AWG
2. Construction: Dual Strand Solid Copper Conductors with PE Insulation and Polyethylene Jacket.
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, ASTM B-8
5. Markings: Manufacturer, Rating, Size, and Type
6. Manufacturer/Model:
 - a. Paige Wire, P7389D
 - b. Regency Wire, R7534D
 - c. Service Wire, DEC 14/2
 - d. Approved Equal

B. Conventional Wire

1. Size: 14AWG
2. Construction: Single Strand Solid Copper Conductor with Polyethylene Insulation
3. Ratings: UL-Listed, NEC (Class II Circuit), Direct Burial UF/TWU, up to 600-Volt Potential
4. Standards: ASTM B-3, ASTM B-8
5. Markings: Manufacturer, Rating, Size, and Type
6. Manufacturer/Model:
 - a. Paige Wire, P7313D
 - b. Regency Wire, R7079D
 - c. Service Wire, GOLF14

- d. Approved Equal

C. Wire Splices

1. Type: Direct Burial Wire Splice Kit (All Components Intact)
2. Construction: Lockable Plastic Tube, Pre-Filled with Insulation Gel
3. Ratings: UL-Listed, NEC, Direct Burial and Submersion, up to 600-Volt Potential
4. Manufacturer/Model:
 - a. 3M, Direct Bury Splice Kit (DBR/Y-6)
 - b. Rain Bird, WC100 Wire Connectors (DBR/Y-6)
 - c. Underhill, Direct Bury Splice Kit (DBR/Y-6)
 - d. Approved Equal

D. Decoder Cable Fuse Device

1. Type: Direct Burial Quick Disconnect Signal Splitter with 5-Amp Fuses
2. Construction: Waterproof PVC with O-Ring Seal and ACME Threads
3. Provide in-line, two-way split, and three-way split configurations following mainline branch splits.
4. Manufacturers:
 - a. Paige Wire DCFD
 - b. Approved Equal

2.3 ELECTRIC ZONE VALVES

A. Sprinkler and Drip Zone Valve (Kit)

1. Size: 1-Inch
2. Construction: Plastic Diaphragm with Reinforced Nylon or Fiberglass Body
3. Ratings: 200 psi, Minimum Flow of 0.2 gpm
4. Features: Manual Bleed Screw, Flow Control, Pressure Regulation (to 40-45psi), and Stainless Steel Screen Filtration to 100 micron (150 mesh).
5. Manufacturer/Model:
 - a. Hunter ICZ
 - b. Rain Bird XCZ-PRB
 - c. Rain Bird XCZLF-100-PRF

- d. Approved Equal

2.4 ISOLATION VALVES

A. Mainline Isolation Valve

- 1. Size: 1-Inch Maximum
- 2. Construction: Bronze, Gate Valve
- 3. Ratings: 200 psi
- 4. Features: Steel Cross Handle, Non-Rising Stem
- 5. Manufacturer/Model:
 - a. Nibco T-113K
 - b. Apollo 102T-K
 - c. Approved Equal

2.5 QUICK COUPLING VALVES

A. Mainline Quick Coupling Valve

- 1. Size: 1-Inch, Normally Closed
- 2. Construction: Brass, Spring-Loaded Valve Seat, Key Engaged, Brass Swing Joint Assembly
- 3. Ratings: 125 psi
- 4. Features: ACME Key with 1-Inch Male ACME and $\frac{3}{4}$ Female AMCE Top, Vinyl Cover
- 5. Manufacturer/Model:
 - a. Hunter, HQ44 - LRC - AW
 - b. Rain Bird, 44-RC
 - c. Toro, 100-2SLVC
 - d. Approved Equal

B. Swing Joint Assembly

- 1. Size: 1-Inch
- 2. Construction: PVC, with O-Ring Seals and Brass Threaded Outlet
- 3. Manufacturer/Model:
 - a. Hunter HSJ-1 with SnapLok

- b. Approved Equal

2.6 VALVE BOXES

- A. Valve Boxes in Planter Beds only. Coordinate final field locations with Landscape Architect.

- B. General

- 1. Size

- a. 12-Inch Standard Valve Box

- 1) Single or Double 1-Inch Drip Kits

- b. 6-Inch Round

- 1) Wire Splice
 - 2) Decoder Cable Fuse Device
 - 3) Check Valve
 - 4) Flush Valve

- c. 10-Inch Round

- 1) Single 1-Inch Electric Zone Valve
 - 2) Isolation Valve
 - 3) Quick Coupling Valve

- 2. Construction: Resin

- 3. Ratings: Tensile Strength 3,000-5,000 psi

- 4. Lid Color: Black or Green (Confirm color with Landscape Architect prior to ordering)

- 5. Features: Lockable, Bolt-Down Covers (Provide Bolts and Install), Brick Supported

- 6. Manufacturer/Model:

- a. Carson, Model Specification Grade NDS Pro
 - b. Rain Bird VB
 - c. Approved Equal

2.7 DECODERS

- A. Manufacturer/Model:

- 1. RainBird FD-101TURF, FD-102TURF, FD-202TURF, FD-401TURF, and FD-601TURF
 - 2. Approved Equal

2.8 FIELD EARTH GROUND SYSTEM

A. Bond field decoders and provide Earth Ground System per manufacturer requirements.

1. Provide:

a. 6AWG Solid Bare Copper Wire

1) Manufacturer/Model:

a) Paige Wire, Model 160635

b) Approved Equal

b. 8-foot long by 5/8-inch diameter UL-Listed Copper-Clad Ground Rods with Welded, Insulated Conductor and Shrink Tubing

1) Manufacturer/Model:

a) Paige Wire, Model 182000

b) Approved Equal

c. UL-Listed exothermic weld to copper ground rod meeting NEC requirements

1) Manufacturer/Model:

a) Paige Wire, Model 182000IC10

b) Approved Equal

2. Separate Field Earth Ground System from Irrigation Controller Earth Ground System

2.9 PIPE AND FITTINGS

A. Irrigation Mainline and Laterals

1. Size: 1-Inch Maximum

2. Construction: Polyvinyl Chloride (PVC), Solvent Weld

3. Ratings: Schedule 40 Pressure Pipe

4. Standards: ASTM D-1785

5. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark.

a. Manufacturer/Model:

1) Cresline

2) Certainteed

- 3) JM Eagle
- 4) Approved Equal

B. Irrigation Mainline and Lateral Fittings

- 1. Size: 1-Inch Maximum
 - a. For Valves TOE Nipples: Schedule 80 PVC
 - b. Other Fittings: Schedule 40 PVC
- 2. Markings: NSF Designation, Size, Class or Schedule
 - a. Manufacturer/Model:
 - 1) Lasco
 - 2) Spears
 - 3) Dura
 - 4) Approved Equal

C. Solvent

- 1. Type: NSF Type I or Type II PVC
- 2. Standards: ASTM D-2564
 - a. Manufacturer/Model:
 - 1) IPS Weld-On 711
 - 2) Oatey HD Cement
 - 3) Rectorseal Gold
 - 4) Approved Equal

D. Primer

- 1. Type: NSF for PVC
- 2. Standards: ASTM F-656
 - a. Manufacturer/Model:
 - 1) IPS Weld-On P-68
 - 2) Oatey Clear Primer
 - 3) Rectorseal Jim PR-2
 - 4) Approved Equal

E. Sleeves

1. Sizes: 6-Inch minimum, Refer to Drawings for Sizes
2. Construction: Polyvinyl Chloride (PVC), Solvent Weld
3. Ratings: SDR 35
4. Standards: ASTM D 1785
5. Pipe Markings: Manufacturer, Nominal Size, Schedule, Pressure, Extrusion Date, NSF 14, Pipe Insertion Mark.
 - a. Manufacturer/Model:
 - 1) Cresline
 - 2) Certainteed
 - 3) JM Eagle
 - 4) Approved Equal

2.10 ROTARY SPRINKLERS

A. Body

1. Size: 6-Inch Pop-Up
2. Construction: Plastic, Ratcheting Riser, Removable Nozzle, Internal Check Valve
3. Ratings: Pressure Regulated to 40 psi
4. Manufacturer/Model:
 - a. Hunter PROS-06-PRS40-CV
 - b. Rain Bird RD06-S-P-45
 - c. Approved Equal

B. Nozzles

1. 12' – 30' Radius (see Drawings)
2. Features: Full and Part-Circle Fixed-Arc and Strip Patterns
3. Manufacturer/Model:
 - a. Hunter MP Rotator
 - b. Toro Precision Rotating
 - c. Approved Equal

C. Swing Joints

1. Size: ¾-Inch
2. Construction: PVC, with O-Ring Seals and Brass Threaded Outlet
3. Manufacturer/Model:
 - a. Rain Bird
 - b. TSJ
 - c. Approved Equal

2.11 DRIP IRRIGATION

A. Integral Emitter Drip Tubing (Plant Beds)

1. Type:
 - 1) Tubing: 17 mm
 - 2) Emitters:
 - a) Rate: 0.6 gph
 - b) Spacing: 12 Inches On Center
2. Construction: Polyethylene (PE) with Embedded Pressure Compensating Emitters
3. Ratings: Minimum Bending Radius = 7-inches
4. Fittings: 17mm PVC Barbed Fittings with Stainless Steel Clamps, Corrosion Tubing Stakes to Secure Drip Tubing to Ground
5. Features: Pressure Regulation, Check Valve
6. Manufacturer/Model:
 - a. Netafim, TLCV6-12, and TLCV0
 - b. Rain Bird, XFS-CV-6-12, XFS-CV-0
 - c. Hunter, HDL-CV-6-12, HDL-CV-0
 - d. Approved Equal

B. Integral Emitter Drip Tubing (Tree Rings)

1. Type:
 - a. Outside Tree Drip Rings (Outside of Root Ball Minimum 6 Inches)
 - 1) Tubing: 17 mm

- 2) Emitters:
 - a) Rate: 0.9 gph
 - b) Spacing: 12 Inches On Center
 - b. Blank Tubing (Inside Drip Rings)
 - 1) Tubing: 17mm
 - 2) Emitters: none
 - 2. Construction: Polyethylene (PE) with Embedded Pressure Compensating Emitters
 - 3. Ratings: Minimum Bending Radius = 7-inches
 - 4. Fittings: 17mm PVC Barbed Fittings with Stainless Steel Clamps, Corrosion Tubing Stakes to Secure Drip Tubing to Ground
 - 5. Features: Pressure Regulation, Check Valve
 - 6. Manufacturer/Model:
 - a. Netafim, TLCV9-12, and TLCV0
 - b. Rain Bird, XFS-CV-9-12, XFS-CV-0
 - c. Hunter, HDL-CV-9-12, HDL-CV-0
 - d. Approved Equal
- C. Drip Headers
- 1. Size: 1-inch
 - 2. Construction: Polyethylene (PE) 3408
 - 3. Ratings: Class 100, Type III, SDR 15, Class C
 - 4. Standards: ASTM D-2239
 - 5. Colors: Black
 - 6. Fittings: PVC Insert (per ASTM D-2609) with Stainless Steel Clamps on Each Side
 - 7. Markings: Manufacturer, Nominal Size, Class or Schedule, Pressure, Extrusion Date, Pipe Insertion Mark
 - a. Manufacturer/Model:
 - 1) Oil Creek
 - 2) Certainteed
 - 3) JM Eagle

4) Approved Equal

D. Insert Fittings

1. Manufacturer/Model:
 - a. Lasco
 - b. Dura
 - c. Approved Equal

E. Clamps

1. Manufacturer/Model:
 - a. Oetiker
 - b. Approved Equal.

F. Distribution Tubing

1. Size: 1/4-Inch
2. Construction: UV-Resistant Polyethylene Resin (Vinyl Not Acceptable Substitute)
3. Fittings: For Use with Barbed Emitters
4. Manufacturer/Model:
 - a. Rain Bird, XQ
 - b. Hunter, HQPE
 - c. DIG Irrigation, 12-038
 - d. Approved Equal

G. Tree Drip Emitter

1. Size: 1.0 gph (see Drawings)
2. Construction: UV-Resistant Plastic
3. Features: Self-Piercing, Pressure Compensating, Color Coded to Identify Flow Rate
4. Manufacturer/Model
 - a. Rain Bird, XB-PC
 - b. DIG Irrigation, 06-036
 - c. Hunter, HE-050-B-CV
 - d. Approved Equal

H. Manual Flushing Valve

1. Size: 1-Gallon Flush
2. Construction: Plastic
3. Fittings: 17mm PVC Barbed Fittings
4. Manufacturer/Model:
 - a. Netafim TLSOV
 - b. Approved Equal

2.12 IRRIGATION ENCLOSURE AND EQUIPMENT

A. Copper Pipe

1. Size: 1-inch
2. Construction: Type K Copper
3. Standards: ASTM B-88
4. Fittings: Wrought Copper, Silver Solder Joint (per ASTM B-828), Non-Corrosive Flux

B. Reduced Pressure Zone Backflow Preventer Assembly

1. Size: 1-Inch
2. Construction: Bronze with Quarter Turn Ball Valves
3. Ratings: 175 psi Maximum
4. Manufacturer:
 - a. Watts, Model 009M2-QT-S
 - b. Approved Equal

C. Meter

1. Size: 1-Inch
2. Construction: Bronze
3. Features: Magnetic Drive with Automatic Meter Reading Option, Threaded Inlet and Outlet
4. Meter to be Approved by local Water Department.
5. Manufacturer:
 - a. Neptune, Model T-10
 - b. Badger, Model Recordall

- c. Approved Equal
- D. Disc Filter
 - 1. Size: 1-inch
 - 2. Construction:
 - a. Disc Rings: Polypropylene
 - b. O-Rings: EPDM Rubber
 - c. Clamps: Stainless Steel
 - 6. Manufacturer:
 - d. Netafim, Model 25A47-140 (115 micron mesh)
 - e. Approved Equal
- E. Curb Stop and Waste Valve
 - 1. Size: 1-inch, Flared Ends with Curb Stop Key
 - 2. Construction: Brass
 - 3. Ratings: 175 psi Maximum
 - 4. Features: Stop and Waste Feature for Winterization
 - 5. Manufacturer:
 - a. Mueller
 - b. Ford
 - c. Approved Equal
 - 6. Curb Box and Lid
 - a. Size: 2-inch Upper Section, 4-inch Lower Section, Length to Match Finish Grade
 - b. Construction: Cast Iron Base and Lid per ASTM A48, Brass Plug per AWWA C800, Steel Upper Section
 - c. Ratings: 300 psi Maximum
 - d. Features: Arch Pattern, Phosphor Bronze Spring Friction Ring, Plug Style Lid
 - e. Manufacturer:
 - 1) Ford, EA2-xx-40 style
 - 2) Approved Equal

F. Irrigation Enclosure

1. Size: 60" Long x 38" Wide x 39" High
2. Concrete Pad: 72" Long x 50" Wide x 4" Thick, 1" Chamfer on Top Edge
3. Construction: Marine-Grade Aluminum
4. Ratings: Insulated
5. Features: Lockable, Exterior Color to be Confirmed by Owner's Representative
 - a. Carry price for custom painting at factory.
6. Manufacturer:
 - a. VIT Strongbox, Model PE-60AL
 - b. Approved Equal

2.13 EARTH MATERIALS

A. Stone (in Valve Boxes at Grade)

1. Type: ¾-Inch Crushed Stone

B. Clean Sand

1. Gradation: (passing by weight)
 - a. No. 4 Sieve= 80%
 - b. No. 200 Sieve = 5%

C. Concrete (Enclosure Equipment Pad)

1. Ratings: 4,000 psi 28-day Compressive Strength
 - a. Standards: ASTM C-33, ASTM C-94, ASTM-C150

2.14 SPARE PARTS

- A. Wrenches, Keys, and Tools for Servicing and Adjusting Sprinkler Heads (2)
- B. Quick Coupler Valve Keys (1)
- C. Gate Valve (1)
- D. Drip Zone Valve Kit (1)
- E. Assorted Valves and Fittings
- F. Integral Emitter Drip Tubing (100' Roll)
- G. Barbed Drip Fittings and Stainless Steel Clamps (12 Each)

- H. Sprinkler Heads and Nozzles (3 of Each)
- I. Assorted Drip Valves and Fittings

PART 3 - EXECUTION

3.1 GENERAL

- A. Competent superintendents and assistants shall be on-site at all times during product delivery, installation, testing, and system adjustments.
- B. System features shall be laid out as indicated on Drawings, making minor adjustments for variations in planting arrangements or field conditions. Major changes shall be reviewed with Owner's Representative before acceptance.
 - 1. Irrigation lines shown on Drawings are diagrammatic only. Location of irrigation equipment is contingent upon and subject to integration with all other underground utilities, tree roots, and hardscape design elements.

3.2 EXAMINATION

- A. Review and verify project conditions are as indicated on Drawings prior to starting work, including but not limited to:
 - 1. Utilities provided by Others
 - 2. Site grades and dimensions
 - 3. Landscaping features and hardscaping
 - 4. Structures
- B. Report any irregularities of site conditions to Owner's Representative prior to beginning work.
- C. Beginning of installation connotes acceptance of existing project conditions.

3.3 PROJECT COORDINATION

- A. Coordinate with Owner's Representative to expeditiously install system.
- B. Provide written notifications (electronic is acceptable) to Owner's Representative prior to work commencement, weekly for progress report, for any proposed changes to system design, and upon installation completion.
- C. All questions of design intent, proposed design changes, field notifications, and product substitution after installation commences shall be in writing to Owner's Representative as Request for Information (RFI).
- D. Utility Coordination
 - 1. Maintain 6-inch clearance between irrigation lines and any utility line. Do not install irrigation mainlines nor lateral lines directly above another utility of any kind.
 - 2. Exercise care when working near existing utilities.

3.4 SITE PROTECTION

- A. Protect landscaping, paving, structures, walls, and footings from damage caused during work. Damage to work of another trade shall be reported at once.
- B. Replace or repair any damage with same product or material, to satisfaction of Owner's Representative at no additional cost per Guarantee.

3.5 AUTOMATIC IRRIGATION CONTROLLER INSTALLATION

A. Controller

- 1. Install controller at location shown on Drawings.
- 2. Wire valves and external sensors into controller through conduits and set proper programming.
 - a. Program "Cycle-Soak" feature for all zones with sloped or poorly draining soils.
- 3. Using licensed electrical, wire controller to 120-Volt, 20-Amp electrical supply provided by Electrical.
- 4. Provide keys after final walkthrough.

B. Flow Sensor

- 1. Install Flow Sensor as shown on Drawings.
- 2. Provide straight pipe for Flow Sensor to reduce turbulence.
 - a. Upstream: 10 inches (10 times pipe diameter)
 - b. Downstream: 5 inches (5 times pipe diameter)
- 3. Wire Flow Sensor to Automatic Irrigation Controller as specified with waterproof connectors. Do not use splices between Controller and Flow Sensor.

C. Grounding

- 1. Coordinate with Electrical for acceptable earth ground locations.

3.6 WIRE INSTALLATION

- A. Install low-voltage valve two-wire per NEC, state, and local electrical codes for less 30-Volt service.
- B. Install valve two-wire in trench alongside mainline at invert elevation. Backfill carefully to avoid any damage to wire insulation on conductors.
 - 1. In areas of unsuitable material, use clean sand in bottom of trench before placing wire (see Excavation, Trenching, and Backfilling)
 - 2. Cover over wire: 12 inches
- C. Maintain sufficient slack for expansion, contraction and servicing. Do not install wiring tightly.

1. Provide and install additional 8 to 12 inches slack for conventional wire from decoder to valve.
 2. Provide 30 inches slack between decoders for two-wire.
 3. Provide sufficient length of wire in valve boxes to allow valve solenoid, splice, decoder wire, and all connections to be brought above grade for servicing.
 4. Coil slack for neatness in valve box.
- D. Install Decoder Cable Fuse Device as shown on Drawings; generally, prior to junction points on two-wire path.
- E. Provide waterproof splices at in-ground wire connections using approved splice kits. Splices shall be made in valve boxes and recorded on Record Drawings.
- F. Provide complete wiring diagram showing wire routing for connections between controller and valves as specified in Record Documents.
- G. Securely store wire when not scheduled for installation.

3.7 GROUND INSTALLATION

A. Decoder Grounding

1. Provide lightning surge arrestors as shown on Drawings.
2. Provide grounding per manufacturer's instructions. Where no grounding requirements are specified, provide grounding every 6 decoders or 500 feet maximum.

B. Lightning/Surge Arrestor

1. With waterproof splices, connect lightning arrestor red wire to site red wire and lightning arrestor black wire to site black wire. Decoder, lightning arrestor, and site two-wire may be connected in same waterproof splice as per manufacturer.
2. With waterproof splice, connect lightning arrestor ground green wire to 8AWG solid bare copper wire. Bury bare copper wire grounding wire 12 inches (or per local code) and run to approved earth ground location.
3. Place wired lightning arrestor neatly inside valve box.

C. Controller Grounding

1. Connect bare copper 8WG wire to controller ground lug and connect to earth ground as directed by Electrical.
2. Do not create grounding loop with field decoders (different ground locations outside of influence spheres).

3.8 DECODER INSTALLATION

A. Wiring

1. With waterproof splices, connect decoder red wire to site red wire and decoder black wire to site black wire.
 2. With waterproof splices, connect decoder valve leads to electric zone valve solenoid leads.
 3. Place wired decoder neatly inside valve box.
 4. Connect with irrigation controller and run diagnostic decoder search to link.
- B. Provide grounding for decoders per manufacturer's instructions. Refer to Ground Installation section.
1. With waterproof splice, connect lightning arrestor ground green wire to 8AWG solid bare copper wire. Bury bare copper wire grounding wire 12 inches (or per local code) and run to grounding rod valve box.
 2. Place wired lightning arrestor (if required) neatly inside valve box.
 3. Splice all lightning arrestor green wires in series (with 8AWG green jacketed copper wire) and coordinate acceptable earth grounding with Electrical.

3.9 PIPE INSTALLATION

A. PVC Pipe Installation

1. Cut plastic pipe with handsaw or pipe cutter, removing all burrs at cut ends. All pipe cuts shall be square and true. Bevel cut end as required to conform to manufacturer instructions.
2. Make all solvent-weld joints as per manufacturer's instructions and avoid applying excess primer or solvent. Do not wipe off excess solvent from each connection.
 - a. Allow welded joints 5 minutes set-up/curing time before moving or handling.
 - 1) Above 80°F: Allow connections to set 24 hours.
 - 2) Below 80°F: Follow manufacturer instructions.
 - 3) Below 40°F: Prohibited.
 - b. Maximum deflection per joint shall not exceed manufacturer limits.
 - c. Maintain 1-inch between lines which cross at angles of 45 to 90 degrees.

B. PE Pipe Preparation

1. Cut PE pipe with pipe cutter, removing all burrs at cut ends. All pipe cuts are to be square and true.
2. Clean ends as per manufacturer instructions.
3. Push PE pipe through stainless steel clamp—do not clamp at this point.
4. Soften PE pipe in hot water as per manufacturer recommendations for insert barbed fittings.

5. Assume all responsibility for and warranty all PE pipe to same level as manufacturer when using blowtorch to soften PE ends for fittings.
6. Do not use lubricants or pipe dope with PE pipe.
7. Insert barbed fittings fully and position stainless steel clamp over barbs. At this time, crimp or screw worm gear clamps down with appropriate tools to secure pipe and fitting.

C. Pipe Cover (unpaved surfaces at grade)

1. PVC Mainline = 24 inches
2. PVC Lateral = 14 inches

D. Pipe Protection

1. Prevent foreign material from entering pipe during installation.
2. Open ends of pipe shall be closed by watertight plug or seal when not in use.
3. Securely store pipe when not scheduled for installation.
4. Pipe shall not be installed when water is in trench, during rainstorms, or when temperature is below 40 °F.
 - a. No additional pipe may be installed or backfilled if water enters trench during pipe installation. Remove all water from trench before resuming installation.
 - b. Pipe installed at temperatures below 40°F shall be removed and replaced at no cost to owner.
5. Trenched PVC pipe shall be snaked to accommodate for expansion and contraction due to changes in temperature.

3.10 ELECTRIC ZONE VALVE INSTALLATION

- A. Install electric zone valves on level crushed stone base generally where shown on Drawings. Do not pour stone around valves that are already installed.
- B. Install all Schedule 80 PVC threaded nipples with Teflon tape, isolation valves, and/or union couplings in and out of electric zone valves as shown on details on Drawings.
- C. Set valves plumb with adjusting handle and bolts, screws, and wiring accessible through valve box opening.
- D. Install at sufficient depth to provide between 4-6 inches of cover from top of valve to finish grade.
- E. Install specified valve box over all electric zone valves. Set lid is flush with final proposed grade (coordinate with Site/Civil).
- F. Adjust zone valve operation after installation using flow control device on valve.

3.11 QUICK COUPLING VALVE INSTALLATION

- A. Install quick coupling valves where indicated on Drawings; generally, at ends of mainline branches and immediately downstream of well.
- B. Mount mainline quick coupling valves on 1-inch diameter, 12-inch long brass swing joint assemblies and stabilizers.

3.12 VALVE BOX INSTALLATION

- A. Furnish and install valve boxes as per valve schedule above for each valve, splice, or sensor.
- B. Install plastic valve boxes on minimum 4-inches crushed stone base. Pouring stone into valve box after installation is not acceptable.
- C. Finish elevation of all boxes shall be at grade, unless otherwise noted in Drawings.
- D. Provide level brick supports beneath valve boxes.
 - 1. For square/rectangular boxes, provide four (4) supports - one at each corner.
 - 2. For round boxes, provide three (3) supports equally spaced.

3.13 SPRINKLER INSTALLATION

- A. Sprinklers shall not exceed maximum spacing as indicated on Construction Drawings.
- B. Install sprinklers flush with grade on PVC swing joints as specified.
- C. Flush system before installing internals, flush caps, and nozzles (see Testing and Adjustments)
- D. Adjust all sprinklers after installation using flow control device on valve. Do not exceed radius reduction recommendations from manufacturer.

3.14 DRIP IRRIGATION INSTALLATION

- A. Integral Drip Emitter Tubing
 - 1. Install in areas as shown on Drawings by hand under mulch with average depth of 2 inches. Maximum 3-inch burial.
 - 2. Install all tubing below surface, no tubing visible.
 - 3. Install tubing on high side of plants to ensure vertical and lateral water distribution.
 - 4. Install emitter tubing 4-inches from all planter bed edges, curbs, walls, and hardscape features.
 - 5. Level Ground Installation
 - a. Install emitter tubing in rows spaced at design spacing for level ground.
 - 6. Slope Installation
 - a. Install emitter tubing in rows spaced at design spacing for top 2/3 of slope.

- b. Install emitter tubing in rows spaced at 1.5 times design spacing for bottom 1/3 of slope.
 - c. Orient rows parallel to slope.
- 7. For every 4 feet of elevation difference within drip zone, install check valve on supply header.
- 8. Provide pressure regulation as designed.
- 9. Secure emitter tubing with stakes every 5 feet to prevent shifting from compaction, slopes, and general operation.
- 10. Install Flush Valves on farthest ends of PE exhaust headers and at lowest elevation; generally, where shown on Drawings.

B. Electric Zone Valves (Drip Zone Kits)

- 1. Electric Zone Valves shall be installed as shown on details within appropriately sized valve boxes.
- 2. Wire and program valves to Irrigation Controller.

C. Drip Emitters

- 1. Install emitters with barbed connections.
- 2. Run ¼-inch Distribution Tubing from each barbed end emitter. Provide sufficient slack (6 inches) for ease of maintenance. Install diffuser cap at Drip Stake end of ¼ inch Distribution Tubing. Distribution Tubing visibility shall be minimal (bury where possible).

3.15 COMMISSIONING SITE VISIT

A. Pre-Commissioning Site Visit requirements to be submitted to Owner's Representative for approval:

- 1. Pressure and Leak Test Results of Pipe Network
- 2. Solenoid Valve Resistance Readings
- 3. Receipt of Cellular Card, Antenna, and/or Data Service Plan, if not connected to Local Area Network (LAN)

B. Verification of Web-Enabled Application with:

- 1. Account Information (Login and Password)
- 2. Owner's Representative shall Login to verify system setup and programming
- 3. Push Notification and Short Messaging Service (SMS) setup to designated landscape managers and irrigation installer to notify of alerts during guarantee period.
- 4. Screenshots of Learned Flow, Master Valve Enabling, and Programs.
- 5. Connection and operation of pressure sensor, flow sensor, and weather sensing devices.

6. Demonstrate to Owner's Representative during Commissioning Site Visit
7. All components of irrigation system including:
 - a. Clean and neat layout of all components
 - b. Pressure Gauges showing adequate pressure
 - c. Secured pipe, wire conduit, and controller
 - d. Valve Boxes flush with finish grade
 - e. Interiors of all Valve Boxes that have neat, clean valves and wiring
8. Normal operation of irrigation watering sequence for two (2) minutes per zone sequentially.
9. Ability to hand water through quick coupling valve with key.
10. Ability of Normally Open (NO) Master Valve to close within three (3) minutes of abnormal flow using multiple quick coupling valves and multiple solenoid valves manually open.

3.16 TESTING AND ADJUSTMENTS

- A. Include all testing and adjustments in submitted bid price.
- B. System Flushing:
 1. Flush entire irrigation system after complete installation.
- C. Testing
 1. Test pipe and valves for leaks at operating pressure. Repair leaks and retest until leaks are remedied.
 2. Perform coverage test with Owner's Representative present. Operate electric zone valves for five (5) minutes during coverage test. Readjust sprinkler nozzles and head locations (as necessary) to attain proper coverage. Replace any equipment that does not meet specified standards.
 3. After testing, clean equipment of debris during installation.
- D. Adjust sprinkler heads and valve boxes as necessary for mowing and landscaping.
- E. Throughout the guarantee period, adjust sprinklers and ensure coverage due to settlement and landscaping operations.

3.17 RECORD DOCUMENTS

- A. Record (As-Built) Drawings
 1. Maintain and update Record Drawings with red-line markings as project progresses, including locations of:
 - a. Sprinklers and descriptions (nozzles, pop-up height, and type)

- b. Valve Boxes and descriptions (valve type, zone numbers, and splice)
 - c. All equipment installed with distinct symbols.
 - d. Pipe routing and tees.
 - e. Wire routing and splices.
 - f. Controller Location(s) and Room Number(s)
- 2. Locations of installed equipment (valve, controller, sensors) shall be referenced by two permanent locations (swing ties) or GPS.
- 3. Make all notes legible as work progresses, any new equipment added shall use distinct symbols denoting location.
- 4. Document any changes from original Drawings.
- 5. Prints of original Drawings may be obtained from Owner's Representative at cost (0% markup).
- 6. Record Drawings shall be used as basis of payment for work completed. Provide copies of red-lined set to Owner's Representative along with payment request.

B. Record Documents

- 1. Record Documents shall be on-site at all times. Maintain record of following as project progresses:
 - a. Plumbing and Electrical permits (state whether or not required).
 - b. Materials Approved and approval date.
 - c. Materials delivered, Accepted, and Installed by whom and date.
 - d. Field Communications and Requests for Information (RFI).
- 2. Prior to final punchlist, provide complete electronic and hard copy files of Record Drawings and Documents to Owner's Representative as part of project completion. All information must be complete and shall be added to submitted documents prior to acceptance.

3.18 OPERATION AND MAINTENANCE

A. General

- 1. Bid price shall include up to four (4) hours of irrigation system overview and instruction with Owner's Representative.
- 2. Operation and Maintenance Manual
- 3. Provide three (3) hard cover binders titled "Operation and Maintenance for Lincoln Square Irrigation System" prior to application for acceptance and final payment.
- 4. Operation and Maintenance Manual shall include, but not be limited to:

- a. Title Page and Table of Contents
- b. One-Paragraph Written Description of Irrigation System
- c. Manufacturers' Data and Cut Sheets of Equipment, including:
 - 1) Copies of all approved submittals
 - 2) Wire resistance readings to each electric valve at completion (for future troubleshooting)
 - 3) Recommended operating settings
 - 4) Recommended maintenance schedule
 - 5) Name, address, and telephone number of installer (for repairs, spring startup, and winterization during 1-year guarantee period)
 - 6) Irrigation program for periods without rain and recommended settings including, zone run time, days per week, cycle-soak, and rain sensor suspension.
- d. Winterization and Spring Startup Instructions (after 1-year guarantee period)
- e. Guarantee Data
- f. Pockets with Folded Plans of:
 - 1) Original Design Drawing
 - 2) Final Record Drawing
 - 3) Controller Valve and Wiring System Diagram Drawing

3.19 SITE CLEANUP

- A. Remove unused materials and equipment from project site safely and efficiently. Dispose of unused materials legally, including construction debris and trash.
- B. Adjust ground, compact, and re-plant around irrigation sprinkler heads and trenches as necessary for proper angle and elevation.
- C. Fill depressions and erosion rills with specified planting soil mix to ensure site drainage.

3.20 FINAL ACCEPTANCE

- A. Final Acceptance of Irrigation System is predicated on:
 - 1. Complete system installation, adjustment, testing, and instructional overview.
 - 2. Submission of Operation and Maintenance Manuals to Owner's Representative.
 - 3. Proper Programming of Automatic Irrigation Controller.
 - 4. Completed and approved punchlist items.

- B. Owner's Representative shall provide written notice (hard copy and/or electronic) for Final Acceptance. Date of Final Acceptance notice shall serve as start of 1-year Guarantee period as described above.

END OF SECTION

SECTION 32 90 00 - LAWNS AND PLANTING

PART 1 - GENERAL

1.1 REFERENCE

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.

1.2 SECTION INCLUDES

- A. Preparation of final subgrades in lawns; testing, furnishing and spreading of topsoil; fine grading; application of soil conditioners; erosion control; sodding; planting; staking; mulching; protection of sodded areas; maintenance; and guarantee.

1.3 RELATED WORK

- A. Section 02 41 13 – SITE PREPARATION.
- B. Section 31 20 00 – EARTHWORK.
- C. Section 32 30 00 – SITE IMPROVEMENTS.
- D. Section 32 84 00 – IRRIGATION.

1.4 REFERENCES

- A. ASNS: "American Standard for Nursery Stock", American Association of Nurserymen, Latest Edition.
- B. ASTM: American Society for Testing and Materials.
- C. Federal Specification JJJ-S-181b, Seeds, Agricultural.
- D. Federal Specification O-F-241c(1), Fertilizers, Mixed, Commercial.
- E. IPNI: International Plant Names Index, <http://www.ipni.org>
- F. SRA-156: U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act.

1.5 CERTIFICATES, INSPECTIONS, TESTS AND SUBMITTALS

- A. At least 30 days prior to intended use, the Contractor shall provide the following samples and submittals for approval in conformance with the requirements of General Conditions Section 00 70 00, SUBMITTALS. Do not order materials until Owner's Representative's approval of samples, certifications or test results has been obtained. Delivered materials shall closely match the approved samples. Acceptance shall not constitute final acceptance. The Owner's Representative reserves the right to reject on or after delivery any material that does not meet these Specifications.

1. Material Sampling and Testing of Loam Borrow from Off-Site Sources, and Organic Compost shall be specified, performed and paid for under this Section.

- a. No planting soil, loam borrow or compost from off-site sources shall be delivered until the review of samples and test results by the Owner's Representative, but such review shall not constitute final acceptance. The Owner's Representative reserves the right to reject on or after delivery any material which does not meet specifications or match the sample.

2. Fertilizer: Submit product literature of lawn and planting fertilizers and certificates showing composition and analysis.

3. Sod: Submit a manufacturer's Certificate of Compliance to the Specifications with each shipment of the sodded lawn. These certificates shall include the guaranteed percentages

of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.

4. Filter Barrier: Submit 4 copies of manufacturer's literature and one material sample.
 5. Limestone: Submit supplier's certification that the limestone being supplied conforms to these Specifications.
 6. All Additives needed to amend a specific soil in order to meet these specifications.
- B. Plants shall be subject to inspection and approval by the Owner's Representative at their place of growth, and upon delivery for conformity to specification requirements. Such approval shall not obviate the right of inspection and rejection during the progress of the work.
1. Submit a written request to the Owner's Representative at least 10 calendar days prior to digging for inspection of plant materials at their place of growth. State in the written request the place of growth and quantity of plants to be inspected. The Owner's Representative reserves the right to refuse inspection at this time if, in his judgment, a sufficient quantity of plants are not available for inspection.
- C. Comply with all applicable State and Federal laws in respect to inspection for plant diseases and infestation for all plants including seed. Provide certificates of inspection with the invoice for each shipment as may be required by laws for transportation. File certificates with Owner's Representative prior to acceptance of material. Inspection by State and Federal governments at place of growth does not preclude rejection of material at the site.
- D. Submit samples of the following materials in the quantities indicated for approval prior to use.
1. Mulch for planting: .5 cubic foot.
 2. Compost: .5 cubic foot.
- 1.6 DELIVERY, STORAGE AND HANDLING
- A. Do not deliver TOPSOIL to the site until soil analysis has been approved by the Owner's Representative. Do not deliver topsoil to the site in a frozen or muddy condition.
- B. Deliver all SOIL AMENDMENTS to the site in manufacturer's standard containers showing weight, analysis, name of manufacturer and warranty. Append a summary of this product information to each invoice. Store in a weatherproof storage place in such a manner that they will be kept dry and their effectiveness not impaired. Caked or otherwise damaged soil amendments shall be rejected.
- C. Digging Sod:
1. Sod shall not be dug at the nursery or approved source until ready to transport sod to the site of the work or acceptable storage location.
 2. Before stripping, sod shall be mowed at a uniform height of 2 in.
 3. Cut sod to specified thickness and to standard width and length
- D. Transportation of Sod:
1. Sod transported to the Project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury. Closed vehicles shall be adequately ventilated to prevent overheating of the sod.

2. Evidence of inadequate protection following the digging, carelessness while in transit, or improper handling shall be cause for rejection.
3. Sod shall be kept moist, fresh, and protected at all times. Such protection shall encompass the entire period during which the sod is in transit, being handled, or are in temporary storage.
4. Upon arrival at the temporary storage location or the site of the work, sod material shall be inspected for proper shipping procedures. Should the sod be dried out, the Owner's Representative will reject the sod. When sod has been rejected, the Contractor shall at once remove it from the area of the work and replace it with acceptable material.
5. Unless otherwise authorized by the Owner's Representative, the Contractor shall notify the Owner's Representative at least two working days in advance of the anticipated delivery date of sod material.

E. Handling and Storage of Sod:

1. Sod material shall be handled with extreme care to avoid breaking or tearing strips.
2. Sod shall not be stored for longer than 30 hours prior to installation. Sod shall be stored in a compact group and shall be kept moist. Sod shall be prevented from freezing.
3. Sod that has been damaged by poor handling or improper storage will be rejected by the Owner's Representative.

F. PLANT MATERIAL

1. Immediately before digging spray all plant material in full leaf with anti-transpirant, applying an adequate film over trunks, branches, twigs and foliage. Do not prune plants before delivery.
2. Dig, ball and burlap (B&B) plants with firm natural balls of earth of diameter not less than that recommended by ASNS, and of sufficient depth to include the fibrous and feeding roots. Dig balls for collected material at least 1/3 greater in diameter than above. Double burlap all plants which are 6 inches in caliper and larger.
3. Dig up and prepare plants for shipment in a manner that will not cause damage to branches, shape and future development of the plants after replanting. Cover all plant material while in transit.
4. Do not remove container grown material from containers until ready for planting.
5. Protect plants at all times from sun or drying winds. Keep plants that cannot be planted immediately upon delivery in the shade, well protected with soil, wet moss or other acceptable material and keep well watered. Plants shall not remain unplanted for longer than 3 days after delivery.
6. Do not bind plants with wire or rope at any time so as to damage the bark or break branches. Lift and handle plants from the bottom of ball only. Plants with cracked or broken balls before or during planting operations shall be rejected.

1.7 QUALIFICATIONS

- A. The fine grading and sod lawn installation and planting shall be performed by personnel familiar with the accepted procedure of lawn construction and planting and shall be under the constant supervision of a qualified foreman.

1.8 ACCEPTANCE

A. Acceptance:

1. The Owner's Representative will inspect all work for Substantial Completion upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.
2. Acceptance of material by the Owner's Representative will be for general conformance to specified requirements, and shall not relieve the Contractor of responsibility for full conformance to the Contract Documents.
3. Upon completion and reinspection of all repairs or renewals necessary in the judgement of the Owner's Representative, the Owner's Representative will recommend to the Owner that the work of this Section be accepted.

B. Sodded lawn will be accepted when in compliance with all the following conditions:

1. Roots are thoroughly knit to the soil;
2. Absence of visible joints (sodded areas);
3. All areas show a uniform stand of specified grass in healthy condition;
4. At least 60 days have elapsed since the completion of work under this Section.

PART 2 - MATERIALS

2.1 GENERAL

- A. Materials shall be extracted or recovered and manufactured from within 500 miles of the project site.

2.2 TOPSOIL

- A. TOPSOIL shall be topsoil borrow. If additional topsoil is required, it shall be provided from an off-site source by the Contractor. It shall be fertile, friable, natural loam capable of sustaining vigorous plant growth. Topsoil shall be a "sandy loam" or a "fine sandy loam" of uniform composition as determined by mechanical analysis and based on the USDA classification system. In addition, it shall meet the requirements above as well as the following mechanical analysis:

<u>Sieve Size</u>	<u>% Retained</u>
1 inch	0
1/2 inch	0-3
No. 100	40-60

1. The clay content of the material passing U.S.S. No. 100 mesh shall not be greater than 60% as determined by the Bouyoucous Hydrometer or by the Decantation Method. The organic content shall be 5% to 20% as determined by the Thomas Rapid Test Method or by loss on ignition on moisture free samples dried at 100 degrees C. The pH value shall be between pH 6.0 and pH 6.5. It shall contain no toxic materials. Soluble salts shall not be greater than 75 parts per million. If soil amendments are required, they shall be added at no additional cost to the Owner.

2.3 SODDED LAWN

- A. Certified Turfgrass Sod: Superior sod grown from certified, high quality seed of known origin or from plantings of certified grass seedlings or stolons. It shall be inspected by the

certification agency of the state in which it is grown to assure satisfactory genetic identity and purity, overall high quality and freedom from noxious weeds as well as excessive quantities of other crop and weedy plants at time of harvest. All seed or original plant material in mixture must be certified. Turfgrass sod shall meet the published state standards for certification. All sod shall be from one source.

1. Sod shall be a mixture of four or five current and improved bluegrass varieties found in the top 25% of the NTEP (National Turfgrass Evaluation Proceedings), with last two tests spanning over 8 years. Mixture shall contain approximately equal proportions of each hybrid component.
- B. Sod shall be nursery grown on cultivated mineral agricultural soils. Sod shall have been mowed regularly and carefully, and otherwise maintained from planting to harvest.
- C. Thickness of Cut: Sod shall be machine cut at a uniform soil thickness of 5/8 in., plus or minus 1/4 in., at the time of cutting. Measurement for thickness shall exclude top growth and thatch.
- D. Strip Size: Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 1/2 in. on width, and plus or minus 5% on length. Broken strips and torn and uneven ends will not be acceptable.
- E. Strength of Sod Strips: Standard size sections of sod shall be strong enough to support their own weight and retain their size and shape if suspended vertically when grasped in the upper 10% of the section.
- F. Moisture Content: Sod shall not be harvested or transplanted when moisture content (excessively dry or wet) may adversely affect its survival.
- G. Time Limitations: Sod shall be harvested, delivered, and transplanted within a 36 hour period unless a suitable preservation method is approved prior to delivery. Sod not transplanted within this period shall be inspected and approved by the Architect prior to its installation.
- H. Thatch: Sod shall be relatively free of thatch. A maximum of 1/2 in. (uncompressed) thatch will be permitted.
- I. Diseases, Nematodes, and Insects: Sod shall be free of diseases, nematodes, and soil-borne insects. State Nursery and Plant Materials Laws require that all sod be inspected and approved for sale. The inspection and approval must be made by the State Agricultural Department, Office of the State Entomologist.
- J. Weeds: Sod shall be free of objectionable grass and broad leaf weeds. Turfgrass sod shall be considered free of such weeds if less than five such plants are found per 100 sq. ft. of area.
 1. Turfgrass sod shall not be acceptable if it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel and brome grass.

2.4 SOD FARM GROWING MEDIUM

A. LAWN/SOD SOILS

1. Stripped Existing or Imported Base Loam, Sand and Compost, each as specified above, shall be combined in an approximate mix ratio of two and a half parts by volume Sand to one part by volume Base Loam to one and one half parts by volume Compost (**2.5S:1L:1C**) to create a uniform blend which meets the following requirements.
2. Gradation for Material Passing the Number 10 Sieve:

U.S. Sieve Size No.	Percent Passing	
	Minimum	Maximum
10	100	100
18	70	90
35	45	72
60	28	43
140	18	22
270	14	18
0.002mm	2	4

3. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample.
4. Ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 5.5 or less ($D70/D20 < 5.5$).
5. Saturated hydraulic conductivity of the mix shall not be less than 3.0 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 88% Standard Proctor, ASTM 698.
6. Organic content shall be between 4.5 and 6.0 percent by weight.
7. pH shall be between 6.2 and 6.8
8. Chemical analysis shall be undertaken for Phosphorus, Potassium, Calcium Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

2.5 SOIL AMENDMENTS

- A. GENERAL: All soil amendments shall conform to the standards of the Association of Agricultural Chemists and shall comply with State and Federal regulations.
- B. LIMESTONE, if required, shall be free flowing Agricultural Grade Dolomitic Limestone ground to such fineness that 50% will pass a 100 mesh sieve and 98% will pass a 20 mesh sieve. Limestone shall contain at least 50% total oxides and not less than 85% total carbonates.
- C. ALUMINUM SULFATE, if required, shall be unadulterated commercial grade.
- D. GYPSUM, if required, shall be unadulterated commercial grade Calcium Sulfate.
- E. COMMERCIAL FERTILIZER shall be a complete fertilizer, uniform in composition and free flowing. At least 50% of the Nitrogen shall be derived from natural or synthetic organic sources. Available Phosphoric Acid shall be from superphosphate, bone or tankage. Potash shall be derived from Muriate of Potash containing at least 60% Potash.
 1. Fertilizer for new trees shall be 5-10-5.
 2. Fertilizer for new lawns, applied in the fall, shall be 3-1-2.
- F. BONEMEAL shall be finely ground commercial raw bonemeal with 4% minimum Nitrogen and 20% minimum Phosphoric Acid.
- G. ORGANIC COMPOST shall be mature leaf compost, mature composted animal manure, other aged, composted vegetable materials that meet the requirements of the EPA and the State of

Massachusetts for intended use. Raw (uncomposted or unprocessed) organic matter shall not be accepted.

1. Peat moss or other material the harvesting of which depletes natural wetlands shall not be used.
2. Organic material shall contain no bulking agents, such as visible, uncomposted wood chips, and be free from hard lumps. It may be shredded or granular in form. No plastic shall be present. The material shall be free of noxious odor. Organic compost shall be tested for % organics, carbon: nitrogen ratio, ammonium nitrate, moisture content, pH, and sieve analysis and test results shall be submitted for review before use may be approved as a soil component.
3. Manure shall be well rotted, unleached cattle manure, free of harmful chemicals and other injurious substances. Manure shall be free of sawdust and refuse of any kind and shall not contain more than 25% straw, shavings, leaves or other organic material. Manure shall be not be aged more than 2 years or less than 9 months.

H. MYCORRHIZAL FUNGI shall be 'PHC PLANT SAVER 4-7-4' manufactured by Lebanon Seaboard Corporation, tel: 800-233-0628, or approved equal.

1. After plants have been installed and prior to placement of mulch, place 1 packet of "PHC Plant Saver 4-7-4" around each plant in the top 1/2" of planting soil. Work into planting soil so that the material is incorporated.

2.6 PLANTING SOIL

A. PLANTING SOIL shall consist of seven (7) parts topsoil and one (1) part compost by volume. It shall have a pH value between 6.0 and 6.5.

2.7 ANTI-TRANSPIRANT

A. ANTI-TRANSPIRANT shall be suitable for spray application which upon drying shall produce a gas permeable, but water retarding, colorless film, having a moisture vapor transmission value of not more than 2.5 in accordance with ASTM E96. It shall be equal to "Wilt Pruf" by Nursery Specialty Products, Inc., Greenwich Conn. Apply in accordance with manufacturer's instructions.

2.8 FILTER BARRIER

A. The Contractor shall keep the site erosion free throughout the duration of planting and sodding. Refer to Section 02 41 13 – Site Preparation, of this Specification for filter barrier options.

2.9 PLANT MATERIALS

A. Selection of the Nursery Stock

1. At least thirty (30) days prior to the expected planting date, the Contractor shall request, in writing, that the Owner's Representative provide representatives to select and tag stock to be planted under this Section. This request shall be made ten (10) days prior to the date on which stock selections are to be made. The Contractor shall arrange for and bear the cost of transportation, meals in transit, and overnight accommodations, if necessary, for the Owner's Representative during the period of time required to select and tag the required number of sized stock. The letter of request shall also have attached a letter of certification from the supplier attesting to the fact that the stock to be selected from is, in fact, the patented tree or plant required under this Section. The Contractor shall supply the

necessary tags or seals which shall be durable and capable of accepting weather-resistant ink or an embossed process. The tags or seals shall be attached directly and securely to each selected plant. The Owner's Representative will make up to two tagging trips. The Owner's Representative reserves the right to seek compensation from the Contractor for additional tagging trips caused by the mismanagement of the Contractor.

- B. PLANTS shall be of specimen quality, exceptionally heavy, symmetrical, tightly knit plants so trained or favored in development and appearance so as to be unquestionably and outstandingly superior in form, number of branches, compactness and symmetry.
1. Plants shall be nursery grown in accordance with good horticultural practices, unless specifically authorized to be collected, and grown under climatic conditions similar to those in the locality of the project for at least two years. They shall have been root pruned within the past two years.
 2. Plants shall be freshly dug at time of delivery. No heeled-in plants or plants from cold storage will be accepted.
 3. Plants shall be sound, healthy and vigorous, well branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs or larvae and shall have healthy, well developed fibrous root systems. They shall be free from physical damage or adverse conditions that would prevent thriving with the specified result.
 4. Plants shall be true to species and variety and shall conform to the measurements specified in the Plant List except that plants larger than specified may be used without an increase in Contract price if approved by the Owner's Representative. Substitutions of plant materials will not be permitted unless authorized in writing by the Owner's Representative.
 5. Plants shall be measured when branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to tip.
 6. If a range of size is given, no plant shall be less than the minimum size and not less than 50% of the plants shall be as large as the upper half of the specified range. The measurements specified are the minimum size acceptable and are the measurements after pruning where pruning is required.
 7. Plants that meet the measurements specified, but do not possess a normal balance between height and spread shall be rejected. Thin, poorly branched or sparsely rooted plants will be rejected, regardless of whether they meet the minimum technical requirements of ASNS.
 8. In case of any discrepancy between the Plant List and the Planting Plan, the Planting Plan will govern.

2.10 MULCH FOR PLANTED AREAS

- A. MULCH for planting shall be shredded pine bark, passing a one inch square mesh and retained on a 1/8 inch square mesh. Moisture content shall not exceed 35%. Mulch shall contain no dye.

2.11 GUYING APPARATUS

- A. WOOD STAKES shall be 2" x 2" x 8 feet in length from sound Cedar pointed at one end and reasonably free of knots. Binding and guying shall be done with biodegradable webbing. Stake fastenings shall be galvanized 10 penny nails. Trees shall not be wrapped.

2.12 WATER

- A. WATER shall be free of substances harmful to plant growth. Contractor shall provide all labor and water required to establish turf and plantings. During the maintenance period the Contractor shall water as required to insure that a minimum of one inch of water per week is

applied to all turf areas and plant beds and that soil moisture is maintained to a depth of two inches or greater at all times.

2.13 LAWN PROTECTION BARRIER

- A. All edges of newly sodded lawn areas shall be protected by a 4-foot high barrier constructed of 2 inch by 2 inch hardwood stakes or iron pipes set 18 inches in the ground at 10 foot intervals and connected by No. 10 wire. Flags of white cloth shall be secured to the wire at center points between stakes.

PART 3 - INSTALLATION

3.1 PREPARATION OF SITE

- A. After the subgrade of the areas required to be sodded has been brought to the grades shown on the Drawings, thoroughly till the subgrade to a depth of 6 inches by an approved method. Loosen subgrade which has been consolidated or compacted during construction so as to interfere with the porosity of the soil, or where the natural void ratio has been changed, to a depth of no less than 12 inches. The top 3 inches shall be free from stones, rock or other foreign matter 2 inches or greater in dimension.
- B. Thoroughly and evenly incorporate soil amendments into subgrade by an approved method if indicated necessary by the subgrade analysis. Perform this work only when soil is in a friable condition. If the subgrade analysis recommends the incorporation of soil amendments, the Contract Price will be adjusted.
- C. When tilling within the branch spread of trees scheduled to remain, do so in a manner which will cause minimum damage to root systems.
- D. Before spreading topsoil, establish new finish grades and regrade subgrade as necessary to a true smooth slope parallel to and to the required depth below lawn areas and in new plant beds. Care shall be taken to eliminate depressions and ridges. Spread topsoil to meet finish grades smoothly and evenly. Provide sufficient grade stakes to insure correct line and grade of subgrade and finished grade. Where no grades are shown, areas shall have a smooth and continual grade between existing or fixed controls and elevations shown on the Drawings. Subgrade shall be inspected and approved by the Owner's Representative before the placing of topsoil.
- E. During the spreading operation, rake the topsoil and remove all rubbish and all stones in excess of one inch in diameter. Do not spread topsoil while either topsoil or subgrade is in an excessively dry, frozen or muddy condition. Uniformly distribute the topsoil in new lawn areas with a minimum thickness of 6 inches.
 - 1. Thickness shall be measured after natural settlement and light rolling. Place topsoil only when it can be followed within a reasonable time by sodding operations. Mechanically remove any weed growth prior to sodding. Do not permit weed growth to go to seed.
- F. Prior to sodding operations Contractor shall request an inspection be made of the finished topsoil areas. No sodding shall take place until the Owner's Representative approves the topsoil grade. All topsoil areas shall slope to drain. Correct finished surfaces to eliminate depressions holding water.

3.2 EROSION CONTROL

- A. The Contractor shall keep the site erosion free throughout the duration of planting and sodding. Refer to Section 02 41 13 – Site Preparation, of this Specification for filter barrier options. Approval of the method by Owner's Representative does not free Contractor of responsibility for controlling erosion.

3.3 ADDITION OF SOIL AMENDMENTS

- A. After the topsoil has been spread and graded, apply soil amendments at the rate recommended in the topsoil analysis. Apply limestone at least 5 days prior to application of fertilizer. Apply commercial fertilizer within 10 days of sodding or planting. Spread organic compost at the rate of 4 cubic yards per 1,000 square feet.
- B. Thoroughly and evenly incorporate soil amendments into the soil to a depth of 4 inches by discing or other approved method. In areas inaccessible to power equipment, use hand tools. After the incorporation of soil amendments into the soil, fine grade the bed to remove all ridges and depressions, and clear the surface of all stones one inch or more in diameter and other debris. Remove excessive quantities of smaller stones as directed by the Owner's Representative.
- C. Sodding or planting may be done immediately thereafter provided the bed has remained in a good friable condition and has not become muddy or hard. If it has become hard, till to a friable condition. Water dry soil to a depth of 4 inches 48 hours prior to sodding or planting.

3.4 SCHEDULE FOR SODDING AND PLANTING

- A. The actual sodding of lawns and planting shall be done only during periods within the season which are normal for such work as determined by weather conditions and by accepted practice in this locality. At the option of, and on the responsibility of, the Contractor sodding of lawns and planting may be done under unseasonable conditions, or out of season, without additional compensation subject to the approval at the time of work and methods of operation by the Owner's Representative. Lawn maintenance will be the same as for normal planting. Plant guarantee periods remain as specified. No frozen ground planting will be allowed.
- B. Sodding and Planting shall be done within the following dates:
- | | | |
|-----------------|---------|--------------------------|
| 1. Trees | Spring: | April 1 to May 15 |
| | Fall: | October 1 to November 15 |
| 2. Shrubs | Spring: | April 1 to May 30 |
| | Fall: | August 15 to Nov. 30 |
| 3. Sodded Lawns | Spring: | April 1 to June 1 |
| | Fall: | August 15 to Oct. 1 |

3.5 SODDING

- A. Limit of grading and earthwork shall be the limit of sodding unless otherwise indicated on the Contract Documents. All lawn areas disturbed outside the limit of sodding shall be prepared and sodded as specified herein at no additional cost.
1. To prevent loss of soil via water and wind erosion and to prevent the flow of sediment, fertilizer, and pesticides onto roadways, sidewalks, and into catch basins, sod newly graded loam areas within 5 Days of spreading the loam.
 2. Install erosion control measures as needed prior to start of sodding.

- B. Edges of the sodded areas shall be smooth, and all sodded areas shall conform to the design cross sections and grade. At edges adjacent to curbs, paved areas, etc., top surface of earth in sod shall be 1/2 in. below adjacent hard surface.
- C. Sod shall be placed and all sodding operations completed within 72 hours following stripping from sod source bed.
- D. On slopes steeper than 2 to 1, sod shall be fastened in place with suitable wood pins or other approved methods, spaced at not less than 1 pin per square foot.
- E. Surface of completed sodded area shall be smooth. Sod shall be laid edge-to-edge, with tight-butted, staggered joints. Sod shall be carefully placed to ensure that it is neither stretched or overlapped. Immediately after laying sod shall be pressed firmly into contact with sod bed by tamping or rolling, to eliminate air pockets. Following compaction, topsoil shall be used to fill all cracks, and excess soil shall be worked into grass with rakes or other suitable equipment. Sod shall not be smothered with excess fill soil.
- F. Immediately after sodding operations have been completed, entire surface shall be compacted with a cultipacker roller or other approved equipment weighing 100 to 160 lb./ft. of roller.
- G. Completed sod shall immediately be watered sufficiently to uniformly wet the soil to at least 1 in. below the bottom of sod bed.

3.7 PLANTING

- A. Inform the Owner's Representative when planting will commence and the anticipated delivery date of plant material. Failure to notify the Owner's Representative in advance, in order to arrange proper scheduling, may result in loss of time or removal of any plant or plants not installed as specified or directed.
- B. EXCAVATION OF TREE PITS:
 - 1. Stake out on the ground locations for trees and obtain approval of Owner's Representative before excavation is begun. Make adjustments in locations as directed.
 - 2. Establish finish grades for new tree pits. Excavate to depths required and regrade subgrade as necessary. Separate subgrade soils from upper "topsoil" portions and remove subgrade soils immediately wherever encountered during planting operations. Loosen top 6 inches of subgrade in tree pits immediately prior to placing planting soil.
 - 3. If stone, underground construction work, tree roots, poor drainage or obstructions are encountered in the excavation of plant pits, alternate locations may be selected by the Owner's Representative without additional cost. Where locations cannot be changed as determined by the Owner's Representative submit cost required to remove obstructions to a depth of not less than 6 inches below the required pit depth. Proceed with work only after approval of Owner's Representative.
 - 4. Notify Owner's Representative in writing of all soil or drainage conditions which the Contractor considers detrimental to the growth of plant material.
- C. PLANTING OPERATIONS FOR TREES:
 - 1. Set plants at the same relationship to finished grade as they bore to the ground from which they were dug. After settlement, the crown of the plant ball shall not be more than one inch lower than the surrounding finished grade. Backfill planting soil in layers of not more than 8 inches and tamp each layer before the next layer is placed. When plants have been backfilled approximately 2/3 full, water thoroughly before installing remainder of planting soil to top of bed, eliminating all air pockets.

2. Set trees in the center of pits, plumb and straight. Brace rigidly in position until the planting soil has been tamped solidly around the ball and roots. Cut ropes or strings from top of ball after plant has been set. Remove top 2/3 of burlap from root ball prior to backfilling. Remove wire baskets in entirety.
3. Mulch and water all plants immediately after planting. Flood plants with water twice within 24 hours of planting. Smooth planting areas to conform to specified grades after full settlement has occurred and mulch has been applied. Form saucers around trees planted in lawn areas.
4. After plants have been installed and prior to placement of mulch, place 1 packet of "PHC Plant Saver" in the top 1/2" of planting soil. Work into planting soil so that the material is incorporated.

D. FERTILIZING

1. For Spring planting only add commercial fertilizer to the planting soil at the rate recommended in the topsoil analysis. Mix thoroughly.
2. Fertilize Fall planting the following Spring. Use commercial fertilizer at the following rates:

Trees: 2 pounds per inch of caliper

E. PRUNING

1. Prune new plants only at time of planting and in accordance with American Association of Nurserymen standards in such a manner as to preserve the natural character of the plant. Pruning shall be done by experienced personnel under the supervision of the Owner's Representative.
2. Remove all dead wood, suckers and badly bruised or broken branches. In addition, remove approximately 1/4 of all small branching leaf canopy of deciduous plants by thinning out and shortening branches. Do not cut the leader. Trees with leaders removed shall be rejected. Use only clean sharp tools. Make all cuts flush with the trunk or branch.

- F. CLEANUP: Upon completion of planting and pruning operations, remove all excess soil and debris from the site and repair any damage caused by these operations.

3.8 PLANTING MAINTENANCE AND PROTECTION

- A. Maintenance and protection shall begin immediately after each plant is planted and shall continue until acceptance or for at least 30 days or as much longer as necessary to establish new plantings or until substantial completion, whichever is later with the following requirements.

1. Maintenance of new planting shall consist of pruning, watering, cultivating, weeding, mulching, resetting plants to proper grades and/or upright position and restoration of planting saucers and tree stakes.
2. Maintenance shall begin immediately after an area is planted and shall continue until final acceptance. The minimum maintenance period shall be 90 days after completion of the planting of all plant materials.
3. Furnish and apply such pesticides as are necessary to keep these areas free of insects and disease. Pesticides shall be approved by the Owner's Representative prior to use. Use in accordance with the specifications of the prevailing Public Health Authority.
4. Protect planting areas and plants at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any plants become damaged or injured, treat or replace them as directed by the Owner's Representative at no additional cost to the Owner.

3.9 LAWN MAINTENANCE AND PROTECTION

- A. Maintenance of sodded areas shall begin upon completion of sodding and shall continue a minimum of 45 days thereafter including two mowings, unless sodding is not completed until after September 15, in which case maintenance shall continue through June 15 the following year.
 - B. WATERING shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment.
 - 1. The Contractor shall provide all labor and arrange for all watering necessary to establish an acceptable lawn. A fully functional irrigation system may replace hand-watering of the sodded lawn. The Contractor shall be responsible for all costs associated with delivery of water to the plant beds and sodded lawns until Final Acceptance.
 - a. Week No. 1: Provide all watering necessary for rooting of sod. Soil on sod pads shall be kept moist at all times. Perform watering daily or as necessary to maintain moist soil to a depth of 4 in. Watering shall be done during the heat of the day to prevent wilting.
 - b. Week No. 2 and Subsequent Weeks: Water as necessary to maintain adequate moisture in the upper 4 in. of soil to promote deep root growth.
 - 2. At no time shall a tank truck be allowed on the sodded beds.
 - C. PROTECTION OF SODDED LAWNS
 - 1. After sodding has occurred, Contractor shall place stakes and wire fence at all edges of newly sodded lawn to prevent trespass.
 - 2. Provide additional temporary protection fences and barriers in other locations where deemed necessary.
 - 3. Remove temporary protection devices at the completion of maintenance period.
 - D. MOWING
 - 1. Mowing shall not be attempted until the sod is firmly rooted and securely in place. Not more than 40% of the grass leaf shall be removed during the first or subsequent mowings.
 - 2. Bluegrass and other cool season grasses shall be maintained between 1-1/2 in. and 2-1/2 in.
 - 3. All clippings shall be removed.
 - 4. After 2 mowings, the Contractor shall top dress the sod with an application of fertilizer at the rate of 1 pound of actual nitrogen per 1000 square feet.
 - E. FERTILIZING: Immediately prior to the end of the maintenance period after Spring sodding, or early the following Spring for lawns established in the Fall, apply ammonium nitrate at the rate of 20 pounds per 1,000 square feet over lawn areas. Apply only when grass blades are dry. Water thoroughly after application.
- 3.10 INSPECTION AND ACCEPTANCE
- A. At the end of the maintenance and protection period, submit a written request to the Owner's Representative to inspect all work for acceptance at least 10 calendar days before the anticipated date of inspection.
 - B. Until this portion of the work is finally accepted, the Contractor shall be required to repair and replace any lawn area that is defective or becomes damaged when, in the judgment of the

Owner's Representative, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications. The cost of necessary repairs or replacements shall be borne by the Contractor.

- C. Acceptance of plant material by the Owner's Representative shall be for general conformance to the specified size, character and quality and shall not relieve the Contractor of responsibility for full conformance to the Contract Documents including correct species.
- D. If a substantial number of plants are sickly or dead at the time of inspection, acceptance will not be granted, and the Contractor's responsibility for maintenance of all plants shall be extended until replacements are made. Replacements shall conform in all respects to the Specifications for new plants and shall be planted in the same manner.
- E. Upon acceptance of the work, the Contractor shall be relieved of further responsibility for care and maintenance of the accepted areas. The Owner will be responsible for the maintenance of new lawns and planting upon acceptance of the work, and continuing through the guarantee period.

3.11 GUARANTEE PERIOD AND REPLACEMENTS

- A. The guarantee period for plant material shall begin at the date of acceptance. All plant material shall be guaranteed by the Contractor, for a period of one year from the date of acceptance, to be in a good healthy and flourishing condition.
- B. Lawn turf installed in the fall, shall be guaranteed until the spring.
- C. Replace without cost to the Owner, and as soon as weather permits, and within a specified planting period, all dead plants and all plants not in a vigorous, thriving condition, as determined by the Owner's Representative during and at the end of the guarantee period. Plants shall be free of dead or dying branches and branch tips, and shall bear foliage of a normal density, size and color. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this Specification. Make all necessary repairs due to plant replacements at no additional cost to the Owner.
- D. The guarantee of all replacement plants shall extend for an additional period of one year from the date of their acceptance after replacement. In the event that a replacement plant is not acceptable during or at the end of said extended guarantee period, the Owner may elect subsequent replacement or credit for each item.
- E. Make periodic inspections as necessary, at no extra cost to the Owner, during the guarantee period to determine what changes, if any, should be made to the Owner's maintenance program. Submit in writing to the Owner's Representative and Owner any recommended changes.

END OF SECTION
32 90 00

SECTION 33 05 05 – SELECTIVE SITE UTILITY DEMOLITION

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Protection of Existing Utilities.
 - 2. Utility Demolition as required to accommodate new construction, including demolition of Phase I Site Enabling Utilities.
 - 3. Protection and Abandonment of Utilities
- B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:
 - 1. Section 312000 – EARTHWORK for soil materials, excavating, backfilling, and site grading and removal of site utilities.
 - 2. Section 312500 – SEDIMENTATION AND EROSION CONTROL for required erosion and sedimentation control measures.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Schedule indicating proposed sequence of operations for demolition work for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise protection.
 - a. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
 - b. Coordinate with Owner's continuing occupation of portions of existing building, adjacent buildings, and with Owner's partial occupancy of completed portions of proposed building or additions.
 - 2. Preconstruction survey photographs of existing conditions of structure surfaces, equipment, and adjacent improvements that might be misconstrued as damage related to removal operations are recommended. File with Owner's Representative prior to start of work.

1.4 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

PART 2 – PRODUCTS

(Not applicable to work of this section.)

PART 3 – EXECUTION

3.1 DISPOSAL OF WASTE MATERIALS

- A. Removal from Owner's Property: Remove waste materials offsite in a legal manner.

3.2 SITE UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities. The Contractor is responsible for coordinating and scheduling with the authorities having jurisdiction the removal and/or abandonment of existing utilities as required to complete the work.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner's Representative or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify the Owner's Representative not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without the Owner's Representative's written permission.
- C. Utility pipes designated to be abandoned in place shall be plugged at their ends with watertight brick masonry or cement mortar with a minimum thickness of 8 inches.
- D. Utility pipes designated to be removed shall consist of the complete removal and disposal of the entire length of pipe and backfill and compaction of the void with ordinary borrow. When the void is within the footprint of the new building, gravel borrow shall be used to backfill the void.
- E. Utility structures designated to be abandoned in place shall have their cast iron castings removed and disposed, inlet and outlet pipes plugged, the bottom of the structures shall be broken, the void of the structure shall be backfilled and compacted with ordinary borrow, and the top of the structure shall be removed so that it is at least 36 inches below finished grade.
- F. Utility structures designated to be removed shall consist of the removal and disposal of cast iron castings, plugging of inlet and outlet pipes, removal of the structure, and backfill and

compaction of the void with ordinary borrow. When the void is within the footprint of the new building, gravel borrow shall be used to backfill the void.

3.3 DISPOSAL, CLEANUP, AND REPAIR

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Owner's property.
 - 1. Burning on site is prohibited.
 - 2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.
- B. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from site.
- C. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start operations. Repair adjacent construction or surfaces soiled or damaged by site utility demolition work.

End of Section

This Page Intentionally
Not Used

SECTION 331000 – WATER UTILITIES

PART 1-GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of Specifications.

1.2 DESCRIPTION OF WORK

- A. Provide labor, materials, and equipment necessary to construct the exterior water system complete, including connections to existing pipelines and testing, all as indicated on the Drawings and as specified, including but not limited to the following:
 - 1. Furnishing and installation of all materials required to connect to existing water mains, replace existing services, install new gate valves, remove existing gate valves, install corporation cocks, saddles, curb stops, service boxes, all as shown on the Contract Drawings.
- B. Unless otherwise indicated on the Drawings, exterior water lines shall be installed from a point 10 feet outside the building foundation walls to the potable water source
- C. Related Work: The following items are not included in this Section and will be performed under the designated Sections.
 - 1. Section 312000 – EARTHWORK for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 2. Section 328400 – IRRIGATION for water requirements.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract.
 - 1. Descriptive literature showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.
 - 2. Product Data: Submit manufacturer's technical product data and installation instructions for potable water system materials and products.
 - 3. Shop Drawings: The Contractor shall submit for review shop drawings or descriptive literature for potable water system, showing piping, fittings, couplings, valves, hydrants, materials, dimensions, restrained joint calculations, joints and other details, blocks, and anchors. All hydrants and valves furnished under the Contract shall be manufactured only in accordance with the Specifications and the approved Shop Drawings.
 - 4. At project closeout, submit record drawings of installed potable water system piping and products, in accordance with requirements of Division 1. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built drawings shall be stamped and signed by a Massachusetts Licensed Land Surveyor or Licensed Professional Engineer. The as-built plans shall also be submitted electronically as an AutoCAD drawing.
 - 5. Maintenance Data: Submit maintenance data and parts lists for water system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual in accordance with requirements of Division 1.

1.4 REFERENCE STANDARDS

- A. The following standards are applicable to the work of this Section to the extent referenced herein:
1. ASTM: American Society for Testing and Materials.
 2. ANSI: American National Standards Institute.
 3. AWWA: American Water Works Association.
 4. AASHTO: American Association of State Highway and Transportation Officials.
 5. Reference is made herein to the Commonwealth of Massachusetts, Department of Transportation (MassDOT), Formerly Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, latest edition, hereinafter referred to as the "Standard Specifications". All references to method of measurement, basis of payment, and payment items in the "Standard Specifications" are hereby deleted. References made to particular sections or paragraphs in the "Standard Specifications" shall include all related articles mentioned therein.
 6. MassDOT, Construction Standards, latest Edition with amendments, hereinafter referred to as the "Construction Standards."
 7. Commonwealth of Massachusetts State Plumbing Code, latest edition.
 8. City Water Department Regulations.

1.5 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of potable water systems materials and products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.
- B. Installer's Qualifications: Firm with at least three years of successful installation experience on projects with potable water piping work similar to that required for this project.
- C. Water Purveyor Compliance: Comply with requirements of Purveyor supplying water to project, obtain required permits and inspections.

1.7 PROJECT CONDITIONS

- A. Site Information: Perform site inspection and survey, research utility records, and verify existing utility locations and elevations. Verify that water system piping may be installed in compliance with Contract Drawings and referenced standards.
- B. Interruption of Existing Water Distribution System: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to the requirements indicated:
1. Notify Architect no fewer than two days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Architect's written permission.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate with interior building domestic water and fire protection system piping.
- B. Coordinate with other utility work.
- C. The Contractor is responsible for developing a sequence of work to maintain existing services in operation until the new services are operational.
- D. The Contractor is responsible for coordinating and scheduling the inspection of the work by the jurisdictional authority. All permits and inspection costs and fees shall be included in the bid prices and no additional costs will be paid to the Contractor.

PART 2-PRODUCTS

2.1 SERVICE TUBING, CORPORATIONS, STOPS, SADDLES, AND VALVE BOXES

- A. Service tubing shall meet the requirements of Federal Specification WW-T 7996 and shall conform to ASTM specification B75, B68 and B88 as they apply to Type K Copper Tubing.
- B. Copper Tube Size (CTS) Polyethylene Tubing for domestic water uses shall conform to AWWA C901, ASTM D3350, and ASTM D2737 and shall have a working pressure rating of 200 psi. Tracer wire shall be attached to the tubing and connected to upstream piping of the associated water meter for the water service, as applicable.
- C. The Contractor shall furnish and install, including necessary taps and connections, corporation stops, CTS Polyethylene Tubing, curb stops and wastes.
- D. The corporation stops shall meet the most recent revision of the AWWA standard "Threads for Underground Service Line Fittings." (AWWA C800).
- E. Corporation stops shall be sized as shown on the drawings and be brass compression-type with CC thread (Mueller Brand with compression nut with set screw). Corporation stops shall open right.
- F. Curb Stops: Curb stops shall be sized as shown on the drawings and be brass compression-type with drain (Mueller Brand with compression nut with set screw). Curb stops shall open right.
- G. Tapping Saddles: Service connections shall be tapped with Size 2" X 8" double strap service saddles.
- H. Fittings and Boxes: Service boxes shall be cast iron. Extension service boxes of the required length and having slide-type adjustment shall be installed at all service box locations. The boxes shall have housings of sufficient size to completely cover the curb stop and shall be complete with identifying covers
- I. Service boxes shall be 2 1/2" Buffalo Style, heavy cast iron, tar coated, sliding type, consisting of three (3) pieces; a flanged bottom piece, a flanged top piece and bolted cover with the word "water" cast on the top. A minimum 6-inch overlap is required between sliding sections. The boxes lengths shall be as necessary to suit ground elevation.

2.2 IDENTIFICATION

- A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils. minimum thickness, with continuously printed caption

in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer

PART 3-EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which potable water system's materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Engineer.
- B. The Contractor is responsible for the provisions and all test requirements specified in herein. In addition, all pipe and appurtenances may be inspected at the plant for compliance with these specifications by an independent testing laboratory.
- C. All tests shall be made in accordance with the methods prescribed by the above-mentioned AWWA Standards, and the acceptance or rejection shall be based on the test results.
- D. Inspection of the pipe and appurtenances may also be made after delivery. The pipe and appurtenances shall be subject to rejections at any time on account of failure to meet any of the specifications requirements, even though samples may have been accepted as satisfactory at the place of manufacture.
- E. Pipe which does not conform to the requirements of this contract shall be immediately removed and replaced by the Contractor at no cost to the Owner.

3.2 HANDLING PIPE

- A. The Contractor shall take care not to damage pipe by impact, bending, compression, or abrasion during handling, and installation. Joint ends of pipe especially shall be kept clean.
- B. Pipe shall be stored above ground at a height no greater than 5-feet, and with even support for the pipe barrel.
- C. Only nylon protected slings shall be used for handling the pipe. No hooks, chains or bare cables will be permitted.
- D. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

3.3 INSTALLATION OF PIPE AND PIPE FITTINGS

- A. The Contractor shall provide all adapters and fittings such as transition couplings, as determined in the field, necessary to complete all cross connections, whether or not specifically stated in the Contract Drawings and Specifications.
- B. Care shall be taken in loading, transportation, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before placement, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Engineer or Owner's Representative.
- C. If any defective pipe is discovered after it has been placed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense. All pipe and fittings shall be kept clean until they are used in the work, be thoroughly cleaned before placement, and when placed, shall conform to the lines and grades required. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm even bearing throughout the length of the pipe shall be constructed by compacting sand gravel borrow around the pipe and up to 18 inches above the pipe.
- D. Blocking will not be permitted.
- E. A minimum horizontal separation of ten (10) feet shall be maintained between and existing, proposed or relocated sewer and the new water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten-foot separation, it is permitted to install a water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located eighteen (18) inches above the top of sewer. Where the horizontal clearance is less than ten (10) feet or the vertical clearance is less than eighteen (18) inches and the sewer crosses under the water main, both water main and sewer main shall be constructed of mechanical joint cement lined ductile iron pipe for 10-feet on either side of the crossing. One (1) full length of water pipe shall be centered over the sewer at the crossing. If the sewer crosses over the water main, regardless of the vertical separation, both pipes shall be concrete encased for a distance of ten (10) feet to either side of the respective centerline.
- F. Provide minimum cover over piping of 5-feet below finished grade.
- G. Extend water systems from the water main located within the public way and terminate potable water piping 10-feet 0-inches from the building foundation. Provide temporary pipe plug for piping extension into building if required by construction progress.
- H. All pipes shall be sound and clean before placement. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be temporarily closed by watertight plug or other acceptable means. Alignment shall be maintained during placement. The deflection at joints shall not exceed sixty percent of that recommended by the manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities, which may be encountered upon opening the trench. Solid sleeves shall be used only where allowed by the Engineer.
- I. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a push-on type bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be inspected for damage and shall be re-mortared as required to ensure a continuous lining.
- J. Mechanical joint restraints shall be used for all valves, bends, hydrants and piping section less than 50 feet. The contractor shall restrain all pipe runs to the lengths indicated on the approved restrained joint calculation shop drawings.

- K. Jointing of ductile iron push on pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8 inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to ensure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.
1. Jointing Ductile Iron Pipe (Push-On Type): Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.
 2. Jointing Mechanical Joint Fittings: Mechanical joints at valves, fittings, and where designated shall be installed in accordance with the "Notes on Method of Installation" under ANSI Specification A 21.11 and the instructions of the manufacturer. To assemble the joints in the field, the Contractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torque. Under no condition shall extension wrenches or pipes over handles or ordinary ratchet wrenches be used to secure greater leverage.
- L. Installation and jointing of ductile iron pipe shall be in accordance with AWWA C600, Sections 9b and 9c, latest revision, as applicable.
- M. Service tubing shall be installed with minimum 6-inches of sand bedding and 12-inches sand cover. Service tubing shall have a minimum total cover of 5 feet.

3.4 INSTALLATION OF VALVES AND APPURTENANCES

- A. Cleaning and Prime Coating Valves and Appurtenances (Except Epoxy Coated Valves)
1. Prior to shop prime coating, all surfaces of the valves and appurtenances shall be thoroughly clean, dry, and free from all mill-scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer or Owner's Representative.
 2. All ferrous surfaces shall be sand blasted or pickled according to SSPC-SP6 or SSPC-SP8, respectively.
 3. All gears, bearing surfaces and other surfaces not to be painted shall be given a heavy coat of grease or other suitable rust resistant coating unless otherwise specified herein. This coating shall be maintained as required to prevent corrosion during any period of storage and installation and shall be satisfactory through the time of final acceptance.
- B. Installation
1. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired before they are installed.
 2. Care shall be taken to prevent damage to valves and appurtenances during handling and installation. All materials shall be carefully inspected for defects in workmanship and materials, all debris and foreign material cleaned out of valve openings, etc., and all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves and other equipment that does not operate easily, or are otherwise defective, shall be repaired or replaced.
- C. Shop Painting Valves and Appurtenances

1. Interior and exterior surfaces of all valves which are not factory epoxy coated shall be given two coats of shop finish of an asphalt varnish conforming to AWWA C504 for Varnish Asphalt. The pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

D. Buried Valves

1. Install valves as indicated with stems pointing up. Provide valve box over underground valves. Buried valves and boxes shall be set with the operating stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping selected excavated material under and at the sides of the valve.

E. Valve Boxes

1. Valve boxes shall be installed vertically, centered over the operating nut, and if they are within the limits of the roadway or within limits where the plowing of snow will take place in the winter, the tops of the boxes shall be set $\frac{1}{2}$ " below the top of the finished grade. In locations where these boxes are not likely to be disturbed, the tops shall be set flush with the adjoining ground. Boxes shall be adequately supported during backfilling to maintain vertical alignment.

F. Corporation Cocks

1. The tapping machine shall be rigidly fastened to the pipe as near the horizontal diameter as possible. The length of travel of the tap should be so established that when the stop is inserted and tightened with at 14" wrench, not more than one to three threads will be exposed on the outside. When a wet tapping machine is used, the corporation stop shall be inserted and tightened in accordance with the manufacturer's specifications.

3.5 BACKFILLING

- A. General: Conduct excavation and backfill operations for utility installations in accordance with Section 312000 – EARTHWORK, local requirements, and the contract documents.
- B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.6 FIELD QUALITY CONTROL

A. Testing of Water Main/Service:

1. Prior to pressure testing, the entire line shall be water jetted to remove any rocks or debris that may have inadvertently entered the pipe during construction.
2. The Contractor in accordance with AWWA C651-99 specifications or latest revision will make pressure and leakage tests thereof, to determine that the ductile iron pipe is structurally safe and free of excess leakage. Pipeline shall be subject to a hydrostatic test of 150 pounds per square inch (psi) or 150% of the static pressure, whichever is greater. The Contractor shall furnish all equipment, materials, and labor for testing. Testing shall be done between valved off sections in approximately 1000-foot maximum section of the main. The Contractor shall furnish at his own expense the water needed for all water main testing.
3. Once the pipeline section has been filled at normal pressure and all entrapped air removed from the line, the Contractor shall raise the pressure to the approved test pressure by a special pressure pump taking water from a small tank of proper dimensions for satisfactorily measuring the rate of pumpage into the pipeline. The pipe shall maintain this pressure, within 5 psi, for a minimum of two hours during which time the line shall be checked for leaks. The measured water leakage shall not exceed the maximum allowed leakage as determined by the following equation for the section under test:

$$L = \text{SDP}^{1/2} / (133,200)$$

Where:

L = Allowable leakage, gallons per hour

S = Length of pipe section tested, feet
(1,000-foot maximum)

D = Nominal pipe diameter, inches.

P = Average test pressure (psi)

Should leakage exceed this rate, the Contractor shall immediately locate the leak or leaks and repair same at his expense. Pipe shall be flushed and chlorinated when leakage does not exceed above standard. Approval does not absolve the Contractor from his responsibility if leaks develop within the new main or water services (to curb box) later within the period of warranty.

B. Testing of Fire Protection Service:

1. Testing of fire protection services shall conform to the most current NFPA requirements.

C. Chlorinating and Flushing:

1. Prior to chlorination, the Contractor shall properly flush mains. In general, flushing shall be performed at a flow rate required to achieve a minimum velocity of 2.5-feet per second (approximately 900 GPM in a 12-inch diameter main and 400 GPM in 8-inch diameter main). Flushing shall be performed for a sufficient period of time to allow for a minimum of 3 volume changes of water in the main (approximately 20 minutes per 1,000-foot of 8-inch main at the above flow rate).
2. Chlorinating shall be accomplished by pumping a chlorine solution into the mains. Water shall be allowed to enter the new water mains until the mains are full of a solution containing 25-ppm available chlorine. The valves shall then be closed and the chlorinated water allowed to stay in the mains for 24 hours. At the end of this period, the chlorine residual shall be at least 10 mg/l. If it is less than 10 mg/l measured, Contractor shall flush and rechlorinate the mains at no cost to the Owner. All valves and hydrants shall be operated to ensure their proper disinfection and shall be manipulated to prevent superchlorinated water from entering the existing distribution system. After this period, the Contractor shall flush the mains until clear, clean water is being discharged.
3. Chlorinating and flushing shall be done in accordance with AWWA C651-99 Specifications.
4. Twenty-four hours after the main has been flushed of chlorinated water, bacteriological samples shall be taken. Water samples shall be taken from corporation stops along the length of the water main. A minimum of two (2) samples shall be taken, per 3,000 foot of pipe or on each street, whichever is greater, each in duplicate, in sterile bottles and sent to a State approved private laboratory for analyses. The Contractor shall perform all necessary work including delivery of samples to a certified laboratory, and shall include the cost of sampling and analysis in his bid price. The results of the tests on these samples will determine the acceptance of the work and allow these new mains to be connected to the District's system. The failure of any sample to pass the laboratory tests shall require the Contractor to reflush and rechlorinate the mains and resample and test the water until acceptable results are obtained, all at no additional cost to the Owner.
5. The Contractor shall submit a Disinfection report detailing the following:
 - a. Type and form of disinfectant used.
 - b. Date and time of disinfectant injection start and time of completion.

- c. Test locations.
 - d. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - e. Date and time of flushing start and completion.
 - f. Disinfectant residual after flushing in ppm for each outlet tested.
6. The Contractor shall submit a Bacteriological Report detailing the following:
- a. Date issued, project name, and testing laboratory name, address, and telephone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - d. Test locations.
 - e. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
 - f. Coliform bacteria test results for each outlet tested.
 - g. Certification that water conforms, or fails to conform, to bacterial standards.
7. Contractor shall note that work under this Contract shall NOT be considered completed until satisfactory installation and testing of the water mains have been completed.

3.7 FINAL INSPECTION

- A. Final inspection and acceptance of pipe, valves, appurtenances, and hydrants shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system. Prior to placing the systems in service, all components shall be inspected, with the Owner's Representative present, to ensure that no debris or other contaminants are present. If necessary, the Contractor shall clean and flush piping.
- B. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

End of Section

33 10 00

SECTION 334000 – STORM DRAINAGE UTILITIES

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials, and equipment necessary to construct the storm drainage system complete including but not limited to surface drain, retaining walls drain, and footing and foundation drain systems; and including connections to existing structures and testing, as indicated on the Drawings and as specified.
- B. Unless otherwise indicated on the Drawings, building drain service lines shall be installed from a point 10 feet outside the building foundation walls to the point of disposal.
- C. Related Work: The following items are noted and included in this Section and will be performed under the designated sections:
 - 1. Section 312000 – EARTHWORK for excavation, backfill, & compaction requirements.
 - 2. Section 050170 – MAINTENANCE OF DECORATIVE METALS for area drain.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - 1. Product Data: Submit manufacturer's technical product data and installation instructions for storm drain system materials and products.
 - 2. Submit descriptive literature for piping, fittings, couplings, and appurtenances showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.
 - 3. Submit shop drawings for storm drain systems, showing piping and manhole materials and sizes.
 - 4. Submit shop drawings of complete layout of detention/retention structures, including all fittings and appurtenances.
 - 5. The precast concrete structure shop drawing submittals for the manholes, catch basins, gas trap, grease trap, other vaults, and tanks shall contain erection drawings showing connections, cast-in items, waterproofing details, lifting hooks, and production drawings showing elevations, sections, and details indicating sizes and quantities of reinforcement.
 - 6. Submit shop drawings for structure frames, grates, and covers.
 - 7. Submit shop drawings for footing drains and underdrain systems at the building and utility coordination process/drawings as specified in division 1 specifications.
 - 8. Filter fabric: Submit the manufacturer's information.
 - 9. For trench drains submit shop drawings showing a schematic plan of the entire trench drain system, listing all parts being provided with exact centerline dimensions suitable for installation. Copies of the manufacturer's recommended method of installation and assembly shall be submitted for review.

10. For water quality structures and stormwater quality filter treatment structures submit shop drawings for the structure and performance. Shop drawings shall detail the structures precast concrete components, inserts, and castings. Where an external bypass is required, the manufacturer shall provide calculations and designs for all structures, piping and any other required material applicable to the proper functioning of the system, stamped by a Professional Engineer.
11. The Contractor shall submit buoyancy calculations for storm drainage structures assuming groundwater is one (1) foot below finish grade. If buoyancy is an issue the structure(s) shall be modified to prevent uplift. All buoyancy calculations and precast concrete structure designs shall be prepared and sealed by a professional Civil Engineer licensed in the state of Massachusetts.
12. Prior to the acceptance of the storm drainage system, the Contractor shall submit to the Engineer, for review and approval, As-Built Drawings that indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built drawings shall be stamped and signed by a Massachusetts Licensed Land Surveyor or Licensed Professional Engineer. The as-built plans shall also be submitted electronically as an AutoCAD drawing file (release 2010 or higher).
13. Prior to acceptance of the storm drainage system, the Contractor shall submit the results of the pipe deflection measurements and the video inspection reports.

1.4 REFERENCE STANDARDS

- A. The following standards are applicable to the work of this Section to the extent referenced herein:
 1. ASTM: American Society for Testing and Materials.
 2. ANSI: American National Standards Institute.
 3. AASHTO: American Association of State Highway and Transportation Officials.
 4. Reference is made herein to the Commonwealth of Massachusetts, Department of Transportation (MassDOT), Formerly Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, latest edition, hereinafter referred to as the "Standard Specifications". All references to method of measurement, basis of payment, and payment items in the "Standard Specifications" are hereby deleted. References made to particular sections or paragraphs in the "Standard Specifications" shall include all related articles mentioned therein.
 5. MassDOT Construction Standards, latest Edition with amendments, hereinafter referred to as the "Construction Standards."
 6. City of Worcester Department of Public Works Standard Specifications and Details, February 1, 2021 or latest edition.

1.5 EXAMINATION OF SITE AND DOCUMENTS

- A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.
- B. Plans, surveys, measurements, and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.6 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to storm drain systems.
- B. Utility Compliance: Comply with the City of Worcester Department of Public Works regulations, standards, and guidelines pertaining to storm drainage system installation and inspections.
- C. Plumbing Code Compliance: Comply with applicable portions of Massachusetts Plumbing Code and National Standard Plumbing Code, latest editions, pertaining to selection and installation of storm drain system's materials and products.
- D. Manufacturer's Qualifications: Firms regularly engaged in manufacturing of storm drain system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five years.
- E. Installer's Qualifications: Firms with at least three years of successful installation experience on projects with storm drain work similar to that required for the project.

1.7 PROJECT CONDITIONS

- A. Site Information: Perform site inspection and survey, research utility records, and verify existing utility locations and elevations. Verify that storm drainage system structures and piping may be installed in compliance with Contract Drawings and referenced standards.
- B. Interruption of Existing Storm Drainage System: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to the requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate with interior building storm drain system piping.
- B. Coordinate with other utility work.
- C. The Contractor is responsible for developing a sequence of work to maintain existing services in operation until the new services are operational.
- D. The Contractor is responsible for coordinating and scheduling the inspection of the work by the jurisdictional authority. All permits and inspection costs and fees shall be included in the bid prices and no additional costs will be paid to the Contractor.

PART 2 – PRODUCTS

2.1 MANHOLES

- A. General: Provide precast reinforced concrete structures as indicated and complying with ASTM C 478.
- B. Manhole Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated in the Contract Drawings. Tops shall be designed to meet H20 loadings.
- C. Base and Riser Sections: Precast concrete, with base riser section with integral floor. Diameter, base and riser thicknesses shall be as indicated on the Contract Drawings.

- D. Cement: Type II.
- E. Concrete strength: 4,000 psi minimum.
- F. Precast concrete sections shall have tongue and groove joints.
- G. Horizontal Joints: Joints between sections of concrete structures shall be sealed with a flexible, watertight joint, made with preformed butyl rubber joint sealant conforming to ASTM C990 or with a rubber gasket joint conforming to ASTM C443. Sealants and/or gaskets shall be installed in accordance with the manufacturer's written instructions.
- H. Manhole Steps: Steps for manholes shall be non-skid raised edge-front steel reinforced polypropylene plastic type with at least 13-inch-wide stepping surface. Steps shall meet the requirements of ASTM C-478 and AASHTO M-199. Steel shall be 1/2-inch grade 60 conforming to ASTM A615 encapsulated with molded copolymer polypropylene. The polypropylene shall conform to ASTM D-4101. Rungs shall protrude no more than 6 inches from the wall. The portion of the legs to be embedded in the precast section shall have fins and be tapered to ensure a secure bond. Steps shall start a foot above the shelf of the manhole floor and continued twelve inches on center spacing up through the completed height of the unit. The steps shall finish no lower than twenty-four (24)-inches below the rim elevation. Placement into precast walls shall be by a method recommended by the supplier of the precast manhole sections. Steps shall be installed per the manufacturer's specifications.
- I. Pipe Connections: Drainage structures shall have plain beveled openings to accept the type of pipe specified. Pipe openings shall be minimum size required to receive the pipe and shall be accurately set to conform to the required line and grade. Drain pipe shall be joined to the wall of the concrete manhole or catch basin with non-shrink grout or flexible manhole sleeve as indicated on the drawings. Grout mixture shall follow instructions provided by manufacturer. Flexible manhole sleeves shall be cast in the walls of the manholes during the manufacturing process. Flexible manhole sleeves shall be NPC Kor-N-Seal Pipe-to-Manhole Connector as manufactured by Trelleborg Pipe Seals Milford, Inc., Milford, NH; Z-Lok as manufactured by A-Lok Products, Inc., Tullytown, PA; Tylox CIB Series Cast-In Boot Connector as manufactured by Hamilton Kent, Winchester, TN; or approved equal.
- J. Drain manholes shall be constructed with drop connections when the proposed invert of the connection is at least 2.75 feet above the manhole invert. All drop manholes will be of the external type. The drop pipe shall be constructed of minimum SDR 35 PVC. The drop piping and horizontal cleanout sections will be sized the same as the drain main piping and shall enter the manhole at invert elevation. The drop portion of the piping shall be secured with anchor straps. The drop piping shall be encased with control density fill.
- K. Storm Drainage Brick Masonry: Bricks shall be sound, hard, uniformly burned, regular, and uniform in shape and size. Underburned or salmon brick shall not be acceptable. Only whole brick shall be used.
 - 1. Bricks for raising manhole and catch basin frames to finished grade shall conform to ASTM C32, Grade MS.
 - 2. Mortar shall be in conformance with ASTM C270, Type M. The mortar shall be composed of one-part Portland cement, 3-1/2 parts sand, and 1/4 parts hydrated lime, by volume. Portland cement shall be ASTM C150, Type II; hydrated lime shall be Type S conforming to ASTM D207.
 - 3. Sand shall be washed, cleaned, screened, well-graded with all particles passing a No. 4 sieve, and conform to ASTM C33.
- L. Inverts in drain manholes shall be constructed of cement concrete shaped to conform accurately to size of the adjoining pipe. Side inverts and main inverts where the direction

changes shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerline of the adjoining pipe lines.

- M. For all manhole depths greater than 10 feet, the inside diameter of the manholes shall be at least 5'-0".
- N. Safety landings will be installed inside manholes greater than 16-feet in depth.
- O. When installing manholes on existing lines and when flows cannot be diverted, drop-over manholes shall be used. Drop-over manholes shall be precast with opening cast in the sidewalls of sufficient size to fit over the existing line(s) to remain in service. Drop-over manholes shall be set on a precast or cast-in-place concrete base slab. Drop-over manholes shall be manufactured to the same requirements and dimensions as standard manholes.

2.2 MANHOLE FRAMES AND COVERS

- A. Manhole frame and cover shall be EJIW 1056Z frame and EJIW 1056A cover or LeBaron LC239/L23C-1. Non-bolted casting manhole covers shall be supplied with a closed pickhole and shall show the wording 'Worcester, A Town June 14, 1722: A City February 29, 1848" cast into said cover.

2.3 AREA DRAIN

- A. See Section 05 01 70 – Maintenance of Decorative Metals for restoration of exiting and replacement of missing or unrepairable grates. Grates shall meet ADA requirements.

2.4 PVC DRAINAGE PIPE

- A. General: Provide JM Eagle C900 Blue-Brute SDR-18 PVC pipe or equal. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.
- B. PVC (Polyvinyl Chloride) Gravity Sewer Pipe and Fittings: ANSI/AWWA C900-16. The pipe shall have a Standard Dimension Ratio (SDR) of 18.
- C. Joints: PVC pipe shall have an integral wall bell and spigot push-on joint with elastomeric gaskets secured in place in the bell of the pipe. The bell shall consist of an integral wall section with solid cross section elastomeric gasket, factory assembled, securely locked in place to prevent displacement during assembly. Pipe joints shall conform to ASTM D3139 and elastomeric gaskets shall conform to ASTM F477.
- D. Spigot pipe ends shall be supplied with bevels from the manufacturer to ensure proper insertion. Each spigot end shall have an "assembly stripe" imprinted thereon to which the bell end of the mated pipe will extend upon proper joining of the two pipes.
- E. PVC gravity sewer fittings and accessories shall be as manufactured and furnished by the pipe supplier or approved equal and have bell and spigot configurations compatible with that of the pipe.

2.5 FILTER FABRIC

- A. Filter Fabric used as a drainage medium shall be a needle-punched, non-woven geotextile made from polypropylene or polyethylene filaments or yarns.
- B. Filter fabric shall be inert to organic chemicals commonly encountered in the soil.

- C. Filter fabric shall be meet AASHTO M288 Survivability Class 2 Standards.
- D. The edges of filter fabric shall overlap a minimum of one foot.
- E. Filter fabric shall be in compliance with the following properties, measured as per the referenced test methods:

PROPERTY	Required Value	TEST METHOD
Grab Tensile Strength	160 lbs. (min.)	ASTM D 4632
Elongation @ Failure	50% (min.)	ASTM D 4632
Trapezoidal Tear Strength	60 lbs. (min.)	ASTM D 4533
CBR Puncture Strength	410 lbs. (min.)	ASTM D 6241
Permittivity	1.5 sec ⁻¹ (min.)	ASTM D 4491
Water Flow Rate	110 gal./min./SF (min.)	ASTM D 4491
Apparent Opening Size	#70 Standard US Sieve	ASTM D 4751
U.V. Radiation Stability	70% (min.)	ASTM D 4355

2.6 CRUSHED STONE

- A. Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious or organic material. The crushed stone shall be uniformly blended and shall conform to the following requirements.

Percent Passing by Weight		
Sieve Size	3/4-inch Stone	1/2-inch Stone
1-inch	100	---
3/4-inch	90-100	---
5/8-inch	---	100
1/2-inch	10-50	85-100
3/8-inch	0-20	15-45
No. 4	0-5	0-15
No. 8	---	0-5

2.7 DRAIN COUPLINGS

- A. Drain Couplings shall be pressure rated at least equal to that of the pipe. The coupling sleeve, shall be 1/4-inch minimum thickness elastomeric polyvinylchloride with a minimum tensile strength of 1500 psi. The sleeve shall fit snugly onto the pipe to be joined and be resistant to common chemicals present in storm water. Adjustable pipe clamps shall consist of a slotted band that mate with the worm gear screw and a screw housing all manufactured of stainless steel, and suitable for underground service.

2.8 CLEANOUTS

- A. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.
- B. The drain cleanouts shall be minimum 6-inch diameter or sized to match the service pipe, whichever is greater. The cleanout shall be complete with a flush mount over. The cleanout cover shall be clearly marked "DRAIN" and shall be minimum eight inches in diameter or two

inches greater than the cleanout size, whichever is greater. Cleanouts shall include a watertight cap.

2.9 IDENTIFICATION

- A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils. minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

- A. General: General Locations and Arrangements: Contract Drawings indicate the general location and arrangement of the underground storm drainage system piping. Location and arrangement of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. Any modifications to the layout of the storm drainage system shall be submitted to the Engineer for review and approval at least five days prior to the start of the affected work.
- B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations, accepted practices, and utility owner's requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- C. All pipe shall be laid in the dry. Adequate measures shall be taken to prevent floatation of pipe in the trench.
- D. Whenever encountered within the trench, existing abandoned water, sewer, and/or drain lines shall be removed within the trench limits, unless otherwise noted. The remaining portion of the abandoned lines shall be plugged at all open ends.
- E. When bell and spigot pipes are used, bell holes shall be dug in the bedding to accommodate the bells. They shall be deep enough to ensure that the bell does not bear on the bottom of the hole but shall be excessively wide in the longitudinal direction of the installation.
- F. Use manholes for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into an existing storm drain is indicated.
- G. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited without the written approval of the Engineer.
- H. Install piping pitched down in direction of flow as indicated on the Contract Drawings.

- I. Extend storm drainage system piping to connect to building drain services, of sizes and in locations indicated on the Contract Drawings.
- J. Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
- K. Acceptance of Pipe: Acceptance will be on the basis of tests specified herein before. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to review by the Engineer. Inspection may be made at the place of manufacture, or on the work site after delivery or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected shall be immediately removed from the project site by the Contractor.
- L. Pipe Storage: Pipe sections shall not be stored on areas over the newly laid pipe or other pipelines which might be damaged by the superimposed load, and storage sections shall be restricted to approved areas.
- M. Handling Pipe: Each pipe unit shall be handled into its position in the trench only in such manner and by such means, as the Engineer accepts as satisfactory. The Contractor will be required to furnish suitable devices to permit satisfactory support of all parts of the pipe unit when it is lifted.
- N. Laying Pipe: Except where a concrete cradle or envelope is required, the pipe shall be laid in a crushed stone cradle. In trenches, no blocking or supporting of the piping by concrete, stones, bricks, wooden wedges, or method other than bedding the pipe on crushed stone will be permitted. Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.
- O. Jointing Pipe: After the pipe are aligned in the trench and are ready to be jointed, all joint surfaces shall be cleaned.
- P. Alignment and Placement: All pipe shall be laid with extreme care as to grade and alignment. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.
 - 1. Stakeout of drain work and setting of line and grade is the responsibility of the Contractor.
 - 2. The Contractor shall establish centerline and offset stakes at each manhole, plus one intermediate centerline and offset stake as a check point between manholes. Laser aligning shall not be used to establish a continuous line in excess of 400-feet.
- Q. Cleaning: Care shall be taken to prevent earth, water, and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water and debris from entering any existing drainage system.
 - 1. Place plugs in end of uncompleted conduit at end of day or whenever work stops.
 - 2. Flush lines between manholes to remove collected debris.
- R. Review of Completed Storm Drain System: The completed drain system shall be visually inspected by the Owner's Representative. If the visual observation of the completed drain or any part thereof shows any pipe, manhole, or joint to be of defective work or material, the defect shall be replaced or repaired as directed by the Engineer or the Owner's Representative. The Contractor shall coordinate and provide site access for inspection.

3.2 PVC PIPE

- A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.
- B. PIPE HANDLING
 - 1. All pipe and fittings shall be carefully handled from the truck onto the ground and into the trench or excavation so as to prevent damage to the pipe. Pipes shall be kept free of dirt and foreign material, especially on the inside. Joint ends of pipe shall especially be kept clean.
 - 2. Pipe stored on site shall be protected from heat and direct sun light and shall be suitably ventilated.
 - 3. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.
- C. ALIGNMENT AND PLACEMENT OF PVC PIPE
 - 1. Bedding material for the pipe must be installed with care in the area around the pipe. Bedding material must be placed to provide uniform and adequate support under pipe. Do not use blocking to bring pipe up to grade.
 - 2. Provide bell holes at each joint to permit joint to be assembled properly while maintaining uniform pipe support.
 - 3. Place and consolidate the bedding material under the pipe haunch to provide adequate side support while avoiding both vertical and lateral displacement of pipe.
 - 4. Initial backfill must be completed to a point at least 12-inches over the top of the pipe and be hand placed. Use little or no tamping of initial backfill directly over the top of pipe. Compaction methods may be utilized during final backfilling.
 - 5. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.
 - 6. Full lengths of pipe shall be used in the installation except that partial lengths may be used at the entrance to structures, and to accommodate the required locations of service connection fittings.
 - 7. Pipe entrances to structures shall be cut flush with the inside face of the structure, and cut ends of the pipe surface within the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges or imperfections that will impede or affect the hydraulic characteristics of the sewage flow. The method of cutting and finishing shall be subject to the approval of the Engineer.
 - 8. The Contractor shall protect the installation at all times during construction. The movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's own risk.
 - 9. Drain pipes shall be laid to the required grades by use of a laser and target system, unless otherwise specifically approved by the Engineer.
 - 10. Jointing of PVC drain pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The bell end of the pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be lubricated prior to making up the joint. The position of the gasket shall be checked to ensure the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.
 - 11. PVC pipe shall be pushed home by hand or with the use of bar and block. The use of power equipment, such as a backhoe bucket, is not acceptable.
 - 12. Field-cut pipe ends shall be cut square and the pipe surface beveled to the size and shape of a factory-finished beveled end. All sharp edges shall be rounded off.

3.3 INSTALLATION OF DRAIN MANHOLES

- A. The bases shall be supported on a compacted level foundation of gravel borrow a minimum of 12 inches thick. Crushed stone may be substituted for gravel borrow if field conditions at the bottom of the excavation are wet.
1. The Contractor shall install the manholes and catch basins as soon as the pipe laying reaches the location of the structures.
 2. The Contractor shall accurately locate each manhole and catch basin and set accurate templates to conform to the required line and grade. Any manhole or catch basin which is not installed in the correct location or oriented improperly shall be removed and rebuilt in its proper location, alignment, and orientation at no additional cost to the Owner.
 3. Manhole risers and tops shall be installed using approved butyl rubber sealant or rubber gasket for sealing joints of manhole risers and tops; jointing shall be performed in accordance with the manufacturer's recommendations. Manhole risers and tops shall be installed level and plumb. Water shall not be permitted to rise over newly made joints, nor until after inspection as to their acceptability. All jointing shall be done in a manner to ensure watertight joints.
 4. Openings shall be provided in the precast concrete manhole sections to receive entering pipes and these openings shall be made at the place of manufacture. Pipe entrances at catch basins shall have plain beveled openings to accept the type of pipe specified and to be sealed with non-shrink grout. Grout mixture shall follow instructions provided by manufacturer. Pipe connections at drain manholes shall be made as indicated on the Drawings with either non-shrink grout or integral flexible rubber sleeves and Corrugated Pipe Adapters designed for use with the pipe and sleeves. For grouted joints, surface between pipe and wall shall be completely filled with non-shrink grout and troweled to provide a smooth surface conforming to both the outside and inside structure wall.
 5. Care shall be taken to ensure that the openings are made to permit setting of the entering pipe at its correct elevation as indicated or directed. Manhole risers and tops shall be installed so that the manhole steps shall be in alignment.
 6. All holes used for handling shall be thoroughly plugged with non-shrink grout.
 7. Cutting or tampering in the field, for purpose of creating new sidewall openings or altering existing openings, will not be permitted except at the discretion of the Engineer or if necessary concrete block manhole(s) shall be used.
 8. All interior manhole joints where the sealing material is not flush with the inside wall shall be grouted with non-shrink mortar and finished by hand/wet-brush.
 9. A cast-in-place concrete invert shelf and channel shall be poured and shaped to the lower half of the pipes
 10. Clean all debris, mortar, and soil from the bottom of all structures prior to final acceptance of the project.

3.4 SETTING MANHOLE FRAMES AND COVERS

- A. Manhole and catch basin frames shall be set with tops conforming accurately to the grade of the pavement or finished ground surface or as indicated on the Contract Drawings or as directed.
- B. Brick shall be used to bring the frames to the required elevation.
1. Frames shall be set centered with the opening in the top of the precast structure on two to four courses of brick in a full bed of mortar. A thick ring of mortar extending to the outer edge of brick or concrete shall be placed all around the bottom flange of the cast iron frame. The mortar shall be smoothly finished to a height of 5 inches above the flange for 8-inch frames and sloped to shed water away from the frame.

2. Completed brick installation shall be coated with mortar at least a $\frac{3}{4}$ inch thick on the outside to provide a fully sealed and watertight collar between the top manhole section and the cover frame.
 3. Only clean bricks shall be used in brick work to adjust frame elevations. The brick shall be moistened by suitable means.
- C. Manhole covers shall be left in place in the frame until completion of other work at the manholes.
- D. Where directed, the castings shall be temporarily set at such grades as to provide drainage during construction. The castings of structures located within the pavement area shall not be completely set to the established grade until the bottom course of pavement has been laid. The final setting of all other casting shall be performed at the proper stage of construction.

3.5 AREA DRAINS

- A. Install area drains per manufacturer specifications.

3.6 DRAIN COUPLINGS

- A. Couplings which are factory manufactured shall be installed at all connections from existing pipe to proposed pipe unless the existing pipe is the same material as the proposed pipe and the bell and spigot end of the pipes to be connected are compatible and free from defects. All drain couplings shall be installed in accordance with the manufacturer's recommendations for the types of pipe to be connected.

3.7 CLEANOUTS

- A. Install cleanouts and extensions from drain pipe to cleanout at grade as indicated on the Contract Drawings. Set cleanout frame and cover in concrete 18 by 18 by 6-inches deep, except where location is in bituminous or concrete paving. Set top of cleanout 1-inch above surrounding earth grade or flush with grade when installed in paving.

3.8 TAP CONNECTIONS

- A. Make connections to existing underground drainage structures, so that finished work will conform as nearly as practicable to requirements specified for new work. The contractor shall verify the location, size, invert, and type of existing pipes at all points of connection prior to make the connections.
- B. Make branch connections from side into existing piping by installing a wye or T-wyes, and couplings manufactured for use with the same type of pipe as indicated on the Contract Drawings. The Contractor shall install a 45-degree wye branch or 90-degree tee fittings in the drain pipe at all locations where storm service pipe connections are shown on the Drawings. Connections of the storm service pipes shall be made into the wye branches or tees by means of 45-degree bends. The connections shall be made thoroughly watertight and concrete shall be placed under each connection to bear on undisturbed earth and firmly support the connection.
- C. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.
- D. Connections into existing drainage facilities shall be performed in accordance with the requirements of the City of Worcester. The Contractor shall comply with all such requirements, including securing of all required permits and paying the costs thereof.

3.9 BACKFILLING

- A. General: Conduct excavation and backfill operations for structure and pipe installations in accordance with Section 312000 – EARTHWORK, local requirements, and the contract documents.
- B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.10 INSTALLATION OF IDENTIFICATION

- A. Install continuous plastic underground warning tape during back-filling of trench for underground storm drainage system piping. Locate tape two-feet below finished grade, directly over piping.

3.11 FIELD QUALITY CONTROL

- A. Testing: Perform testing of completed piping in accordance with the City of Worcester.
- B. Video Inspections: Seven days after the completion of the backfilling of each section of new pipe, as defined as a length of pipe between two manholes, the Contractor will provide a televised inspection of the pipe to be submitted to the Designer. The Owner's Representative shall be present during the recording. The recording shall be in DVD color format with audio and will show a clear picture of the inside of the new pipe. If the Designer determines that the DVD is unacceptable for review the contractor shall re-televisize the line until an acceptable DVD has been submitted. In the event that the pipe is not acceptable for any reason relating to the proper construction of the pipe according to these specifications, the Contractor will be responsible to re-excavate and repair the defects to the satisfaction of the Designer at no additional cost.
- C. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place watertight plugs in ends of uncompleted pipe at end of day or whenever work stops. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been dewatered and all danger of water entering the pipe eliminated.
 - 3. Flush piping between manholes to remove collected debris.
- D. Interior Inspection: If deemed necessary by the Owner's Representative, inspect piping to determine whether line displacement or other damage has occurred.
 - 1. Make inspections after pipe between manholes has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
 - 2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, the Contractor shall correct such defects and reinspect.
- E. Prior to acceptance of the storm drainage system, the Contractor shall submit the following to the Architect and to the local authority:
 - 1. System As-Built Plan stamped by a Professional Land Surveyor or Engineer Registered in the Commonwealth of Massachusetts.
 - 2. Video inspection DVDs and report: The report shall document the observations of the video inspections.
 - 3. Deflection test report: The report shall fully describe the test procedures and list the test results. The report shall be signed by the Contractor's superintendent.

3.12 FINAL INSPECTION

- A. Final inspection and acceptance of the storm drainage system shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system.
- B. Prior to placing the systems in service, all components shall be inspected, with the Owner's Representative present, to ensure that no debris or other contaminants are present. If necessary, the Contractor shall clean the structures and flush piping.
- C. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

End of Section

This Page Intentionally
Not Used