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SECTION 02 41 13 – SITE PREPARATION

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Protection of existing paving, fencing, light and utility poles, vegetation and utilities to remain within and adjacent to the property.
B. Removal of existing bituminous concrete paving, site vegetation, fencing, and basketball posts and goals.
C. Removal of existing concrete wall and foundations.
D. Removal of existing chain link fencing and posts.
E. Salvage existing granite monument.
F. Erection of construction fence.
G. Sawcutting pavement.
H. Disposal of all debris legally off site.
I. Erosion control.
J. Tree removal.
K. Strip existing lawn.
L. Strip and stockpile existing topsoil.
M. Installation of catch basin filters.

1.3 RELATED WORK

A. Section 31 00 00 - Earthwork

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 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, Commonwealth of Massachusetts, latest edition.

B. 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 Dept. of Environmental Protection, Bureau of Resource Protection, latest edition.

C. 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.

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.

1.9 DIG SAFE

A. Contractor is required to contact Dig Safe (1-888-344-7233) a minimum of 3 business days prior to start of construction, or as required by law.

1.10 DESCRIPTION OF EROSION CONTROL WORK

A. Control measures to prevent all erosion, siltation and sedimentation shall occur in areas of construction within limit of work, adjacent areas and off-site areas outside the limit of work.

1. Control measures shall be accomplished adjacent to or in the following work areas:
   a. Soil stockpiles and on-site storage and staging areas.
   b. At existing drainage structures.

2. The Contractor shall install all measures needed to control sediment and erosion as required by the Contractor’s construction methods and operations, the weather conditions, and as directed by the Owner’s Representative.

3. 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.

4. Periodic maintenance of all sediment control structures shall be provided to ensure intended purpose is accomplished.

5. After any significant rainfall, sediment control structures shall be inspected for integrity. Any damaged device shall be corrected immediately.

B. It shall be the responsibility of the Contractor to render the site erosion free. Approval by Owner's Representative of any method to accomplish this does not relieve the Contractor of full responsibility for controlling erosion and/or sedimentation throughout the construction process.

C. Inspect, repair, and maintain erosion and sedimentation control measures during construction.

D. At the conclusion of the site work, remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

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.

1.12 ACCESS TO JOB SITE

A. No access to the job site shall be allowed on or through the abutting private properties. Access to the job site shall be along the public rights of way.

1.13 DEFINITIONS

A. Clearing: Clearing shall consist of removing all vegetable matter such as trees, brush, downed timber and logs and other objectionable materials found on or above the surface of the site.

B. Grubbing: Grubbing shall consist of removing and disposing of all vegetable matter such as stumps, roots, and brush encountered below the surface of the ground.

PART 2 – PRODUCTS

2.1 MATERIALS

A. CONSTRUCTION FENCE: Erect a 6' high galvanized chain link construction fence along the lines shown on the Drawings with gate location to be determined in the field. Erect the fence immediately after receiving the Notice to Proceed and maintain the fence in a secure and sightly condition until instructed by the Owner's Representative to remove it or portions thereof. Second hand fencing materials meeting the requirements specified herein and in good condition may be used to provide the necessary barrier during construction on this project. Equivalent tubular sections, H-sections or roll formed sections may be substituted for pipe sections if acceptable to the Owner's Representative. Gate location shall be approved by the Owner's Representative.

2.2 EROSION CONTROL

A. FILTER BARRIER [One of the following at the Contractor's option]

1. Rectangular shaped bales of hay or straw, 1' by 1.5' by 3' minimum size, weighing at least 40 pounds per bale and free from primary noxious weeds, rough and woody materials.

2. Silt Fence: UV resistant polyester or polypropylene sedimentation control fabric with a maximum apparent opening size of 20 in accordance with ASTM D4751 and a maximum permittivity of 20 gallons per minute per square foot in accordance with ATM D4491.

Provide 36 inch fabric height with plastic mesh backing and reinforced top edge with high strength tensioning belt. Provide 48 inch minimum length 1-1/2 inch square hardwood posts. Provide all necessary cables, connectors, etc. as required for a full and complete installation and as necessary to secure in place. Subject to compliance with requirements, the following manufacturers are acceptable:

a. Atlantic Construction Fabrics, Inc., Richmond VA.
b. Contech Construction Products Inc., Middletown OH.
c. AH Harris & Sons, Inc. of Massachusetts, Medfield MA.
d. Linq Industrial Fabrics, Inc., Summerville SC.
e. Nicolon Mirafi, Norcross GA.

2.3 CATCH BASIN FILTER

A. Catch basin filters shall be manufactured from a woven polypropylene geotextile and sewn by a double needle machine, using a high strength nylon thread. Seams have a certified average wide width strength per ASTM D-4884 of 165.0 lbs./in.

B. The filters will be manufactured to fit the opening of the existing catch basin or drop inlet. The filters will have the following features: two dump straps attached at the bottom to facilitate the emptying of the filters; the filters will also have lifting loops as an integral part of the system to be used to lift the filters from the basin. The filters will have a restraint cord approximately halfway up the sack to keep the sides away from the catch basin walls. This yellow cord shall be a visual means of indicating when the sack should be emptied.

C. Catch basin filter's geotextile fabric shall have the following properties:

Property(ASTM Test Method)	**Unit**	**Typical Values**
Grab Strength (D-4632-86)	Lbs.	300
Puncture (D-4632)	Lbs.	120
Grab Elongation (D-4632-86)	%	20(max)
Trapezoid Tear Strength (D-4533-85)	Lbs.	120
Mullen Burst Strength (D-3786-80a)	Psi	800
Coeff. of Permeability (D-4491-85)	Cm/sec	0.55
Water Flow Rate (D-4491-85)	Gal/min/(ft)(ft)	40
Ultraviolet Stability (D-4355-84)	%	80

2.4 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 side 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.

PART 3 – EXECUTION

3.1 INSTALLATION OF FILTER BARRIER

A. It shall be the responsibility of the Contractor to render the site erosion free. Approval by Owner's Representative of any method to accomplish this does not relieve the Contractor of full responsibility for controlling erosion and/or sedimentation throughout the construction process.

B. Install filter barriers prior to any site clearing, removals or general earthwork and maintain in place in good functioning condition until all work is complete or as otherwise directed by the Owner's Representative. Repair as required.

C. Install filter barrier as follows:

1. Bales of hay or straw: Excavate a shallow trench and place two rows of bales laid end to end with staggered joints. Secure each bale in place with two 1" by 1" by 3 foot long wood stakes.
2. Silt fence: Install in accordance with manufacturer's directions in locations as determined with Owner's Representative.

D. Remove filter barrier completely only after receiving approval from Owner's Representative. Remove sediment deposits prior to removing filter barrier.

3.2 CATCH BASIN FILTERS

A. Install catch basin filters prior to disturbance of soils uphill from inlet.

B. Catch basin filters shall be inspected after each rain event and at a minimum every two weeks.

C. Clean debris and silt from filter on a regular basis.

3.3 CLEARING, GRUBBING AND TREE REMOVALS

A. Remove completely all trees, shrubs and stumps from areas as noted on the Drawings and as directed by the Owner's Representative.

B. Where tree removal is required, remove completely all trees, and stumps below grade and as directed by the Owner.

1. Tree stumps that are removed shall be ground out completely to a depth of 2' below proposed finish grade. 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.

3.4 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.

3.5 REMOVALS, SALVAGE AND DISPOSAL OF MATERIALS

A. Within the actual construction area, remove all existing obstructions such as chain link gates, fencing and the like. Pavements which are to be abandoned to at least one (1) foot below final finish grades and to greater depths as required by new construction.

1. Remove existing bituminous concrete and concrete paving completely, leaving existing gravel base course in place if material is determined to be appropriate for sub-base material under new site improvements.
2. The use of explosives will not be permitted.
3. 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.
4. Backfill all holes from which obstructions 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.

B. 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.

C. 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.

D. Salvage:

1. The Owner retains the first right of refusal of anything found on the site.
2. Existing memorial found on site shall be salvaged and stockpiled on site and stored in a secure protected area on a wood pallet.

3.6 SAWCUTTING

A. Sawcut all existing bituminous concrete and 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.

B. All sawed 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. Remove the portion behind the cut with proper tools, keeping noise and disturbance to a minimum.

3.7 DUST CONTROL

A. Throughout the construction period, 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 Owner's Representative with concurrence by the Owner.

3.8 REMOVAL AND FINAL CLEANUP

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

END OF SECTION

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SECTION 03 30 01 - CAST-IN-PLACE HANDBALL WALL CONCRETE

PART 1. - GENERAL

1.1 GENERAL PROVISIONS

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

1.2 SCOPE OF WORK

A. Provide all labor, materials, equipment, services, and transportation and perform all operations necessary to:

1. Design, fabricate, furnish, place, and set all concrete formwork for all plain reinforced concrete on the project including site development and utilities outside the building.

2. Furnish and place all concrete reinforcing steel and welded wire fabric.

3. Complete all concrete work as shown on Drawings, as specified herein, or both.

B. All work shall be performed to secure for the entire job homogenous concrete having required strength, durability and weathering resistance without planes of weakness, and other structural defects, and free of pronounced honeycombs, air pockets, voids, and projections, offsets of plane, and other defacements on exposed surfaces.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Anchor bolts are furnished under Section 05100 Structural Steel.

1.4 RELATED WORK IN OTHER SECTIONS

A. Section 31 00 00 – Earthwork.

B. Section 09 00 00 – Finishes

1.5 REFERENCES

A. Comply with Provisions of the following codes and standards, except as otherwise shown or specified.

1. American Concrete Institution Publications:

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

ACI 301 Specifications for Structural Concrete for Buildings

ACI 302 1R-04 Guide for Floor and Slab Construction

ACI 305R Hot Weather Concreting.

ACI 306R Cold Weather Concreting.

ACI Standard Practice for Curing Concrete

ACI 315 ACI Detailing Manual

ACI 318 Building Code Requirements for Reinforced Concrete.

ACI 347 Guide to Formwork for Concrete.

ASTM C 260 Standard Specification for Air Entraining Admixtures for Concrete.

ASTM C 494 Standard Specification for Chemical Admixtures for Concrete.

B. The Contractor shall always keep available on the site for reference the above codes and standards.

1.6 SUBMITTALS

A. Submit in accordance with Section 01300, for conformance with these Specifications and the related ACI recommendations the following items:

1. Name and Location of the Concrete Supplier and Plant.
2. Concrete Design mix.
3. Reports of Concrete Tests.
4. Manufacturer's Information on admixtures and curing agents.
5. The methods proposed for hot and cold weather curing and protection of concrete.

B. *Submit shop drawings in electronic format (Adobe Acrobat) to the Architect for approval prior to fabrication in accordance with the General Conditions. In each submittal, pages shall be bound into one file for each specification section.* Shop drawings shall include but shall not be limited to the following:

1. Bar reinforcement shop drawings shall include setting plans, wall elevations, bending diagrams, cutting lists, and other information so as to completely and unambiguously define and establish the location, spacing, size, length, bending, splicing, keying at construction joints, and all other pertinent information as required. Drawings shall show grades of reinforcing steel. Opposite hand reinforcing shall be detailed separately. Wall reinforcing shall be detailed on wall elevations.
2. Type, size and location of all accessories required for the proper assembling, placing and support of the reinforcement.
3. All openings, depressions, construction and control joints, trenches, sleeves, inserts and all other project requirements affecting reinforcing details and placing.

4. Furnish shop drawings showing the size and placement of the welded wire fabric specified for floor slabs and supported slabs on metal decking.

C. Before being submitted to the Architect, all shop drawings shall be properly checked and coordinated by the fabricator and by the Contractor and shall be stamped and signed accordingly. Drawings not complying with requirements will be returned unchecked and stamped "NOT APPROVED".

D. Preparation and submittal of shop drawings shall be arranged so as to afford ample time for checking, correcting and resubmitting as necessary until approval is obtained. No materials shall be fabricated until these drawings have been approved.

1.7 MOCK-UPS

A. Prepare sample wall edge panel 6 feet by 6 feet by 12". Include all additives and surface treatments approved for construction, Carry out all steps – forming, edge strips (on side and top), placing, vibrating, curing, damping, and protection -- to produce a sample product for approval. Use this panel for corrective patching for approval.

1.8 FIELD TESTS AND INSPECTIONS

A. The Architect will select a qualified Testing Laboratory or Materials Engineer to make inspection tests during work as specified herein and as otherwise considered necessary. The Owner will pay costs of all tests.

B. All measuring, mixing, placing, and curing shall be subject to inspection by the Testing Laboratory and approval by the Architect. However, such inspection and approval shall in no way relieve the General Contractor of his responsibility to fulfill the requirements of this Contract.

C. Contractor shall cooperate in making tests and shall be responsible for notifying designated laboratory in sufficient time to allow making of cylinders at time of pour.

D. Compression Tests shall consist of four (4) cylinders for each test made, cured, and tested by the laboratory during the progress of the job. At least one (1) test shall be made for each strength of concrete up to 60 cubic yards poured and at least one (1) test per strength for each 60 cubic yards thereafter. When pouring other concrete, at least one (1) test shall be made for each pour more than 30 cubic yards. Concrete for each set of cylinders shall be from one (1) sample representative of entire batch. If the Contractor wishes to establish the probable strength of the on-site concrete with job cured cylinders for stripping or shoring, the contractor will arrange and pay for these additional sets of cylinders.

E. Slump test, to check consistency, shall be made from samples used to mold cylinders. Slump tests shall be made for each set of cylinders. Do not place concrete having slump outside of allowable slump range.

F. Test for determination of air content shall be made for approximately every third set of test cylinders in compliance with ASTM C138.

G. Contractor shall provide a covered box large enough to contain four (4) standard sets of concrete cylinders. At temperatures below 60 degrees F., box shall be electrically heated to maintain inside temperature of 60 to 80 degrees F. Cylinder shall be covered with moist burlap until delivery to laboratory, 24 to 72 hours after molding.

H. Sampling, molding, curing, and testing of cylinders shall conform to ASTM C31 and C39. Specimens shall be cured under laboratory conditions. Architect may require additional cylinders to be cured under field conditions when unusual conditions may tend to reduce concrete strength. Contractor shall cure these cylinders at the site under job conditions which approximate the curing conditions of the representative concrete.

I. One (1) cylinder of each set shall be tested for seven-day strength and three (3) for 28-day strength, unless otherwise directed by the Architect.

J. Report of tests submitted to Architect shall include name of job, date and location of pour, design strength of concrete, mix data, slump, air content (if tested), compressive strength, age and condition of test cylinder, submitted in six copies.

K. Architect has authority to order, for any strength of concrete, increase in cement content and mix redesign for remaining work if either:

1. Average 7-day strength of any two (2) tests representing a particular design is less than 66% of specified strength; or

2. Average 28-day strength of any two (2) sets of 3 cylinders representing a particular design strength is less than 90% specified strength.

L. Average of all 28-day compression cylinder tests, as well as average of any five (5) consecutive strength tests of 3 cylinders each, representing each design strength, shall equal or exceed specified strength. No strength test of 3 cylinders each shall have average value of less than 85% of specified strength.

M. Where concrete does not comply with these requirements, Architect shall have the right to require, at Contractor's expense:

1. Test of hardened concrete cores according to ASTM C42.

2. Load test on portion of structure affected.

N. Where tests show that concrete is below specified strength, the Contractor shall remove all such concrete as directed by the Architect. Full cost of removal of low strength concrete and replacement with concrete of proper specified strength shall be borne by the Contractor, as shall all work required by such remedial action.

PART 2. - PRODUCTS

2.1 SLUMP

A. Use the stiffest mix possible that can be placed efficiently as listed in the following table.

Types of Construction	Slump	
	Maximum	Minimum
Reinforced foundation walls and footings	3	1
Beams and reinforced walls	4	1

May be adjusted according to Table 6.3.1 in ACI 211.1-91

2.2 APPROXIMATE DESIGN MIX PROPORTIONS

A. Concrete shall be proportioned based on the following tables computed on a weight basis.

28-day Compressive Strength (psi)	Air Entrained [a, b]				Use
	Cement [c] (Lb/yd)	W/C	Coarse [d] Aggregate (Lb/yd)	Fine Aggregate (Lb/yd)	
4000	663	0.48	1,701	1,291	Footings, foundation walls.
4500	693	0.44	1,701	1,261	Walls subject to freezing when wet or exposed to deicing salts

a. Adjust proportions according to Table 6.3.3 in ACI 211.0-91
b. Based on ¾ maximum aggregate and four-inch slump.
c. Cement content based on W/C ratios listed in Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass concrete (ACI 211.1-91) Reapproved 1997, Table 6.3.4(a).
d. Based on a fine aggregate fineness modulus of 2.7.

2.3 CONCRETE CONTROL

A. Concrete producer shall furnish concrete, which meets strength and quality requirements specified herein.

B. The Contractor shall retain the services of a qualified testing agency or materials engineer approved by the Architect to test aggregate and to prepare mix design for each strength of concrete specified and shall submit such mix designs and test results to the Architect for approval. The cost of all such preliminary services shall be borne by the Contractor.

C. Concrete mix design shall be carried out in accordance with Chapter 3, "Proportioning" of ACI 301, Specifications for Structural Concrete Buildings. Required reports shall be submitted to the Architect in six copies.

D. Before start of concrete operations, the testing agency shall submit to the Architect the following data:

1. Fine aggregate: Organic content, sieve analysis and fineness modulus.
2. Coarse aggregate: Sieve analysis and results of sodium sulfate soundness test.
3. Concrete strength: Mix designs for each strength, including cement brand, proportions of aggregates by weight, slump, water-cement ratio, and percentage of air.
4. Result of compressive strength tests on proposed mixes conforming to ASTM C192 and ASTM C39; (Submit 28-day test results on completion of test).

E. The material acceptance tests, trial mix data, and recommended job mixtures shall be presented to the Architect for approval as soon as possible and at least ten (10) working days prior to the proposed beginning of the concreting. Materials shall not be delivered to the site or used until the samples have been approved, and as used they shall in all respects be equal to the approved samples.

F. Proportion changes made after submission of initial mix designs shall be submitted by the testing agency to the Architect.

2.4 CEMENT

A. Cement shall be Portland cement conforming to ASTM C-150 Type I. One brand and type of cement shall be used for all structural concrete.

B. Submit to the Architect upon request, manufacturer's statement attesting to the compliance of each shipment with standard specification.

C. Handle and store cement to protect from air, ground, or other moisture, to permit ready access for inspection and to protect from contamination by foreign materials. Cement stored longest shall be used first. Caked or hardened cement shall not be used.

2.5 OTHER CEMENTITIOUS MATERIALS

A. The following cementitious materials may be substituted for Portland cement as approved by the Architect.

1. Fly ash and natural pozzolans meeting ASTM C 618.
2. Ground Granulated Blast Slag (GGBS) meeting ASTM C 989.
3. Silica fume conforming to ASTM C 1240.

2.6 AGGREGATE

A. Fine Aggregate: Shall be natural sand consisting of clean, hard, durable, uncoated particles, conforming to ASTM C33. Organic content shall be determined according to ASTM C40, and supernatant liquid above test sample shall show color no darker than referenced standard color solution prepared at the same time.

1. Allow no frozen or partially frozen aggregate in the mix.

2. Aggregate Protection: Protect aggregates from foreign materials, and store each separately until placed in mixer.

B. Coarse Aggregate: Shall be crushed stone or gravel from approved source conforming to ASTM C33. Lightweight aggregate shall conform to ASTM C330. Coarse aggregate shall not contain greater amounts of deleterious materials than specified in ASTM C33 Table III.

1. Grading requirements shall be as given in ASTM C33, Table II. Nominal sizes of coarse aggregate shall range from No. 4 minimum size as follows:

Location	**Maximum Size**
• Wearing Courses	5/8"
• Heavily Reinforced Sections such as slabs, beams, girders, columns, and walls	3/4"
• Lightly Reinforced Sections such as footings	1"
• Stair and Floor Fill	3/8"

2. Coarse aggregate shall be subjected to sodium sulfate soundness test according to ASTM C88.

3. Aggregate Protection: Protect aggregates from foreign materials, and store each separately until placed in mixer.

2.7 WATER

A. Water: Shall be from approved source, potable, clean and free from oils, salt, alkali, organic matter, and other deleterious materials.

2.8 ADMIXTURES

A. Water-reducing, air-entraining agents, corrosion inhibitors, and shrinkage reducers used in concrete, shall be used in strict accordance with the manufacturer's printed instructions. Agents shall be stored safe from adverse temperature in accordance with manufacturer's printed

instructions. Admixtures shall be from a single manufacturer. The following are acceptable admixtures. Approved equals are acceptable:

Manufacturer	**WR Grace Company**	**BASF Master Builders**	**SIKA**
Water-Reducing Agent meeting ASTM C494 Type A 3-6 oz/100 lb cement	WRDA 64	POZZOLITH 200 N	Plastiment NS
Air-Entraining Agent meeting ASTM C260 Total air entrained 5.0%	Darex AEA	MB-AE 90	SIKA AEA-14
Corrosion Inhibitor , Calcium nitrate meeting ASTM C 494 4 gal/yd	DCI S	Rheocrete CNI	SIKA CNI
Shrinkage Reducer 1 gal/yd	Eclipse	Tetraguard AS20	SIKA Control 40

B. No other admixtures may be used without Architect's approval. Admixtures containing calcium chloride are not permitted.

2.9 SURFACE CONDITIONERS

A. Surface conditioners shall be used in strict accordance with the manufacturer's printed instructions. Agents shall be stored safe from adverse temperature in accordance with manufacturer's printed instructions. The following are acceptable conditioners. Approved equals are acceptable:

Manufacturer	**Dayton Superior**	**Euclid Chemical Company**	**L&M Construction Chemicals**
Bonding agent	Strong Bond	Rheocrete CNI	Everbond

2.10 OTHER MATERIALS

A. Filler Strips for Expansion Joints: Where used with caulking or sealants shall be cork type, non-extruding, bituminous type in accordance with ASTM D1751.

B. Filler strips for exterior expansion joints: Closed-cell polyethylene having a density of two pounds per cubic foot, temperature resistance of -65 to 170 ° Fahrenheit, and compressive strength of 4 psi for 25% deflection/10.5 psi for 50% deflection and a tensile strength of 60.5 psi for machine direction/30 psi for cross direction meeting ASTM D 3575.

C. Sleeves: Sleeves through structural concrete beams, ribs, and columns shall be steel pipe conforming to ASTM A120. Sleeves through slabs and topping may be sheet metal or plastic.

2.11 FORM MATERIALS

A. Concrete surfaces exposed to view in final construction shall be formed with new High-Density Overlay (HDO) Grade A Douglas Fir Plywood not less than 5/8" thick free of gouges and defects.

B. Form ties for use at exposed walls shall have 1-1/2" outside diameter wood or plastic cones 1-1/2" deep. The cone voids shall be filled in the finish work and the location of coned ties shall be subject to the approval of the Architect.

C. Forms shall be coated before initial pour and between subsequent pours in accordance with manufacturer's printed instructions, with form release agent approved by the Architect. Form coatings used shall not impart any stain to concrete nor interfere with the adhesion of any finish material to any concrete surfaces.

2.12 REINFORCEMENT MATERIALS

A. Bar Reinforcement: ASTM A615, Grade 60.

B. Reinforcement Accessories: Include all spacers, chairs, ties, slab bolsters, clips, chair bars and other devices for properly assembling, placing, spacing, supporting, and fastening the reinforcement. Tie wire shall be annealed wire not less that No. 18 gauge. All accessories touching interior formed surfaces exposed to view or exterior surfaces exposed to earth or weather shall be stainless steel. Individual and continuous slab bolsters and chairs shall be of a type to suit the various conditions encountered and must be capable of supporting a 300-pound concentrated load without measurable permanent deformation of the reinforcement or supports or indentation of the supporting surfaces. Precast concrete bricks, of a type approved by the Architect shall support reinforcement for structural slabs on grade. Wood blocks, stones, brick chips, etc., will not be permitted.

2.13 REINFORCEMENT FABRICATION

A. Reinforcement shall be accurately formed to dimensions on the approved shop drawings, details, and schedules.

1. Fabrication shall not commence until shop drawings, details and schedules have been approved by the Architect.

2. Reinforcement shall be bent cold and shall not be heated for any purpose except as specifically approved by the Architect.

3. Bars reduced in section will not be accepted.

4. Bars with kinks or bends not shown on the drawings will be rejected. Bars shall not be formed in a manner injurious to the bars.

5. Bars may be moved laterally as necessary to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances; the resulting arrangement of bars shall be subject to approval.

PART 3. - EXECUTION

3.1 MIXING OF CONCRETE

A. Cast-in-place concrete shall be ready-mixed and delivered in conformance with requirements of ASTM C94.

B. Mixing and conveying equipment shall be thoroughly cleaned and free from hardened concrete and foreign materials before concrete operation is started. Liquid admixtures shall be dispensed by automatic metered devices with at least 5 percent accuracy.

C. Mixer shall produce thoroughly mixed uniform mass, and discharge mixture without segregation. Entire batch shall be discharged before mixer is recharged. Maximum time from inclusion of water in the mix to placing of the concrete shall be placed within 90 minutes and concrete within 60 minutes after arriving at the site.

D. Partially hardened concrete shall not be retempered or used.

E. Concrete placed in air temperature below 40 degrees F., shall have batch temperature of 60 degrees F. Temperature of individual materials, including mixing water, shall not exceed 140 degrees F.

3.2 PLACING CONCRETE

A. Notify Architect 24 hours before each pour, so that forms and reinforcing may be examined. Do not place concrete until inspection has been made or waived.

B. Before concrete is placed, check forms for construction and detail. Secure reinforcement, sleeves and inserts in correct position. Forms shall be free of water and all debris and shall be coated as specified.

C. Deposit concrete continuously and rapidly to prevent segregation and loss of ingredients. Concrete shall be placed within five (3) feet vertically and five (5) feet horizontally of its final position in form. Avoid rehandling. Deposit concrete in a manner that will prevent segregation of concrete materials and the spattering or accumulation of concrete on forms or reinforcement above the surface of the concrete. Maintain a plastic and

approximately horizontal surface on the concrete as the pour progresses to avoid vertical or inclined pour lines. Place concrete in accordance with ACI 306R (Cold Weather Concreting) and ACI 305R (Hot Weather Concreting), when applicable. Wall pours shall have a maximum drop of 4'-0" unless deposited with a tremie or by other suitable method.

D. Vibrate concrete during depositing with internal type-high frequency mechanical vibrator having a speed of not less than 7000 rpm. Do not use vibrators to move concrete. Supplement all vibration by wood spading between reinforcing and forms into corners. Air or water pockets, laitance, sand streaking and honeycombing are not acceptable.

E. Do not, under any circumstances, place hardened concrete in forms. Concrete shall have quality required when in final position regardless of handling methods employed.

F. Pumping: Should the Contractor elect to use a pumping process to convey concrete, the established field mixture in each case shall not be altered by more than the following.

Cement:	+20 lbs./Cu. yd.
Fine Aggregate:	+50 lbs./Cu. yd.
Coarse Aggregate:	-50 lbs./Cu. yd.

G. Before placing fresh concrete on or against hardened concrete, tighten forms and clean hardened concrete surface of laitance and loose materials, roughen by chipping and saturate with water. Then coat roughened surface with thin layer of neat cement paste. Place the fresh concrete before the paste has attained its initial set.

H. Hard steel trowel tops of parapets, overhangs, canopies, etc. to provide maximum protection from weathering.

3.3 CURING AND PROTECTION

A. Protect all concrete work against injury and defacement during construction operations.

B. Commencing with the first frost of each year, cold weather curing and protection techniques must be employed in accordance with ACI 306R Cold Weather Concreting." All temporary heating, insulation and other required items shall be supplied without additional cost to the Owner. Use of calcium chloride or other admixes except as noted above is prohibited.

C. When heat of any kind is used it shall be gradually reduced, after the required heating period, at the rate of not more than two (2) degrees F., per hour before discontinuing.

D. During periods of hot weather, curing and protection shall be as described in ACI 305R Hot Weather Concreting", at no additional cost to the Owner.

E. All concrete and particularly exposed surfaces, shall be treated immediately after concreting or cement finishing is completed to provide continuous moist curing above 50 degrees F., for at least seven (7) days regardless of ambient air temperatures and, in the case of exposed slabs, for at least fourteen (14) days.

F. Walls and vertical surfaces may be cured by maintaining wood forms continuously wet during curing period, or by wrapping with continuous 6 mil polyethylene with taped joints as approved by the Architect.

3.4 FINISHING OF CONCRETE SURFACES

A. It is the intent of this Specification to require forms, mixture or concrete and workmanship so that concrete surfaces, when exposed, will require no patching or repairs. Concrete exhibiting defects on surfaces exposed to public view shall be removed and replaced or repaired in accordance with a method that achieves a surface, which is acceptable to the Architect. All such removal or repairs shall be at the Contractor's expense.

B. At formed surfaces exposed to view, chip off fins and other projections and trowel patch all voids, honeycombs and air pockets. Pull tie-rods and patch voids formed by tie-rod cones flush with adjacent surfaces. At outside faces of foundation walls, except for surfaces to receive waterproofing membranes, trowel patch all voids, honeycombs and air pockets. At other concealed surfaces, patching if any, shall be as directed by the Architect and shall in general be only such as is required to assure or protect the structural integrity of concrete or reinforcing.

C. In all cases, concrete surfaces shall be sound and dense. Pull tie-rods to full depth of cones or, at concealed work where other types are allowed, to a point 1-1/2" from exterior surfaces and 1" from interior surfaces. Where patching of voids and honeycombs is required, it shall be done as soon as possible after removal of forms, and in accordance with the following instructions:

1. Patching mortar shall be same materials as concrete except for omission of coarse aggregate and the addition of small quantities of white Portland cement as required to match color of adjacent surfaces. Proportions of Portland cement to sand shall be approximately one to two, as required to make a dense, workable mix. use as little mixing water as consistent with requirements of handling and placing. Mix mortar at least one (1) hour before it is to be used and remix occasionally during hour without additional water to prevent setting.

2. Where trowel patching is permitted, cut out void for removal of obviously soft or porous material. Wet area and apply grout. Apply mortar with trowel and finish smooth and level with adjacent surfaces in same operations.

3.5 FORMWORK

A. Design of formwork shall comply with ACI 347, and wind loads as specified by the State Building Code.

B. Formwork shall be constructed plumb, true, water and mortar tight; sufficiently rigid and strong to prevent sagging between supports and to maintain true position and shape during and after placing concrete, without waves or bulges. Wall forms to have High Density Overlay (HDO) to achieve smooth, flat, and defect free surfaces. Take exceptional care at HDO overlaid plywood forms at exposed concrete to minimize fins, ridges, off-sets, leaking of fins and other defects as it is intended that the forming of these surfaces shall be such as to require only a nominal amount of finishing to achieve a true, even surface. Use tape at joints where required to achieve tightness. Plywood HDO for forms shall be in as large size as possible. Joints shall occur at reglets, edges and intersections as far as possible.

C. Only workmen experienced in formwork construction shall be used for this work.

D. Temporary openings shall be provided at the base of wall forms and at other points where necessary to facilitate cleaning and observations immediately before concrete is deposited.

E. Use side forms at footings not cast directly against existing foundations.

F. Form reglet joints in concrete where indicated, using varnished wood battens on forms, milled to indicated profiles. Install chamfer strips in form corners where indicated. Battens and co-strips shall be carefully inspected before concrete is placed and damaged pieces replaced.

G. Install anchor bolts, plates, sleeves, frames, reglets, and inserts for attachment of other work. Coordinate with requirements of mechanical work and other trades for proper lines locations and spacing. Install dovetail anchor slots at locations and spacing indicated on Drawings and as specified.

H. Cooperate and coordinate work with other trades as necessary to assure proper placement and location of all sleeves, inserts, reinforcing steel, duct openings, chases, conduits, etc., and give ample notification to all responsible for such items prior to time installation is required.

I. All forms shall be thoroughly cleaned before reuse. Replace portions of plywood forms which become damaged or otherwise present an unacceptable surface.

J. An experienced workman shall be employed during concrete placing to inspect formwork and supports.

K. Notify Architect 24 hours before placing footing forms for examination of bearing materials.

L. Construct forms for sample panels as indicated or directed by the Architect using all materials and techniques as they will be used in actual construction.

M. Wall Tolerances: Meet ACI 117-10 standards for wall construction tolerances for visible surfaces which are the lesser of the following:

1.	Deviation from plumb	±1 1/4"
2.	Horizontal deviation	±1 1/4"
3.	Vertical deviation	±1/2"
4.	Cross section dimension	±1"
5.	Deviation from vertical plane	±2%
6.	Deviation from horizontal plane	±4%

7. Prior to concrete placement, survey the wall for plumbness, straightness, and flatness attempting to be entirely plumb, straight, and flat. Record start and end points and every ten feet in-between. Provide a written report to architect for approval.

8. Following removal of forms, backfilling, and paving, resurvey wall to check it meets wall tolerances.

3.6 FORM REMOVAL

A. Contractor shall be solely responsible for safety of construction during and after form removal, and no act of Architect shall relieve him of this responsibility.

B. Formwork for walls, sides of beams and slabs, and other parts not supporting the weight of the concrete may be removed a soon as the concrete has hardened sufficiently to resist damage from removal operations.

C. Formwork for beam soffits, slabs and other parts that support the weight of concrete, shall remain in place until the concrete has reached its specified 28-day strength, except that after the concrete has reached its 7-day strength, the form facing material may be removed in sections so that no span exceeds one-quarter (1/4) of the final design span. Each section thus removed shall be securely reshored before the removal of adjacent sections. Reshoring shall remain in place until the concrete has reached its specified 28-day strength.

D. In no case shall supporting forms or shoring be removed until members have acquired sufficient strength to safely support their weight and the load thereon. Until full 28-day strength has been achieved, all concrete shall be protected from shock vibration, and heavy loads. Particular attention shall be given to assure self-supporting members, whether at 28-day strength or not, are not over-stressed.

E. Exercise care in form removal to prevent chipping of corners or other damage to concrete. Competent and experienced foremen shall supervise for removal, and at no time shall more men be engaged in this work than can be properly supervised.

F. Protect corners of columns and other columns from damage after form removal by boxing, corner boards or other approved means.

3.7 PLACING

A. All reinforcing bars shall be supported and wired together to prevent displacement by construction loads or the placing of concrete beyond the tolerances as noted above. On ground supporting concrete blocks may be used. Over formwork, concrete, metal, plastic or other approved bar chairs and spacers shall be furnished. Where the concrete surface will be exposed to the weather in the finished structure or where rust would impair architectural finishes, the portions of all accessories in contact with the formwork shall be stainless steel.

B. Before being placed in position, reinforcement shall be thoroughly cleaned of loose mill scale, rust, dirt, ice, and other coatings that may reduce or destroy bond. Where there is delay in depositing concrete after reinforcement in place, bars shall be reinspected and cleaned as necessary.

C. Welded wire fabric shall have lapped end and side splices so made that the overlap measured between outermost cross wires of each fabric sheet is not less than 2 full squares. It shall be supported as required for reinforcing bars.

D. Vertical bars in piers shall be offset at least one bar diameter at lapped splices. To ensure proper placement, templates shall be furnished for all column and pier dowels.

E. All splices not shown on the project drawings or approved shop drawings shall be approved prior to concrete placement.

F. Concrete cover to reinforcement shall be in accordance with ACI 318 unless otherwise indicated on the drawings.

G. Reinforcement shall not be bent after being partially embedded in hardened concrete unless otherwise noted.

3.8 CONSTRUCTION JOINTS

A. Joints not shown on the drawings shall be so made and located as to least impair the strength of the structure and shall be approved by the Architect. Joints in walls and piers shall be at the underside of floors or slabs and at the top of footings or floor slabs. Beams, girders, brackets, column capitals, haunches and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

B. All reinforcing steel and welded wire fabric shall be continued across joints. Keys and inclined dowels shall be provided as directed by the

Architect. Longitudinal keys at least 1-1/2" deep shall be provided in all joints in walls and between walls and slabs or footings.

C. The surface of the concrete at all construction joints shall be thoroughly cleaned and all laitance removed.

D. Bond shall be obtained by one of the following methods:

E. The use of an approved adhesive.

F. The use of an approved chemical retardant which delays but does not prevent setting of the surface mortar. Retarded mortar shall be removed within 24 hours after placing to produce a clean exposed aggregate bonding surface.

G. By roughening the surface of the concrete in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface. Brush coat the concrete surface with a cement slurry immediately prior to concreting.

END OF SECTION 03300

SECTION 03 30 10 – SITE CONCRETE

PART 1 – GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

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 new concrete walk pavement and pads.
2. Furnishing, placing, curing and finishing of all new footings for site improvements except handball court wall.
3. Erection and removal of form work except handball court wall.
4. Pouring and curing of concrete except handball court wall.

1.3 RELATED WORK

A. The following items of related work are specified and included in other Sections of the Specifications:

1. Section 03 30 01 - Cast in Place Handball Wall Concrete
2. Section 31 00 00 - Earthwork
3. Section 32 10 00 - Paving and Curbing
4. Section 32 12 16 - Bituminous Concrete Paving
5. Section 32 30 00 - Site Improvements

1.4 RELATED WORK NOT FURNISHED UNDER THIS SECTION

A. Section 03 30 01 - Handball Wall Concrete

1.5 REFERENCES

A. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.
B. City of Worcester Department of Public Works and Parks, ‘Special Conditions and Specifications’, latest edition.
C. AASHTO: American Association of State Highway and Transportation Officials.
D. ACI 306: Recommended Practice for Cold Weather Concreting.
E. ACI 315: Manual of Standard Practice for Detailing Concrete Structures.
F. ACI 347: Recommended Practice for Concrete Formwork.
G. ACI 604: Recommended Practice for Winter Concreting.
H. ACI 605: Recommended Practice for Hot Weather Concreting.
I. ACI 614: Recommended Practice for Measuring, Mixing and Placing Concrete.
J. ASTM C94: Standard Specification for Ready Mixed Concrete, American Society for Testing and Materials.
K. ASTM C143: Standard Method of Test for Slump of Portland Cement Concrete.
L. Federal Specifications (Fed. Spec.): SS-S-1401C Sealing Compound, Hot Applied, for Concrete and Asphalt Pavements.

1.6 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
1. Massachusetts State Building Code, Latest Edition.
2. ACI 117-90 "Standard Specifications for Tolerances for Concrete Construction and Materials".
3. ACI 214 "Recommended Practice for Evaluation of Strength Test Results of Conc."
4. ACI 311 "Guide for Concrete Inspections".
5. ACI 211.1-91 "Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete".
6. ACI 211.2 "Guide for Selecting Proportions for No Slump Concrete".
7. ACI 304 "Guide for Measuring, Mixing, Transporting and Placing Concrete".
8. ACI 302 1R-96 "Guide for Concrete Floor and Slab Construction".
9. ACI 305 R-99 Hot Weather Concreting.
10. ACI 306 R-97 Cold Weather Concreting.
11. ACI 308-97 Standard Practice for Curing Concrete.
12. ACI 347 R-99 "Guide to Formwork of Concrete".
13. ACI 309 "Guide for Consolidation of Concrete".
14. The ACI Field Reference Manual, SP-15 shall be kept at the job site, and the practices set forth therein shall be strictly adhered to.
15. ASTM C 494 Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C 309 Liquid Membrane-Forming Compounds.

B. Concrete Testing Service: Owner will engage a testing laboratory acceptable to Owner's Representative to perform material evaluation tests and to design concrete mixes.

C. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

D. HANDICAP ACCESSIBLITY: 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, with amendments effective Jan. 1, 2009.

1.7 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 furnishings, equipment, and 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/authorities having jurisdiction. 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.

1.8 QUALITY ASSURANCE

A. Comply with all laws, rules and regulations of governmental authorities having jurisdiction over concrete work. Design all concrete work in accordance with the applicable specifications and standards specified herein.

1. Contractor will be required to provide information demonstrating successful use in prior placement involving all admixtures.

1.9 SUBMITTALS

A. PRODUCT DATA: Submit data for proprietary materials and items, including forming accessories, admixtures, joint systems, curing compounds, and others as requested by Owner’s Representative. Contractor to pay all cost for testing.

B. Test reports on placed concrete:

1. Slump tests.
2. 7, 14 and 20 day compression tests.
3. Field tests as specified herein.

C. Manufacturer's certificates and data on any items requested by Owner’s Representative.

D. Laboratory Test Reports: Submit test reports for concrete design mix including report on design strength test and slump test.

1.10 TESTING LABORATORY SERVICE

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.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Forms for Finish Concrete: Unless otherwise indicated, construct forms of plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient strength and thickness to withstand pressure of newly placed concrete without bow or deflection and to retain horizontal and vertical alignment until removal.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better mill oiled and edge-sealed, with each piece bearing legible inspection trademark.
2. Use flexible spring steel forms or laminated boards to form radius bends as required.

B. Form Coatings: Provide VOC compliant commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

C. Form Oil: Nonstaining type specifically manufactured for concrete forms.

D. Form Ties: Form ties and spreaders: prefabricated assemblies by Richmond; Superior, Dayton or approved equal. Wire ties SHALL NOT BE USED.

2.2 CONCRETE MATERIALS

A. CONCRETE FOR FOOTINGS AND FOUNDATIONS

1. Portland Cement: ASTM C 150, Type I, for exposed work and Type I or II for concealed work. Use one brand of cement throughout project, unless otherwise acceptable to Owner's Representative.

B. CONCRETE PAVING

1. Cement concrete shall be of an air entrained type conforming to the current specifications of Section M4 of the Massachusetts Standard Specifications for Highways and Bridges. Cement concrete shall have a 28-day compressive strength of 4,000 PSI using 3/4 inch aggregate, and with an entrained air content of 7.0 $\pm$ 1.0%.

   a. ADD MIXTURES: Ordinary or emulsified carbon black - 2 pounds per cubic yard, unless otherwise directed by the Owner's Representative.
   b. Upon delivery of each and every concrete mix, the Owner's Representative shall be furnished with a slip clearly stating the design mix and the quantities of the above mentioned add mixture, and any other add mixtures present in the mix. Any concrete mix, which when tested on the job site is found to contain quantities of entrained air less than six (6) or more than eight (8) per cent or which yields a slump of less than three (3) inches or greater than five (5) inches shall be rejected, the decision of the Owner's Representative shall be final. The Owner's Representative reserves the right to change the above mix in order to meet the required strength test.
   c. All concrete shall be transit mix and shall conform to the current specifications of A.S.T.M. C-94. Hand mix concrete or machine mixed on the job concrete shall be used only when permitted by the City Owner's Representative in writing.

C. Water: conforming to Section M4.02.04 of MassDOT.

D. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. "Air-Mix or AEA 92", by Euclid Chemical Co.
   b. "MB-VR or MB-AE", by Master Builders.
   c. "Sika Aer", by Sika Corporation.
   d. "Darex II AEA" or "Daravair", by W. R. Grace.

E. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.05 percent chloride ions.

2. Products: Subject to compliance with requirements, provide one of the following:
   a. "Eucon WR-75, WR-89 or MR", by Euclid Chemical Co.
   b. "Pozzolith 322N", by Master Builders.
   c. "Plastocrete 161", by Sika Corporation.
   d. "WRDA with Hycol", by W. R. Grace.

F. Color Admixture in Concrete Walks: Ordinary or emulsified carbon black at a ratio of 8:1, unless otherwise directed by the Owner's Representative.

1. Upon delivery of each and every concrete mix, the Engineer shall be furnished with a slip clearly stating the design mix and the quantities of the above mentioned add mixture, and any other add mixtures present in the mix.

G. Prohibited Admixtures: Calcium chloride, thyocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

H. Certification: Written conformance to the above-mentioned requirements and the chloride ion content of admixtures will be required from the admixture manufacturer prior to mix design review by the Engineer.

2.3 METAL REINFORCEMENT

A. Welded Wire Mesh: conforming to Sections M8.00.0, M8.01.0 and M8.01.2 of MassDOT except as herein modified. Furnish welded wire mesh in flat sheets, not rolls.

1. Reinforcing and accessories shall be free of excessive rust, scale or other coatings that will reduce bond.

B. Joint Dowel Bars: AISI Type 304 stainless steel plain round bars. Saw cut bars as required, free from burrs or out of round ends. Coat bars in accordance with AASHTO M254.

C. Dowel Caps: plastic having a closed end with a stop to hold the end of the sleeve at a minimum distance of 1 inch from the end of the dowel bar.

D. Wire Ties: 18 gauge stainless steel or galvanized annealed wire conforming to ASTM A82.

E. Bar supports, metal accessories and other devices necessary for proper assembly of concrete reinforcing shall be of standard factory-made wire bar supports conforming to Product Standard PS7-766, National Bureau of Standards, Department of Commerce, Class C. Accessories touching concrete surfaces shall have 1/4 inch of high density polyethylene tips between metal and concrete surface extending not less than 1/2 inch up on metal legs.

2.4 CONCRETE PROPORTIONING, MIXING, STRENGTH AND QUALITY

A. Concrete shall conform to ASTM C94. The design strength of concrete shall be as follows:

1. 4,000 psi minimum at 28 days for above grade use.
2. 4,000 psi minimum at 28 days for below grade use.

B. All concrete exposed to weather shall be air entrained with a total air content of 5 to 8%.

C. Use no more water in the mixture than is necessary to produce concrete that is workable and plastic within the limits specified herein for slump. Use the least amount of water and proportion of mortar to coarse aggregate that will produce uniformly dense concrete, free from aggregate pockets or honeycomb. Make corrections for the amount of moisture contained in the aggregates. Make allowances for absorption of moisture by the aggregates during the period of mixing and handling. Maintain a continuous uniform consistency.

D. In all cases, provide concrete of such consistency and mix composition that it can be worked readily into the corners and angles of forms and around reinforcement, concrete inserts and castings without permitting the materials to segregate or free water to collect on the surface.

E. The consistency of the concrete at time of deposit as measured by ASTM C143 shall be as follows:

PORTION OF WORK	SLUMP RECOMMENDED	SLUMP MAXIMUM RANGE
Base slabs on ground	2-1/2 inches	2-3 inches
Footings	3 inches	2-4 inches

2.5 CONCRETE MIXING

A. Concrete shall be Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

B. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

C. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce maximum mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce maximum mixing and delivery time to 60 minutes.

D. Cold weather mixing procedures shall be submitted to the Owner’s Representative for approval.

E. No water shall be added after mixing to concrete containing HRWR (Superplasticizer). If loss of slump occurs, the concrete treated with HRWR may be re-dosed as long as a "flash set" has not occurred. Re-dosage procedures must be discussed and approved by the Engineer and the manufacturer.

2.6 MISCELLANEOUS MATERIALS

A. Non-Shrink, Non-Metallic Grout: The non-shrink grout shall be a factory pre-mixed grout and shall conform to ASTM C1107. It shall be selected from one of the following:

1. "Euco-NS", by Euclid Chemical Co.
2. "Five Star Grout", by Five Star Products, Fairfield CT.
3. "Masterflow 713" by Master Builders.
4. or approved equal.

B. Moisture-Retaining Blanket for concrete curing complying with ASTM C 171:

1. ‘Hydra-Cure S-16’ as distributed by A. H. Harris, Dorchester MA, tel: 617-269-4800, or approved equal.
2. Polyethylene sheeting

3. Burlap

C. Non-Shrink, Non-Metallic Grout: Sikaflex 110 joint sealant.

D. Fine Aggregate: conforming to Section M4.02.02 of MassDOT.

E. Coarse Aggregate: conforming to Section M4.02.03 of MassDOT except that 3/4 inch shall be the maximum aggregate size.

F. JOINT FILLER AND SEALANT: Expansion Joint Filler for sealed joints shall be a non-extruding and resilient non-bituminous type conforming to AASHTO-M135.

1. Joint filler shall be delivered in lengths that equal the total width of the concrete walk pavement.
2. Joint sealant shall be equal to a flexible silicone sealant, equal to one of the following: 'Concrete Elite' by Silicone Depot; or, 'Watertight Filler and Sealant' by DAP Concrete; or, 'Roadsaver Silicone Sealant' by Crafco Inc.; or approved equal.

PART 3 – EXECUTION

3.1 GENERAL

A. Install concrete conforming to requirements of Section 476 of MassDOT except as herein modified.

3.2 SUBGRADE AND BASE COURSE PREPARATION

A. Excavation and subgrade preparation, including placement of base course, shall be in accordance with Section 31 00 00 EARTHWORK of these Specifications. Do not build up subgrade after forms are in place.

1. Any area that is inaccessible to mobile mechanical equipment or in restricted areas shall be compacted with pneumatic rammers or powered hand tampers.

B. Make any corrections necessary to gravel borrow furnished and installed under Section 31 00 00 - Earthwork, to the sections and elevations as shown on the Drawings.

3.3 FORM CONSTRUCTION – WALK PAVING

A. All concrete walks shall be constructed with the use of side forms. The forms shall be clean, smooth and free from warp. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so that concrete members and structures are of the correct size, shapes, alignment, elevation and position. Maintain formwork construction tolerances complying with ACI 347. Provide Class C tolerances for other concrete surfaces.

1. Design formwork to be readily removable without impact, shocks or damage to cast-in-place concrete surfaces and adjacent materials.

3.4 FORM CONSTRUCTION – FOUNDATIONS

A. Set forms to required lines, grades and dimensions shown, plumb and straight, rigidly braced and secured. Install sufficient quantity of forms to allow continuous progress of work, and so

that forms can remain in place at least 72 hours after concrete placement. Use smooth forms, free from warp. Check completed formwork for grade and alignment to the following tolerances:

1. Top of forms: Not more than 1/8 inch in 10 feet.
2. Vertical face on longitudinal axis: Not more than 1/4 inch in 10 feet.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only.

C. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

D. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed. Retightening forms and bracing after concrete placement is required to eliminate mortar leaks and maintain proper alignment.

3.5 PLACING REINFORCEMENT AND COORDINATION WITH OTHER TRADES

A. Locate, place and support reinforcement accurately as shown on the Drawings. Provide 18 gauge wire ties at the intersection of all reinforcement. Lap all mesh reinforcement 6 inches. Place reinforcing and accessories in accordance with CRSI Standards 63 and 68.

B. Coordinate the installation of all anchor bolts, inserts and imbedded items required by other trades prior to pouring concrete. Do not cut or displace any reinforcement.

3.6 CONCRETE PLACEMENT

A. Ready-mix concrete shall comply with the requirements of ASTM C94 and ACI 304. All plant and transporting equipment shall comply with the concrete plant standards and truck mixer and agitator standards of the National Ready Mix Concrete Association.

B. Notify Owner’s Representative and testing organization at least 36 hours (1 1/2 regular working days) before each pour so that forms and reinforcing may be examined. Do not place concrete until inspection has been made or waived.

C. Pre-placement Inspection: Before placing concrete, inspect and complete formwork installation, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.

D. General: Comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

E. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 18" and in a manner to avoid inclined construction joints. Where placement consists of several

layers, place each layer while preceding layer is still plastic to avoid cold joints. Use internal vibrators penetrating both the top and preceding layers.

F. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309 "Recommended Practice for Consolidation of Concrete". Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6" into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set.

G. Place concrete sidewalks in alternate sections of 30 foot maximum length. Separate sidewalk slabs with traverse preformed expansion joint fillers. Provide joint filler and dowels for expansion joints as indicated on the Drawings. Extend joint fillers full width and depth of joint and 1/2 inch below the finished surface. Furnish joint filler in one piece lengths for the full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together. Protect top edge of the joint filler during concrete placement with plastic joint cap. Remove protection after both sides of joint are placed.

1. Construct cement concrete walk paving in accordance with the MassDOT Standard Specifications Section 451. No spray or curing compounds shall be used.

2. The end of every pour shall end at joints. Fresh concrete will not be allowed to be placed against previously laid concrete which has attained its initial set, excepting at full vertical joints.

H. Construct expansion and contraction joints at the locations as indicated on the Drawings. Score the surface uniformly into block units of areas not more than 36 square feet unless otherwise indicated on the Drawings.

1. Expansion joints shall be placed as indicated on the Drawings. Follow the manufacturer's application recommendations for joint filler. Expansion joints shall be a maximum of 1/2 inch wide. Joints shall be sealed with joint sealant according to manufacturer’s recommendations.
2. Score joints in concrete walks will be sawn. Form contraction joints with poser saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks. Cut within 24 hours. The depth of scoring shall be at least 1/4 of the thickness of the paving.

I. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Use only a non-corrosive, non-chloride accelerator. Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are NOT permitted.

J. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.

2. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing condition.

3.7 CONCRETE – COMPRESSIVE STRENGTH

A. Concrete shall develop the minimum compressive strength at 28 days when sampled and tested in accordance with ASTM C31 and C39 with the maximum slump in accordance with the approved mix design.

3.8 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Protect and cure finished concrete using moist curing methods for initial curing whenever possible in accordance with ACI 301. Protect from drying out by covering with concrete curing blankets, polyethylene sheeting, or wet burlap.

C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Perform curing as soon as possible after concrete placement and in any event within 12 hours. Keep concrete continuously moist for a period of 7 days and maintain at a temperature of at least 50 degrees.

D. Do not use commercial type curing agents which might discolor or otherwise damage the surface.

E. Allow concrete to cure for a minimum of 14 days before the erection of load bearing units on anchor bolts, plates, etc.

F. Curing Method: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

1. Provide moisture-cover curing as follows:
   a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.9 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28-days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

3.10 CONCRETE FINISHING

A. It is the intent of this Specification to require forms, mixture of concrete and workmanship so that concrete surfaces, when exposed, will require no patching. Remove any concrete which is not formed as shown the Drawings or for any reason is out of alignment or level, or shows a defective surface, unless Owner's Representative grants permission to repair the defective area. Permission to patch any such area shall not be considered a waiver of Owner's Representative's right to require a complete removal of defective work if the repair does not, in his opinion, satisfactorily restore the quality and appearance of the surface. The Owner's Representative shall be the sole judge of appearance as such relates to artistic effect.

B. Do not dust the concrete surface with dry cement or sand during finishing except as herein specified. Any excess "puddling" shall be cause to reject the total section of concrete. Perform no finish operation while free water is present. Delay jointing and edging operations until all bled water and water sheen has left the surface.

C. After striking off and consolidating concrete, smooth the surface by screeding and floating with an aluminum or magnesium float. Adjust the floating to compact the surface and produce a uniform texture.

D. After floating, test the surface for trueness with a 10 foot straightedge. Distribute the concrete as required to remove surface irregularities, and refloat all repaired areas to provide a continuous smooth finish. Work edges of slabs and joints with a 1/8 inch radius edging tool. After edging and jointing operations, refloat the surface. After completion of floating, and when excess moisture and surface sheen have disappeared, complete surface finishing as follows:

1. Light Broom Finish: Immediately following floating, steel trowel the surface. Use a stiff bristled wire broom, with a long handle, to obtain a light broom finish. Install brush marks true to the direction indicated on the Drawings or perpendicular to the flow of traffic if not shown. Repeat edging and jointing operations as required to obtain a distinct edge.
2. Rough Form Finish: For formed concrete surfaces not exposed-to-view, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4" in height rubbed down or chipped off.

E. Final concrete finishes:

1. Walk Paving: light broom finish.
2. Bench Pads: light broom finish.
3. Concealed surfaces: rough form finish.

3.11 REPAIR AND PROTECTION AFTER INSTALLATION

A. Repair and replace any broken or defective concrete as directed. Protect concrete from damage until acceptance of the work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing stains and spillage of materials as they occur. Sweep concrete and wash free of stains, discolorations, dirt and other foreign material just prior to final inspection.

B. Remove broken or defective concrete paving by cutting back to the nearest score line or expansion joint, to leave a straight and true edge.

C. If, in the opinion of the Owner's Representative, the foregoing tests indicate concrete strengths below those required, or visual defects indicate concrete of poor quality has been placed, additional tests shall be made and reported as directed by the Owner's Representative at expense of Contractor. No patching or parging of new concrete work is allowed.

D. Remove and replace pavement sections found deficient by 1/2 inch or more in thickness at no additional cost to the Owner.

3.12 CUTTING AND PATCHING

A. Contractor for concrete work shall be responsible for all cutting, removing and patching work where concrete surfaces are not installed within the limits shown on the drawings or specified herein. All such work shall meet with the approval of the Owner's Representative.

B. Where cutting and patching is required to accommodate the work of other subcontractors, such cutting shall be done at the expense of said subcontractors but shall be performed by the contractor for concrete work.

C. The location and extent of cutting in completed concrete work and the patching thereof shall meet with the approval of the Owner's Representative.

3.13 TESTING LABORATORY RESPONSIBILITIES

A. The Contractor will employ a testing laboratory to perform tests and to submit test reports.

B. Sampling and testing for quality control during placement of concrete shall include the following, as directed by Owner's Representative:

1. Slump: ASTM C 143; one slump test at point of discharge for each truck.

2. Compression Test Specimen: ASTM C 39; set for each day's pour exceeding 25 cu. yards plus additional sets for each 50 cu. yards over and above the first 25 cu. yards of each concrete class placed in any one day; one specimen shall be tested at 7 days, three specimens shall be tested at 28 days and one specimen shall be retained in reserve for later testing if required. One cylinder will stay at the site.

C. Design the mix for the concrete to obtain a strength, as determined by test cylinders, at least 15% higher than specified.

D. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

E. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

F. Test results will be reported in writing to Owner's Representative, Owner and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at

28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.

G. Non-Compliance: All test reports indicating non-compliance shall be faxed immediately to all parties on the test report distribution list and the hard copies submitted on different colored paper.

H. Nondestructive Testing: Windsor probes, sonoscope, or other non-destructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.

I. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Owner's Representative. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

END OF SECTION

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DIVISION 9 - FINISHES

SECTION 09 00 00 - FINISHES

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. Surface preparation and paint finish for concrete handball wall.
B. Line striping.

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 01 - Cast in Place Handball Wall Concrete

1.4 QUALITY ASSURANCE

A. Comply with the following standards:

1. Standards of SSPC [The Society for Protective Coatings] except as otherwise required:

a. SSPC-PA2: Paint Thickness Measurement.
b. SSPC-PAL: Paint Application Specification No. 1.
c. SSPC-SP1: Solvent Cleaning.
d. SSPC-SP2: Hand Tool Cleaning.
e. SSPC-SP3: Power Tool Cleaning.

B. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, within recommended limits and in accordance with manufacturer's directions.

C. Include on label of containers: manufacturer's name, type of paint, manufacturer's stock number, color, batch number, instructions for reducing where applicable, label analysis. Paint material containers not displaying manufacturer's product identification will not be acceptable.

D. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified.

E. Provide products which comply with all state and local regulations including VOC/VOS rules at the time of application.

F. Applicator: Company specializing in commercial painting and finishing for 5 years, completing work of similar scope.

1.5 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. COATING MATERIALS LIST: proposed for use, both factory and job mixed, to Owner’s Representative before commencing any work. Provide manufacturer's name, product name and product line number for each material. Provide manufacturer's technical data sheet for each coating giving descriptive data, curing time, mixing, thinning and application instructions, color and shelf life.

C. COLOR SAMPLES: Submit samples of manufacturer's latest paint color chips for selection by Owner’s Representative.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original containers with seals unbroken and labels legible and intact including instructions for mixing and/or reducing.

B. Storage of Materials: Store only acceptable project materials on project site, in a suitable protected and ventilated location within temperature range recommended by manufacturer. Comply with health and fire regulations.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Cover or otherwise protect existing vegetation and surfaces under and adjacent to wall painting during all phases of preparation and painting.

B. Apply coatings outdoors only when work areas are reasonably free of airborne dust at time of application and when coating is drying.

C. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems can be applied. Do not apply exterior paint when the temperature and/or substrate temperature is below 50 or above 90 degrees F. or in frosty, rainy or damp weather until the surface is thoroughly dry. Do not apply urethane finishes when the temperature is below 60 degrees F.

1.8 PROJECT CONDITIONS

A. All applicators shall wear protective clothing suitable for use with mineral spirit based materials. Avoid prolonged breathing of vapors.

B. Protection: Cover or otherwise protect finished work of other trades and surfaces not being painted concurrently or not to be painted.

C. Limit over spray on other nearby surfaces. Prevent over spray from coming into contact with persons, motor vehicles, trees, surrounding buildings and other objects not intended for treatment.

1.9 SCAFFOLDING AND HOISTS

A. Furnish, erect and maintain all necessary scaffolding, ladders, platforms, planks and hoisting equipment required for the execution of the work. Remove these items when no longer needed.

B. All such apparatus, equipment and construction shall meet the requirements of the Labor Laws and State Laws and regulations applicable thereto and the authorities having jurisdiction over this work.

1.10 MAINTENANCE MATERIALS

A. Provide Owner’s Representative with not less than one (1) one gallon containers of each color and material used in clean, unopened, tightly sealed and clearly labeled containers.

1.11 ENVIRONMENTAL REQUIREMENTS

A. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating system can be applied.

1. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F [10 degrees C] and 90 degrees F.

B. Apply coatings only when work areas are reasonably free of airborne dust at time of application and when coating is drying.

PART 2 - PRODUCTS

2.1 PAINT MATERIALS

A. Primer for use on new concrete handball court wall surfaces shall be: Series N69 Hi-Build Epoxoline by Tnemec, or approved equal.

1. Primer paint color will be selected by Owner’s Representative. Color shall be in the same family as finish color.

B. Finish Coat for use over primer coat shall be: Series V290 CRU by Tnemec, or approved equal.

1. Finish paint shall be an aliphatic polyester polyurethane with a semi-gloss finish.
2. Color shall be in the same family as primer color.

C. Line paint shall be Series V290 CRU by Tnemec, or approved equal.

1. Application: Roller or brush.
2. Color shall be chosen by Owner’s Representative.

D. Graffiti Coating shall be equal to a permanent two coat system, Vandlguard Five and Vandlguard Finish Coat, or approved equal.

1. Coating shall be clear and non-yellowing with a low luster sheen.
2. Coating shall protect treated surfaces for a period of up to five years.

2.2 CONCRETE CLEANING MATERIALS

A. Preferred chemicals shall be those with minimal harmful environmental effects and shall be chosen based on level of dirt. Provide one of the following:

1. Cleaning Material shall be chosen from one of the following:
   a. 50% muriatic acid mixed with 50% water;

b. Light Duty Concrete Cleaner, ProSoCo, Inc., Kansas City KS.
c. Or approved equal.

B. LIMESTONE shall be free flowing Agricultural Grade Dolomitic Limestone conforming to the standards of the Association of Agricultural Chemists and complying with State and Federal regulations. It shall be 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. WATER shall be clean, clear and free from deleterious amount of oil, acid, alkali, salts and organic matter.

2.3 CLEANING EQUIPMENT

A. Power washing equipment necessary for this work shall be properly maintained and in good operating condition. Remove and replace any equipment deemed to be in unsatisfactory repair or condition or otherwise unsuitable.

PART 3 - EXECUTION

3.1 CLEANING AND SURFACE PREPARATION OF EXISTING WALL SURFACES

A. Prior to commencing cleaning operations, spread protective coverings below areas to be cleaned. Cover all areas where runoff from cleaning operations may occur.

B. Clean new concrete surfaces of laitance, curing compounds, hardeners, sealers and other contaminants with abrasive blast, shot-blast or water jet. If other materials and dirt still exist on concrete surfaces, remove as follows:

1. Spray the concrete wall with water, then scrub it with the soft bristle brush to loosen up the dirt.
2. Hose off the wall to rinse.
3. Apply a concrete cleaner onto all wall surfaces before starting to power wash.
4. Start at the highest point and work down.
5. Keep the nozzle about 12" from the surface, getting too close could cause damage. Use a steady, sweeping motion as you move back and forth across the concrete
6. Pour water and TSP into the bucket and mix them thoroughly.
7. Spray the solution onto all areas of the wall and scrub with a brush.
8. Rinse the wall with fresh water. Continue the same process to other wall surfaces.
9. Do not use wire brushes, steel wool, abrasive blasting or abrasives mixed with water.

3.2 POST CLEANING EXAMINATION

A. Examine wall conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

1. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces or conditions detrimental to formation of a durable paint film. Owner’s Representative shall inspect concrete walls after surface preparation is complete.

2. Prior to start of painting, allow new concrete wall to cure a minimum of 28 days at 75 degrees. Verify concrete dryness in accordance with ASTM F1869 ‘standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride’.

3.3 PROTECTION

A. Exercise great care not to deface adjacent work. Prior to start of painting, cover or otherwise protect pavement and vegetation not to be painted and the finished work of other trades. Remove device plates, escutcheons and similar items before painting and replace these items after paint has dried.

3.4 FINISH PAINT APPLICATION

A. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. Apply paint in strict accordance with manufacturer's directions.

1. When rolling or spraying, back brush immediately after each section to insure proper penetration.

C. Prime Coats: Before application of finish coats, apply a prime coat of material as recommended by the manufacturer to materials that are required to be painted or finished and has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in the first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing. Primer shall also be applied to top surface of wall.

D. Provide finish coats that are compatible with primers used. According to manufacturer’s recommendations, apply two coats of finish paint to all primed wall surfaces in locations as shown on Drawings. Finish paint shall also be applied to top surface of wall.

1. Line striping shall be done after finish coats are completely dry.

E. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practical after preparation and before subsequent surface deterioration.

1. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
2. Comply with the recommendation of the material manufacturer for drying time between succeeding coats.
3. Successive coats of paint shall differ sufficiently in shade so as to be readily distinguishable.

F. Minimum Coating Thickness: Apply materials at not less than the manufacturer's recommended spreading rate. Provide a total dry film thickness of the entire system as recommended by the manufacturer.

1. Measure dry film thickness using magnetic film thickness gauge in accordance with SSPC-PA2.

G. Completed Work: Remove, refinish or repaint work not in compliance with specified requirements.

3.5 ANTI-GRAFFITI COATING APPLICATION

A. Apply anti-graffiti coating in application of two coats of approved products in strict accordance with manufacturer's directions.

1. Anti-graffiti coating shall not be started until newly finish painted wall surfaces are clean and dry.

3.6 FIELD QUALITY CONTROL

A. The Owner reserves the right to invoke the following test procedure at any time and as often as the Owner deems necessary during the period when the paint is being applied.

1. The Owner may engage the services of an independent testing laboratory to sample the paint material being used. Samples of material delivered to the project will be taken, identified, sealed and certified in the presence of the Contractor.
2. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint, pay for testing, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are incompatible.

3.7 CLEANUP AND PROTECTION

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish and other discarded paint materials from the site in a manner compliant with all applicable regulations.

B. Remove all equipment, materials and debris caused by work of this Section and leave the site of the work in a clean condition insofar as this work is concerned.

C. Provide "Wet Paint" signs and other devices as necessary to protect newly painted finishes.

D. Rectify any damage to adjacent work caused by painting operations. Touch up and restore finishes where damaged. Remove spilled, splashed or spattered paint from all surfaces. Repaint entire item where portion of finish has been damaged or is unacceptable.

E. Protect all painted surfaces against damage until the date of substantial completion. All finished work under this Section shall have perfect surfaces when completed work is ready for inspection for substantial completion. Repair or retouch all areas which do not comply with requirements of this Section for any reason whatsoever to the satisfaction of Owner’s Representative and at no additional cost to Owner.

END OF SECTION

SECTION 26.00.00
ELECTRICAL
(Filed Sub-Bid)

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.

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. Primary conduits (concrete encasement), transformer pad, grounding, bollards per utility standard, metering, etc.
2. Secondary distribution equipment, including secondary switchboards and metering, Surge Protection Devices (SPD's), panelboards including feeders and sub-feeders.
3. Arc flash study.
4. Surge Protection Devices (SPD's) on all electrical panels
5. Lighting systems exterior and interior, including fixtures, lamps, time clocks, and lighting controls.
6. Coordination with the City of Worcester Closed Circuit Television (CCTV)**. Refer to the City of Worcester Request for Bids articles for additional information.**
7. Purchasing and installation of the Musco sports lighting system (turn key)
8. Purchasing and installation of the exterior enclosure for housing the Musco lighting contactors and for panel PP1. **The E.C. is to verify the size specified on the drawings is sufficient size to accommodate both the electrical panel and the lighting contactor.**
9. All raceway systems, including boxes, couplings, and fittings.
10. All branch circuit wiring systems, including wiring devices, plates.
11. Excavation and backfill within building foundation walls for any underground raceways.
12. Drilling, coring, and cutting of holes and openings
13. Scaffolding, rigging, and staging required for all electrical work.
14. Provide seismic restraints for all electrical systems and conform to Massachusetts State Building Code.
15. Closed Circuit Television (CCTV)
16. Signage per National Electrical Code and International Building Code
17. 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 RELATED WORK

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

1. **City of Worcester Request for Bids articles for additional information.**
2. Excavation and Backfill: SECTION 31.00.00, EARTH WORK (except within building foundation).
3. Concrete Bases, Pads, and Duct Envelopes: DIVISION 03.00.00, CONCRETE.
4. CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL: SECTION 01 74 19
5. GENERAL COMMISSIONING REQUIREMENTS: SECTION 01.91.13
6. Submittals: SECTION 01 33
7. Patching: To be done by trade responsible for surface requiring patching.
8. Payment for energy for temporary light and power shall be made by General Contractor.

1.06 CONTRACT COST BREAKDOWN

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

1.07 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.

1.08 CONTRACTOR'S REPRESENTATIVE

A. Retain a competent representative on the project.

1.09 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.

1.10 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*", 2023 Edition
Massachusetts Electric Code Amendments, 2023 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

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. Local housing authority will reimburse electrical contractor for all permit fees.

1.11 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.

1.12 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.

1.13 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.

1.14 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.

b. 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 cadium, 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

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, 90ºC.
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, may be used below slab within the foundation wall and underground outside the foundation wall.
8. Acceptable manufacturers:

   Robroy Industries
   Republic Conduit
   Youngstown Tube Company
   Carlon
   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

B. All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.

C. Connections throughout the entire job shall be made with solderless type devices.

1. For #10 AWG and smaller: spring type.
2. For #8 AWG and larger: circumferential compression type.
3. Acceptable manufacturers:
   3M "Scotchlock"
   IDEAL "Wingnut"
   BURNDY

4. 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.

D. 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:

1. All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75°C) except as follows:

a. In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75°C, 90°C) may be used.

E. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.

F. Acceptable manufacturers:

South Wire
American Flexible Conduit (AFC) Company
American Wire & Cable
Superior Essex
Okonite

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.

B. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction as required to support raceways and equipment.

C. 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.

D. 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.

E. Any openings through fire rated surfaces shall be closed off with fireproofing materials providing the same rating as the surface penetrated.

F. Any openings through concrete foundation walls shall be closed off with waterproofing materials providing the same rating as the surface penetrated. Pipe/conduit sleeves shall be equal to Emerson – WSK series seals.

G. 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 ground fault interrupter, grounding type NEMA 5 20R, Weather Resistant
Cooper TWRVGF20
Pass and Seymour 2095TRW
Leviton W7899-TRE

B. Toggle Switches:

Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.

1. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.

2. Shall be single unit toggle, butt contact, quiet AC type, heavy duty general-purpose use with an integral self-grounding mounting strap with break-off plasters ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.

3. Ratings:

   a. 120 volt circuits: 20 amperes at 120-277 volts AC.
   b. 277 volt circuits: 20 amperes at 120-277 volts AC.

4. Acceptable Manufacturers:

Hubbell 1221,
Pass and Seymour 20AC 2,
Leviton 1221.
Prewired devices with pigtails acceptable

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

D. Cover plates

1. Provide gaskets on all wiring device plates where devices are on walls separating conditioned and non-conditioned spaces.
2. On residential projects. Use weather-proof bell box with in-use cover
3. 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. All specialized lamps to be of a type recommended by the fixture manufacturers in their photometric reports.

C. H.I.D. lamps to be as recommended by the fixture manufacturer.

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.

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. Maximum measured resistance to ground of 25.0 ohms shall not be exceeded (NFPA 70-, Article 250.53(A)(2)).

F. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250.122.

G. 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.

H. 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.

I. 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.

J. Continuity between all metallic and non-metallic raceway systems and equipment shall be maintained.

K. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.

L. Pad-Mounted Transformers:

1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad.
2. Ground the secondary neutral.

M. Grounding Equipment

1. Ground Rods

a. Copper clad steel19 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. Concrete Encased Electrode

a. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

3. Ground Connections

a. Below Grade and Inaccessible Locations: Exothermic-welded type connectors.
b. 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 cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
2) Connection to Building Steel: Exothermic-welded type connectors.
3) Connection to Grounding Bus Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with cadmium-plated steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.
4) Connection to Equipment Rack and Cabinet Ground Bars: Listed for use with aluminum and copper conductors. Use mechanical type lugs, with //zinc-plated//cadmium-plated// steel bolts, nuts, and washers. Bolts shall be torqued to the values recommended by the manufacturer.

2.08 PANELBOARDS

A. Panelboards shall be as shown on the drawings. Refer to drawings for details regarding location of components, voltage and current rating of devices and other required details. Suitable for use as Service Entrance given compliance with NEC.

B. Lighting And Power Distribution Panels (Standard)

1. Furnish Siemens Industry Lighting Panelboards, Type P1.

2. NEMA PB 1, circuit breaker type.

a. Standard Lighting and Power Distribution

1) Main Lug Panels to be rated as indicated on the drawings. Main lugs shall be either removable or lay-in style construction for panels up to 250 amps to facilitate connections.
2) Main circuit breaker panels to be rated as indicated on the drawings.

3. Standard lighting and power distribution panels (P1) shall be field convertible from Main Lug to Main Breaker with no increase in panel height. Field- addable mains (bussed connected) sub-feed breaker or feed-thru lug kits shall also be available, without utilizing any branch circuit space.

4. Interior shall be changeable from top to bottom feed and vice-versa, while maintaining readability of dead- front labeling on standard lighting and power distribution panels.

C. Lighting and Power Distribution (Custom) for applications requiring bus connected RC switches, split bus, special bussing size or material, special wire connectors and other than standard size enclosures or voltages or systems.

1. Furnish Siemens Industry Series Lighting Panelboards, Type P2.

2. NEMA PB 1, circuit breaker type.

a. Custom Lighting and Power Distribution

1) Main Lug Panels to be rated as indicated on the drawings.
2) Main Circuit Breaker panels to be rated as indicated on the drawings.

D. Bussing

1. Copper sized in accordance with UL 67 standards for temperature rise.

E. Ground Bars

1. A copper equipment ground bar shall be provided.

F. Neutrals

1. Neutral bussing shall have a lug for each outgoing branch requiring a neutral connection; P1 and P3 load side neutral connection lugs to be split with each side taking 50% of load neutral connections.

G. Enclosure

1. Boxes shall be fabricated from galvanized, galvaneal steel or protected against corrosion per the requirements of NEMA 250, UL 50 and UL50E. Box or panel interior shall have adjustable screws to provide easy alignment for flush mounted applications. Removable end walls to be with KO's.

2. Surfaces of the trim shall be properly cleaned and painted gray ANSI 61.

H. Trims

1. Trims for Lighting and Power distribution shall be as indicated on the drawings. It shall be fabricated from steel, painted with an ANSI-61 light gray finish and equipped with concealed hinges, flush lock and circuit directory cardholder. Trim shall have two separate supports designed to engage the box flange to stabilize and secure the trim during installation. Trim screws to be located behind the lockable door for tamper resistance. Optional trims may be hinged to the box, door in door.

2. Trims for Distribution Panels shall be as indicated on the drawings. It shall be fabricated from steel, painted with an ANSI-61 light gray finish. Optional trims may be hinged to the box, door in door.

I. Circuit Breakers

1. Molded case circuit breakers shall be bolt-on devices. Short circuit rating shall be amperes symmetrical based on the smallest rating on any circuit breaker installed in the panel and as shown on the drawings, but not less than 10kaic at 240 VAC. Molded case circuit breaker shall be of the quick-make, quick-break, trip-free, thermal magnetic type.
2. Molded case circuit breakers shall be thermal-magnetic, quick-make, quick-break, trip free. Multi-pole breakers shall be common trip.
3. Provide circuit breaker accessories as indicated on the drawings or panel schedules.
4. Provide SWD rated breakers for all lighting branch circuits and UL Listed Type HACR for all air conditioning equipment branch breakers.

J. Surge Protection Device

1. If indicated on drawings, a SPD - Surge Protection Device shall be installed with a direct bus connection for low clamping and without utilizing any circuit breaker positions. It shall be listed in accordance with

UL 67, 1283 and 1449. Designed and tested in accordance with ANSI/IEEE C62.45 and C62.41.

a. Surge capacity shall be 100kA per phase Lighting Panelboards, Type [P1] [P2].
b. Field-addable, bolt-on connection, into existing P1 lighting panels with UL 1449 listing.
c. Factory installed SPD units shall be available for mounting in unit space in distribution panels type P4 and P5.
d. 5 year warranty with LED indicators for immediate status monitoring. Audible alarm with silencing switch and test button.

K. Arc Flash

1. Provide a complete arc flash study of the entire electrical system from the point of incoming service to all panelboards. Labels shall include the arc flash boundary in feet, hazard category and a list of appropriate PPE.

2.09 ELECTRICITY METERING, SINGLE SOCKET

A. The meter socket devices shall have individual covers of ringless style design. Meter sockets shall have a barrel-locking, padlocking, wire hasp or other sealing provision.

B. The sockets shall be rated 200 amps continuous. Up to 300 volts at 3 phase, 4 wire].

C. All current carrying parts shall be tin plated or equivalent to resist corrosion. All lugs shall be the extruded aluminum lay-in type design and shall be suitable for use with 60/75 degree C copper or aluminum wire.

D. Line side meter jaws for non-lever-bypass sockets shall have meter guides and all meter jaws shall be made from copper alloy. Non lever bypass socket jaws shall be spring reinforced mounted to a special thermoset insulating block.

E. Switch Enclosures

1. The single position meter sockets shall be continuous duty rated. Outdoor enclosures shall be fabricated from zinc-coated steel finish or 3003 grade aluminum [with] [without] an ANSI light gray paint applied by electro-deposition process.

F. Factory Testing

1. Standard factory tests shall be performed on the equipment in accordance with the latest version of applicable NEMA and UL standards.

G. Arc Flash

1. Provide a complete arc flash study of the entire electrical system from the point of incoming service to all panelboards rated 240V at 10 kaic or greater. Labels shall include the arc flash boundary in feet, hazard category and a list of appropriate PPE.

2.10 ELECTRIC SERVICE

A. Coordinate and cooperate with National Grid Company, hereinafter called utility company, with respect to providing service and metering. See allowances section for back charges by utility company with respect to permanent service.

B. Provide all primary system raceways, elbows, pull wires and all pad grounding. Utility company will provide pad-mounted transformers, primary switches, and primary conductors including making up of all terminations and connections.

C. Provide secondary service complete including all conductors, raceways, and connectors at transformer. Provide oversize lugs if required due to conductor sizing. Attachment of secondary conductors to the transformer terminals will be done by utility company.

D. General Contractor shall do all excavation and back filling (in accordance with utility company standards) and shall construct the reinforced concrete pads for transformers.

E. All work to be done in accordance with utility company standards.

F. Metering: All usage will be on one secondary meter. Utility Company will furnish current transformers and potential transformers to be installed in switchboard by contractor. Empty raceway with pull wire from the C/T compartment to the meter backboard shall be provided.

2.11 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, ¼" 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 in 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 ¼" less than the conduit.
14. Manholes shall be furnished and installed by electrical Subcontractor. Provide frames and covers as indicated on the drawings.

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. ***Provide screw on nameplate for available fault current of the electrical service in accordance to NEC 110-24. Provide the voltage, available short circuit current along with the date of the installation.***
e. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panel boards. Spare circuits shall be penciled.
f. 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.

g. 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.

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. 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. Support surface or pendant mounted lighting fixtures:
10. From outlet box by means of an interposed metal strap, where weight is less than five pounds.
11. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
12. Directly from structural slab, deck or framing member, where weight exceeds fifty pounds.
13. Pendant lighting fixtures shall be supported by threaded rods in non-public areas and by manufacturers standard tube hangers with swivel aligner and canopy in public areas. Provide nonstandard pendant lengths where required to mount fixtures at elevations either called for on drawings or as shown in architectural elevations.
14. Support recessed lighting fixtures directly from structural slabs, decks or framing members, by means of jack chain or air craft cable, one at each end of fixture at opposite corners.
15. 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.
16. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.
17. 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.
18. 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. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.
l. 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.
m. 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.
n. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.
o. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.
p. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.
q. Each exterior raceway or assembly in a ductbank shall be provided with continuous warning tape installed 12 inches above raceway or ductbank.
r. 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.
s. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.
t. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.
u. 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
Cable Trays	C-AJ-4029	W-J-4021, W-J-4022, W-J-4033	W-L-4008, W-L-4029, W-L-4043
Pipes/conduits thru foundation walls		Emerson - WSK	

3.12 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. Panel boards

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 current transformers and potential transformers.
f. Check ratings of all protective relays per drawings.
g. Physical Inspection:
h. Torque all bus hardware to proper tension.
i. Circuit breaker interlocks all work properly.
j. All doors and hinged panels open and close properly.
k. All circuit breakers operate, close and trip mechanically.
l. Torque all feeder conductors to terminal manufacturers' recommendations.
m. Electrical Testing:
n. Insulation resistance tests made on all circuit breakers, line to load breaker open, line to ground breaker closed, 3 poses tested individually. Switchgear bus to be tested phase to phase and phase to ground with Megohometer type instrument. Relays also to be insulation resistance tested.

E. Conductors: <u>All secondary service conductors, all feeder, as well as, all branch circuits conductors from switchboards, distribution panels, panel boards, and load centers shall be tested.</u>

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

1. Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.
2. Perform continuity test to insure proper conductor connection.

F. Grounding Grids or Electrodes: Measurement of resistance from ground grids or electrodes to earth to determine adequacy of grounding system in building and compliance with specifications and/or electrical code.

G. Settings of Adjustable Devices: Using the result of the fault current and coordination study specified hereinafter, the Testing Contractor shall set all adjustable devices.

3.13 ARC FLASH ANALYSIS

A. Employ the manufacturer of the secondary distribution equipment or an independent organization to perform a fault current and coordination study to ensure a selectively coordinated system from the incoming mains to the branch circuit panelboards.

B. The report shall be submitted in a standard format and shall include the fault current availability at various points in the distribution system, breaker coordination curves, and recommended settings of all adjustable devices in the system.

C. Scope

1. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer or an approved engineering firm.

   a. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2021, Annex D.
   b. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract as well as all directly affected existing distribution equipment at the customer facility.

D. References

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

   a. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.

b. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
c. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
d. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
e. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
f. IEEE 1584 - Guide for Performing Arc-Flash Hazard Calculations.
g. American National Standards Institute (ANSI):
h. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
i. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
j. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
k. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
l. The National Fire Protection Association (NFPA):
m. NFPA 70 - National Electrical Code, latest edition.
n. NFPA 70E – Standard for Electrical Safety in the Workplace.

E. Submittals for Review Approval

1. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

F. Submittals for Construction

1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format. The report shall include the following sections:

a. Executive Summary.

b. Descriptions, purpose, basis and scope of the study.
c. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
d. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
e. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
f. Details of the incident energy and flash protection boundary calculations.
g. Recommendations for system improvements, where needed.
h. One-line diagram.
i. Arc flash labels shall be provided in hard copy only.

G. Qualifications

1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies

a. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm
b. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies
c. The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year

H. Computer Analysis Software

1. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) software program

I. Studies

1. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer or an approved engineering firm.

a. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

J. Data Collection

1. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

    a. Source combination may include present and future motors and generators.
    b. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.
    c. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

K. Short-Circuit and Protective Device Evaluation Study

1. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

    a. Transformer design impedances shall be used when test impedances are not available.
    b. Provide the following:
    c. Calculation methods and assumptions.
    d. Selected base per unit quantities.
    e. One-line diagram of the system being evaluated.
    f. Source impedance data, including electric utility system and motor fault contribution characteristics.
    g. Tabulations of calculated quantities.
    h. Results, conclusions, and recommendations.
    i. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:
    j. Electric utility’s supply termination point
    k. Incoming switchgear
    l. Unit substation primary and secondary terminals
    m. Low voltage switchgear
    n. Motor control centers
    o. Standby generators and automatic transfer switches
    p. Branch circuit panelboards
    q. Other significant locations throughout the system.
    r. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.
    s. Protective Device Evaluation:

t. Evaluate equipment and protective devices and compare to short circuit ratings
u. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
v. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

L. Protective Device Coordination Study

1. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

a. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
b. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
c. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
d. Plot the following characteristics on the TCC graphs, where applicable:
e. Electric utility's overcurrent protective device
f. Medium voltage equipment overcurrent relays
g. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
h. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
i. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
j. Conductor damage curves
k. Ground fault protective devices, as applicable
l. Pertinent motor starting characteristics and motor damage points, where applicable
m. Pertinent generator short-circuit decrement curve and generator damage point
n. The largest feeder circuit breaker in each motor control center and applicable panelboard.
o. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

M. Arc Flash Hazard Analysis

1. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2021, Annex D.

a. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
b. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
c. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.
d. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
e. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
f. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
g. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
h. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
i. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

j. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
k. Miscoordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
l. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

N. Report Sections

1. Input data shall include, but not be limited to the following:

a. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
b. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
c. Reactor data, including voltage rating, and impedance.
d. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X”d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
e. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
f. Short-Circuit Output Data shall include, but not be limited to the following reports:
g. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

1) Voltage
2) Calculated fault current magnitude and angle
3) Fault point X/R ratio
4) Equivalent impedance

h. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

1) Voltage
2) Calculated symmetrical fault current magnitude and angle
3) Fault point X/R ratio
4) Calculated asymmetrical fault currents

a) Based on fault point X/R ratio
b) Based on calculated symmetrical value multiplied by 1.6
c) Based on calculated symmetrical value multiplied by 2.7

5) Equivalent impedance

i. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

1) Voltage.
2) Calculated symmetrical fault current magnitude and angle.
3) Fault point X/R ratio.
4) No AC Decrement (NACD) Ratio.
5) Equivalent impedance.
6) Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a symmetrical basis.
7) Multiplying factors for 2, 3, 5, and 8 cycle circuit breakers rated on a total basis.

j. Incident energy and flash protection boundary calculations:
k. Arcing fault magnitude.
l. Protective device clearing time.
m. Duration of arc.
n. Arc flash boundary.
o. Working distance.
p. Incident energy.
q. Hazard Risk Category.
r. Recommendations for arc flash energy reduction.

O. Field Adjustment

1. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

a. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
b. Notify Owner in writing of any required major equipment modifications.
c. Arc Flash Warning Labels

2. The contractor of the Arc Flash Hazard Analysis shall provide a 3.5” by 5” thermal transfer type label of high adhesion polyester for each work location analyzed.

a. All labels will be based on recommended over-current device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
b. The label shall include the following information, at a minimum:
    1. Location designation.
    2. Nominal voltage.
    3. Flash protection boundary.
    4. Hazard risk category.
    5. Incident energy.
    6. Working distance.
    7. Recommend PPE.
c. Engineering report number, revision number, and issue date.
d. Labels shall be machine printed, with no field markings.
e. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
f. For each 600, 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
g. For each motor control center, one arc flash label shall be provided.
h. For each low voltage switchboard, one arc flash label shall be provided.
i. For each switchgear, one flash label shall be provided.
j. Labels shall be field installed by the electrical contractor.

END OF SECTION

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Not Used

SECTION 31 00 00 - EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 DESCRIPTION OF WORK

A. Excavating, filling, backfilling and grading as required for the construction of paving and other site work.
B. Providing, furnishing and placing of all fill and backfill materials as specified herein, as shown on the Drawings or as required.
C. Stripping, stockpiling and screening existing topsoil.
D. Compaction and decompaction procedures.
E. Protecting all existing structures, utilities, pavements, planting and other site improvements from damage due to construction.
F. Performing all dewatering necessary to maintain excavated areas free from water from any source.
G. Removing and disposing of all unsuitable and surplus excavated materials from the site.

1.3 RELATED WORK

A. The following items of related work are specified and included in other Sections of the Specifications:

1. Section 02 41 13 - Site Preparation
2. Section 03 30 01 - Cast in Place Handball Wall Concrete
3. Section 03 30 10 - Site Concrete
4. Section 32 10 00 - Paving and Curbing
5. Section 32 12 16 - Bituminous Concrete Pavement
6. Section 32 18 16 - Bonded Rubber Surface
7. Section 32 30 00 - Site Improvements
8. Section 32 90 00 - Lawns and Planting

1.4 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials.
B. ANSI A10 Series standards: American National Standards Institute, "Safety Requirements for Construction and Demolition".
C. ASTM: American Society of Testing Materials.
D. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, Commonwealth of Massachusetts, latest edition.
E. City of Worcester Department of Public Works and Parks, ‘Special Conditions and Specifications’, latest edition.

1.5 QUALITY ASSURANCE

A. Comply with all codes, laws, ordinances and regulations of governmental authorities having jurisdiction over this part of the work.

B. Provide protection for all persons and property in accordance with ANSI/NFPA 241, Building Construction and Demolition Operations. Execute all work in such a manner as to protect existing buildings, paving, utility lines, structures, fences and adjoining property from damage by equipment, settlement, undermining, washout, frost and other hazards created by earthwork operations.

1.6 TESTING SERVICES

A. The testing laboratory will be responsible for conducting and interpreting tests, state in each report whether or not the test specimens conform to all requirements of the Contract Documents and specifically note any deviation there from. Specific test and inspection requirements shall be as specified herein.

1.7 SUBMITTALS

A. Test Reports:

1. Gradation tests for all soil materials.
2. Optimum moisture - maximum density of soils.
3. Field density tests.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect and handle manufactured materials during loading, shipping, unloading at the site, storage and erection as required to prevent damage.

1.9 BENCH MARKS AND ENGINEERING

A. Line and grade work in accordance with the Drawings and Specifications shall be laid out by a registered Civil Engineer or Land Surveyor employed by the Contractor. Establish permanent bench marks, as required, to which access can be easily had during the progress of the work. Maintain all established bounds and bench marks and replace as directed any which are disturbed or destroyed. Establish lines and grades in conformity with the Drawings. Provide sufficient grade stakes to witness correct lines and grades.

B. Verify dimensions and elevations on the ground and report any discrepancies immediately to the Owner’s Representative. Any discrepancies not reported prior to construction shall not be the basis for claims for extra compensation.

C. The Drawings indicate, in general, alignment and finish grade elevations. The Owner’s Representative, however, may make such adjustments in grades and alignments as are found necessary in order to avoid interference with any special conditions encountered.

1.10 DEFINITIONS

A. Fill and backfill shall be, for the purpose of this Specification, considered interchangeable terms and shall mean material to be used to bring existing or construction grades up to finish subgrade levels.

B. The words "finish grade" as used herein mean the required final grade elevations indicated on the Drawings.

C. The word "subgrade" as used herein, means the required surface of subsoil, borrow fill or compacted fill. This surface is immediately beneath the site improvements, specially dimensioned fill, paving, loam or other surfacing materials.

D. Excavation is defined as the removal of materials from the construction area to the lines and grades shown on the plans.

1. Unclassified Excavation is defined as the removal of all material encountered regardless of its nature. All material excavated will be considered as Unclassified Excavation unless the Special Provisions specify Classified Materials.

E. "Unsuitable Materials" shall include the following:

1. Pavements, utility structures, building foundations and other manmade structures.
2. Peat, muck, organic silt and other organic materials subject to decomposition, consolidation or decay.
3. Miscellaneous fill including cinders, ash, glass, wood, masonry and metal.
4. Ledge and boulders except as specified herein for fills.

1.11 EXISTING CONDITIONS

A. Subsurface Information: The Owner’s Representative assumes no responsibility for the Contractor's failure to make his own site investigation and makes no representation regarding the character of the soil or subsurface conditions which may be encountered during the performance of the work. Bidders are expected to examine the site and then decide for themselves the character of materials to be encountered.

B. Existing Utilities

1. Before starting earthwork, locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
2. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility Owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of Owner.
3. Do not interrupt existing utilities serving facilities occupied or used by Owner and others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided. Provide minimum of 48 hour notice to Owner, and receive written notice to proceed before interrupting any utility.

C. Retaining Structures: Provide bracing, shoring, sheeting, temporary tie backs, rock anchors and rock bolts, sheet piling, underpinning or other retaining structures necessary to prevent any movement or settlement of existing or new construction, utilities, paving, piping or conduit.

PART 2 - PRODUCTS

A. ORDINARY FILL shall conform to the requirements of Section M1.01.0 of MassDOT. In addition it shall be clean, mostly granular, natural inorganic soil. It shall be free of organic or other weak or compressive materials, frozen materials, cinders, trash, rubble and stone larger than six (6) inches maximum dimension.

1. Material from excavation on the site meeting the above requirements may be used as ordinary fill provided it has not been contaminated with unsuitable material.

B. GRANULAR FILL for borrow shall conform to the requirements of Section M1.03.0, Type c of MassDOT with 2 inches being the largest dimension.

C. GRAVEL, as noted in the Drawings, shall be DENSE GRADED CRUSHED STONE conforming to the requirements of Section M2.01.7 of MassDOT.

D. CRUSHED STONE shall conform to the requirements of Section M2.01.4 of MassDOT for 3/4" maximum sieve size.

2.2 USE OF FILL MATERIALS

A. Granular Fill shall be utilized as fill in the following locations:

1. To replace unsuitable material.
2. All walk embankments to subgrade.
3. Elsewhere as shown on the Drawings or specified. Wherever fill materials such as Ordinary Fill or Gravel have not been specified herein or shown on the Drawings.

B. Gravel shall be utilized as sub-base material for all paved surfaces, where so indicated on the Drawings or specified herein.

C. Crushed Stone shall be utilized as sub-base for resilient rubber surface and tiles, where so indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavation is "Unclassified", and includes excavation to subgrade elevations indicated, or required to accommodate new construction, lawns, plant beds and pathways, regardless of character of materials and obstructions encountered and shall be understood to include rock, shale, boulders, earth, hardpan, fill, foundations, pavements, curbs, piping and debris. It shall include the removal of all rubble, debris, foundations, pavement, utilities, gravel and appurtenances up to one (1) foot minimum below finish grade.

B. Before any other work is begun in this Section, strip topsoil to its entire depth from areas to be occupied by new walk areas, or any areas where the existing grade is to be changed. Strip topsoil free of subsoil, clay, large stones and debris. Do not damage roots of trees that are to remain during topsoil stripping. When excavating or trenching within the branch spread of trees scheduled to remain, do so in a manner that will cause minimum damage to root systems. Do not cut tree roots over 2 inches in diameter. Do not leave surface roots exposed. Prune injured roots clean and backfill as soon as possible.

1. Pile topsoil separately from all other material in locations on the site approved by the Owner and authorities having jurisdiction, and preserve for finish grading and lawn operations specified under Section 32 90 00, LAWNS AND PLANTING. Place, grade and shape stockpile for proper drainage.
2. Contractor shall screen existing topsoil for use on site in new lawn areas, and for backfill at new tree plantings. Screening will remove debris, tree roots, stones, metals and plastics.

3. Screened topsoil that remains on site shall be tested according to Section 32 90 00, LAWNS AND PLANTING, in this specification. Topsoil shall be amended per results of soil tests.
4. All topsoil shall remain on the property of the Owner and shall not be removed from the site. However, if excess topsoil is not required for operations specified under Section 32 90 00, LAWNS AND PLANTING, topsoil shall be removed from the site only after receiving written permission from Owner.

C. Additional Excavation: When excavation has reached required subgrade elevations, notify Owner's Representative who will make an inspection of conditions.

1. If suitable bearing material, as determined by Owner's Representative, is not encountered at the subgrade elevations indicated, carry excavations deeper and replace excavated material with granular fill. Additional excavation work must be authorized in writing before additional excavation work can be performed.
2. Removal of unsuitable material and its replacement as directed will be paid on basis of Contract conditions relative to changes in work.

D. Excavate to the following basic subgrades:

1. Footings and other site improvements: To exact elevations required.
2. Underground utility lines: To exact elevation required plus depth of bedding.
3. Walk Surfacing: To elevations indicated on the Drawings.
4. New Lawns: To approximately 6" below finish grade.

E. Unauthorized Excavation: When suitable bearing material is encountered at subgrade elevations shown and excavation is made to greater depth, bring grade back to elevation required by providing granular fill at no additional cost to the City.

F. Rock Excavation

1. The material to be excavated shall be assumed for bidding purposes to be earth and other materials that can be removed by normal power excavation equipment. This includes rock, concrete and other subsurface materials up to and including two [2] cubic yards in volume encountered during excavation. Excavation of this material shall be at the Contractor's expense.

2. Rock or ledge shall be defined as follows:

   a. Open Ledge - Class A: Rock, stone or boulders over two [2] cubic yards in volume to be removed and disposed of from an open area normally by bulldozer, power shovel or similar type equipment.
   b. Trench Ledge - Class A: Rock, stone or boulders over one [1] cubic yard in volume to be removed and disposed of from a confined area normally by backhoe or similar type equipment.
   c. Open Ledge - Class B: Rock, stone or boulders over two [2] cubic yards in volume that can be removed only by blasting or pneumatic equipment.
   d. Trench Ledge - Class B: Rock, stone or boulders over one [1] cubic yard in volume that can be removed only by blasting or pneumatic equipment.
   e. Anything other is "earth" insofar as removal of the material to be excavated is concerned.

3. When, during the process of excavation, rock is encountered, uncover such materials and free them of loose material. Notify the Owner's Representative before proceeding further.

The area in question shall be cross sectioned as stipulated herein. Do not proceed with excavation of material claimed as rock until the material has been classified by the Owner's Representative. Failure on the part of the Contractor to uncover such materials or notify the Owner's Representative or take cross sections will forfeit the Contractor's right of claim to any credits. The quantity of rock to be removed shall be based upon the pay line limits as established herein. The quantity of rock to be removed shall be approved by the Owner's Representative prior to blasting.

4. The Contractor shall employ and pay for a Land Surveyor or Civil Engineer registered in Massachusetts to take cross sections of rock before removal of same and to provide computations of cross sections within the pay line limits. Complete current records of actual quantities of rock excavated, methods of excavation used and extent of labor and equipment involved shall be maintained jointly by the Contractor and Owner's Representative, and shall be dated and signed by both with duplicate copies retained by the Owner's Representative for record. Such records shall include plot plans showing at a suitable scale all elevations, locations and measurements or computed volumes of rock or boulders encountered. All labor and equipment necessary to make these plot plans and take these measurements shall be furnished by the Contractor. No payment will be considered for rock which has been removed without obtaining the above required data.

5. Excavate rock encountered in grading the site areas to depths as follows:

   a. Under new footings: to six [6] inches below the required subgrade for such footing or piping.

6. Blasting: The use of explosives will not be permitted.

7. If rock is encountered the Contract Price will be adjusted in accordance with industry standard prices.

8. The additional price for rock removal shall include filling the void created by removal of the rock beyond the indicated limits of excavation with suitable materials in accordance with paragraphs on Fill, Backfill and Compaction at no added cost to the Owner. No allowance shall be made by the Contractor on account of rock or ledge, if encountered, reducing the amount of ordinary fill material available for filling operations, the Contractor being responsible to provide all such required material whether obtained from on or off the site.

9. The Owner's Representative reserves the right to adjust the proposed elevations to conform to any rock conditions.

G. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

H. Dewatering: Prevent water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in the excavations. Remove water to prevent softening of foundation bottoms, undercutting footings and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and their diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches. The disposal of water

from excavations shall not cause damage to adjacent property and shall be in compliance with all applicable laws and regulations, in particular, those related to protection of water resources and other environmental features.

3. Keep the water level in areas being compacted at least two (2) feet below the level at which compaction is being done at all times. Under no circumstances lay pipe or install appurtenances in water. Keep all trenches free from water until they have been backfilled.

I. Material Storage: Stockpile satisfactory excavated materials where directed until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Do not store within drip line of trees to remain.

J. Excavation for Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of formwork, installation of services, other construction and for inspection.

K. Frost Protection:

1. Make no excavations to full depth indicated when freezing temperature may be expected unless intended improvements can be accomplished immediately after the excavations have been completed. Protect bottom so excavated from frost if progress is delayed. Protect the subgrade of in place footings from frost. Should protection fail remove frozen materials and replace with concrete or granular fill as directed at no cost to Department.
2. Keep the site clear and free of accumulations of snow within the limit of the Contract lines as necessary to carry out the work of the Contract.
3. Fill materials containing frost shall not be utilized, nor shall filling be done over frozen material.
4. Protect the underside of all in place construction from frost penetration during the construction period of this Contract. Such protection shall include all in place footings and slabs, during all periods of freezing temperatures until such time as the entire project is complete. Minimum frost protection shall consist of a 4 foot thickness of earth, or equivalent in insulating properties.

3.2 BACKFILL AND FILL

A. Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.

1. Under paving and surfacing: Use subbase material, or satisfactory excavated or borrow material, or combination of both.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade.
2. Backfilling of voids with satisfactory materials.

C. Placement and Compaction: Place backfill and fill materials in uniform lifts of not more than 6 inches in loose depth for material compacted by hand operated mechanical compactors.

1. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification.

2. Place backfill and fill materials adjacent to structures evenly to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately the same elevation in each lift.
3. Do not place any fill material until structural components involved have sufficient strength to withstand the pressure to be imposed. Remove from spaces to be filled all unstable material, including all rubbish, trash, refuse and other debris.
4. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
5. Coordinate backfilling with the installation of the work of all trades.
6. Compact backfill to match adjacent areas as specified above. Correct settlement of fill by filling to subgrade levels in all areas where settlement occurs.

3.3 SUBGRADE PREPARATION AND GRAVEL PLACEMENT FOR PAVEMENTS

A. Clean the rough subgrade of all loose, soft, foreign or other unsuitable material and reshape as required. Add suitable fill material to meet required grade.

B. Compact to required grades and sections for paving. Remove spongy or otherwise unsuitable material and replace with approved material. Loosen exceptionally hard spots and recompact. Take every precaution to obtain a foundation of uniform bearing power. In absence of specific requirement, compact foundations by such means as will provide firm base and insurance against settlement of superimposed work.

1. Compact any portion which is not accessible to a roller by mechanical or hand tamper.

C. Maintain the surface of any layer in its finished condition until succeeding layer is placed. Properly drain the subbase at all times.

3.4 COMPACTION

A. Control soil compaction during construction providing minimum percentage density specified for each area classification.

B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density of soils which exhibit a well defined moisture density relationship determined in accordance with ASTM D1557, Method C.

1. Pavements and Site Improvements: Compact top 12 inches of subgrade and each layer of backfill or fill material at 85 percent maximum density.

C. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material, to prevent free water from appearing on surface during or subsequent to compaction operations.

1. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

3.5 DECOMPACTION OF SOILS

A. General:

1. All existing in-place soil within the limit of new lawn turf and new tree plantings that has been subject to compaction, vehicular traffic, equipment storage or material stockpiling

prior to and during the performance of this Contract shall be deep ripped to a depth of 12 inches in accordance with the requirements of this Specification.

B. Decompaction Operations:

1. Vertically fracture all exposed subsoil material in specified areas as noted above within the Limits of Work through deep turnover and ripping, decompaction, restoring soil porosity and permeability and aiding infiltration and reducing runoff. Fracture the subsoil to a depth of 12 inches.
2. Effective fracturing of compressed subsoil material is achieved only when the soil material is moderately dry to moderately moist. Perform subsoiling only when soil has suitable moisture content as described in this Specification.
3. Contractor shall take care to stage operations of loam placement so that newly placed soils are not compacted after placement. Contractor shall demonstrate that his/her protocols for re-spreading topsoil will not cause extensive compaction.

3.6 GRADING

A. Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grade areas to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes, and as follows:

1. Paved areas: Shape surface of areas under paved surfaces to line, grade and cross section, with finish surface not more than 0.10 foot above or below required subgrade elevations.

C. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.7 PROTECTION AND REPAIR

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction.

3.8 DISPOSAL OF UNSUITABLE AND SURPLUS EXCAVATED MATERIALS

A. Remove excess excavated materials, including unacceptable excavated material, trash and debris, and legally dispose of it off the project site.

3.9 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.

B. If in the opinion of the Owner, based on testing service reports and inspection, subgrade of fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

3.10 TESTS

A. Testing laboratory will perform the following general services:

1. Determine maximum dry density and optimum moisture content of soils in accordance with standards herein before specified.
2. Provide optimum moisture - maximum density curves for undisturbed soil used for bearing and material used for compacted fill.
3. Test and approve all subgrades and compacted fill layers before construction thereon.

B. Testing laboratory will perform the following field tests:

1. Determine frequency of field tests to assure densities required. Unless otherwise determined, minimum field testing shall be a density test for each 5,000 square feet of undisturbed subgrade and for each 5,000 square feet of overlying compacted fill.

END OF SECTION

SECTION 32 10 00 - PAVING AND CURBING

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Granite Curbing

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 10 - Site Concrete
C. Section 31 00 00 - Earthwork

1.4 REFERENCES

A. ADA: Americans with Disability Act.

B. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, Commonwealth of Massachusetts, latest edition.

C. City of Worcester Dept. of Public Works and Park, Standard Specifications, latest edition.

1.5 QUALITY ASSURANCE

A. Paving on public property shall comply with all laws, rules and regulations of governmental authorities having jurisdiction over such work.

B. Quality Control

1. All stone shall be strictly in accordance with samples approved by Owner’s Representative.
2. All finishes, dimensions and tolerances shall meet both industry standards and those indicated on approved shop drawings and samples.

C. All stone used shall be sound and free from cracks, seams or starts that might impair its structural integrity or function.

D. No patching shall be permitted except with the approval of the Owner’s Representative.

E. Stone Sources: All stone shall be obtained from one source that is shown to be able to meet project requirements. The specified source shall have adequate capacity and facilities to meet the project requirements.

1. Any source used is subject to approval of the Owner’s Representative.

F. Stone Manufacturing: Fabrication including cutting and finishing shall be carried out at a factory with the demonstrated ability to produce the work required.

1.6 TESTING LABORATORY SERVICE

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.

1.7 SUBMITTALS

A. Submit manufacturer's catalog data and specification sheets for each type of masonry unit, mortar, and other manufactured products, including certifications that each type complies with specified requirements. Include instructions for handling, storage, installation and protection.

1. Cement mortar mix.
2. Masonry mortar samples showing full range of colors available

B. Submit physical samples of the following for approval prior to installation:

1. One sample of granite for curbing at 12" x 12" x .5" conforming to the standards set forth in this Section.

C. Masonry mortar samples showing full range of colors available.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Do not erect any granite curbing 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 materials which are likely to contain frost. Do not use accelerating ingredients with any mortar. Protect all work against freezing for not less than 48 hours after installation.

B. Do not lay granite curbing which is 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 work damaged by frost or freezing.

PART 2 - MATERIALS

2.1 GRANITE CURBING

A. New granite curbing as required by the work shall be granite cut from a light gray New England granite.

1. New vertical roadway curb materials shall be Type VB, conforming to MassDOT Specifications Section M9.04.1.
2. All granite curbing for this project shall be from the same quarry and lot. Veining, color, and quality shall be consistent across all provided product.

2.2 MISCELLANEOUS MATERIALS

A. CONCRETE FOR CRADLE at granite curbing shall conform to ASTM C94 and applicable provisions of Section M4 of the Standard Specification using 3/4 inch maximum size aggregate with a minimum compressive strength of 3,000 psi at 28 days.

B. CEMENT MORTAR for pointing joints in new granite curbing shall be a Type M cement mortar composed of one part Portland cement and two parts sand, by volume with sufficient water to form a workable, stiff mixture. Provide color samples as required by Owner's Representative.

PART 3 - EXECUTION

3.1 PLACEMENT OF GRAVEL BASE COURSE FOR CURBING

A. Construct base course as detailed on the Drawings for all areas of new paved surfaces in this Section. Make any corrections necessary to base materials furnished and installed under Section 31 00 00 EARTHWORK, to the sections and elevations shown on the Drawings.

3.2 INSTALLATION OF GRANITE CURBING

A. Before commencing work, thoroughly clean compacted gravel base of all dust, dirt and foreign matter.

B. Do not install granite curb units until continuous concrete base has attained its design compressive strength.

C. Install curbing plumb, level and true to line. Provide temporary supports and bracing as required to maintain position, stability and alignment as units are being permanently connected. Tamp and beat units to level and embed them in setting bed to full, solid and even bearing.

1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses. Take every precaution to prevent direct bearing contact between pieces of new curbing, and where new curbing meets existing curbing.
2. Remove projecting hoisting devices and cement grout fill recessed hoisting devices.

D. Anchor curbing units in position as indicated with continuous concrete cradle. Remove temporary shims, wedges and spacers as soon as possible after anchoring and grouting are completed. After setting curbing units in place, Contractor shall fill all joints with cement mortar, and neatly point the top and front exposed portions. After pointing, the granite curb shall be satisfactorily cleaned of all mortar that has squeezed out of the joints.

END OF SECTION

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SECTION 32 12 16 - BITUMINOUS CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Bituminous Concrete Walk and Court Pavement
B. Color Sealcoat and Line Striping

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 31 00 00 - Earthwork
C. Section 32 31 00 - Fencing and Gates

1.4 REFERENCES

A. The following standards shall apply to the work of this Section.

1. American Association of State Highway and Transportation Officials (AASHTO):
   M 20 Penetration Graded Asphalt Cement
   M 82 Cut-Back Asphalt (Medium Curing Type)
   M 140 Emulsified Asphalt

2. American Society for Testing and Materials (ASTM):
   D 1557 Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-pounds Rammer and 18-in. Drop.

3. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.

4. Worcester Dept. of Public Works and Parks, Special Conditions and Specifications, latest edition.

5. Federal Specifications (Fed. Spec.):
   SS-S-1401C Sealing Compound, Hot Applied, for Concrete and Asphalt Pavements

1.5 SUBMITTALS

A. At least 30 days prior to intended use, the Contractor shall provide job mix formula for all bituminous concrete specified in this Section, listing quantities and pertinent ingredient properties for review and approval by the Owner’s Representative. Do not order materials until Owner’s Representative's approval of mix formula has been obtained. Delivered materials shall closely match the approved samples.

B. Report on test of in place construction of bottom and top courses of bituminous pavements.

C. Color Sealcoat and Line Striping: The Contractor shall submit manufacturer's specifications and color chips or charts and shop drawings of color sealcoat layout for approval prior to application.

1. Court Games: Submit shop drawing showing dimensions of proposed improvements, and designated colors for color sealcoating and line striping as determined by Owner's Representative.
2. Field layout of color sealcoat must be approved by Owner's Representative prior to start of sealcoating applications.

D. Manufacturer's Product Data shall be submitted for the following items:

1. Bituminous Paving Job Mix.
2. Color Sealcoating and Line Striping. Provide Color Charts.

1.6 QUALITY ASSURANCE

A. Unless otherwise specified, work and materials for construction of the bituminous concrete pavement shall conform to the applicable portions of the following:

1. City of Worcester Special Conditions and Specifications Article 39 for 'Bituminous Concrete Paving', and Article 44 for 'Sports Courts Bituminous Concrete Paving and Painting'.

B. Paving work, base course installation and the like, shall be done only after excavation and construction work that might have damaged them has been completed. Damage caused during construction shall be repaired before acceptance.

C. Pavement subbase shall not be placed on a muddy or frozen subgrade. Pavement courses shall not be placed on frozen or contaminated base course or binder course.

D. Existing pavement under state or local jurisdiction shall, if damaged during the course of this project, be repaired or replaced as specified. Materials and construction shall match local or state paving standards and cross sections, whichever is most stringent.

E. HANDICAP ACCESSIBLITY: 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, with amendments effective Jan. 1, 2009.

1.7 TESTING AND INSPECTION

A. The Owner's Representative reserves the right to retain an independent testing laboratory to perform inspection and testing of paving and associated work in accordance with Division 1.

1.8 SPECIAL REQUIREMENTS – COLOR SEALCOAT APPLICATION

A. The Contractor shall engage the manufacturer's representative to inspect and monitor the application of the initial filler coat upon the prepared surfaces of all pavements to receive color sealcoat.

B. If a latex-ite acrylic sealer/surfacer is to be utilized, the addition of silica by mechanical agitation on-site shall be inspected and monitored by the manufacturer's representative who is to be engaged by the Contractor at the Contractor's cost.

C. Adequate means shall be provided to protect the color sealcoating from damage until such time that each layer has cured sufficiently and no sealcoating will adhere to and be picked up by the tires of vehicles.

D. No color sealcoating shall be applied during any period within which rain or sub-application temperatures are predicted within forty-eight (48) hours, unless otherwise specified by the manufacturer.

1.9 ENVIRONMENTAL REQUIREMENTS

A. Install bituminous concrete pavements in accordance with temperature and weather limitations specified by MassDOT.

1. No mix shall be placed on wet or damp surfaces. No mix shall be placed when ambient temperatures are 40^{O}F and falling.

PART 2 - PRODUCTS

2.1 BASE COURSE

A. Base course shall be dense graded crushed stone as specified, provided and installed under Section 31 00 00, EARTHWORK, of this Specification.

2.2 BITUMINOUS CONCRETE

A. Bituminous Concrete shall be a standard plant-mixed, hot-laid paving material for walk and court work, consisting of clean, crushed rock aggregate, mineral filler, and asphalt, according to Sections 39 and 44 of City of Worcester Special Conditions.

B. The bituminous pavement in the courts shall cure for fourteen (14) days prior to applying the color sealcoat system.

2.3 BITUMINOUS MATERIALS

A. Tack coat shall consist of asphalt emulsion, Type RS-1 conforming to City of Worcester Special Conditions.

B. Prime coat shall be Asphalt Primer conforming to MassDOT Specification Section M3.02.0, Cutback Asphalt, and in accordance with the requirements of AASHTO M 81 for rapid curing type and AASHTO M 82 for medium curing type.

C. The joint sealant shall be a hot poured rubberized emulsified asphalt sealant meeting the requirements of Federal Specifications SS-S-1401.

2.4 COLOR SEALCOAT AND LINE STRIPING

A. Color sealcoat shall be 100% acrylic coating conforming with Article 44 of City of Worcester Special Conditions. Color sealcoat shall be Acrylic Color Playing Surface (Plexichrome Ultra Performance/ Plexipave Color Base), by California Sports Surfaces, a division of the ICP Group, Andover, MA. 01810, tel: 978-623-9980, or approved equal.

1. Sealcoat colors will be chosen from the premium Plexipave colors, by Owner’s Representative.

2. Application Rate: .13 to .15 gallons per square yard per coat.

B. Line paint shall be a 100% acrylic resin containing no alkyds or vinyl constituents, and equal to California Line Paint.

1. Paint shall be fortified with rounded #30 silica sand to provide non-skid texture. Color to be selected by Owner's Representative.

2. Application: Roller or brush.

C. The layout and design of color sealcoating shall be installed per contract drawings and according to approved shop drawings.

D. Prior to the application of acrylic coating materials, the entire bituminous court surface should be flooded and checked for depressions or irregularities. Any puddled area shall be marked and repaired with California Court Patch Binder by California Sports Surfaces Andover, MA, tel: 978-623-9980, or approved equal.

1. The finished surface shall be smooth and uniform, true to required grade and cross section, and free of depressions, ridges, or other irregularities.

PART 3 - EXECUTION

3.1 PLACEMENT OF GRAVEL BASE COURSE FOR PAVEMENTS

A. Areas to be paved shall be compacted and brought approximately to subgrade elevation as specified and performed under the work of Section 31 00 00 - EARTHWORK, before work of this Section is performed. Final fine grading, filling, and compaction of subgrade to receive paving, as required to form a firm, uniform, accurate, and unyielding subgrade at required elevations and to required lines, shall be specified and performed under Section 31 00 00 - EARTHWORK, of this Specification.

B. Existing subgrade material that will not readily compact as required shall be removed from the site 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 specified, delivered, and installed under the Section 31 00 00 - EARTHWORK, of this Specification.

C. Subgrade of areas to be paved shall be recompacted as required to bring top 8 inches of material immediately below gravel base course to a compaction of at least 95 percent of maximum density, as determined by ASTM D 1557, Method D. 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 or subbase subsequent backfill and compaction shall be performed as directed by the Owner's Representative. Completed subgrade after filling such areas shall be uniformly and properly graded.

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.

F. Materials shall not be stored or stockpiled on subgrade.

G. Prepared subgrade will be inspected by the Owner's Representative. Subgrade will be

approved by the Owner's Representative before installation of paving base course. Disturbance to subgrade caused by inspection procedures shall be repaired as specified and performed under Section 31 00 00, Earthwork, of this Specification.

H. Gravel borrow shall be furnished and installed under Section 31 00 00 - EARTHWORK, and shall be inspected prior to installation of finish pavement.

3.2 INSTALLATION OF BITUMINOUS CONCRETE COURT PAVING

A. Installation of bituminous concrete court and walk paving shall be in accordance with Section 39 of the Worcester DPW Special Conditions and Specifications, and as follows.

B. The Owner's Representative may require the Contractor to remove and replace at this own expense any defective mix not conforming to the specified job mix formula.

1. If, at any time before the final acceptance of the work, any soft, imperfect places or spots shall develop in the surface, all such places shall be removed and replaced with new materials and then compacted until the edges at which the new work connects with the old become invisible.

C. Adjacent paving work and other site improvements including fence posts shall be protected from stain and damage during entire operation. Damaged and stained areas shall be replaced or repaired to equal their original condition. Do any repair or patching to pavements outside the project site damaged by the work of the Contract.

D. Application of Tack Coat: Areas to receive tack coat prior to paving operations shall be swept clean of loose materials, dirt or other extraneous materials. Application of tack coat shall be at a rate of 0.10 gallon per square yard. The following areas shall be treated:

1. All cut edges of existing bituminous concrete pavement adjacent to placement of new paving
2. Surfaces of all abutting vertical structures.

E. The temperature of bituminous concrete mixture when delivered to the site shall conform to MassDOT Specifications Section 460.61 and the following:

Base Temp degrees F	MAT THICKNESS IN INCHES					
On Which Mix is Placed	½ inch	3/4 inch	1 inch	1 1/2 inch	2 inch	3 inches or Greater
35-40				305	295	280
40-50			310	300	285	275
50-60		310	300	295	280	270
60-70	310	300	290	285	275	265
70-80	300	290	285	250	270	265
80-90	290	280	275	270	265	260
90+	290	275	270	265	260	255

F. Spreading and Finishing:

1. The equipment for spreading and finishing shall be mechanical, self-powered pavers, capable of spreading and finishing the mixture true to lines, grade, width and crown by means of fully automated controls for both longitudinal and transverse slope.
2. If, during construction, it is found that the spreading and finishing equipment in use leaves tracks or indented areas, or produces other permanent blemishes in the pavement, which

are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the Contractor.

3. The mixtures shall be placed and compacted only at such times as to permit the proper inspection and checking by the Owner's Representative.
4. The mixtures shall be placed only upon approved surfaces that are clean from foreign materials and dry; and when weather conditions are suitable.
5. The contact surfaces of posts or other appurtenant structures in pavement shall be painted thoroughly with a thin uniform coating of bitumen (MassDOT Specifications RS-1) just before any mixture is placed against them. This requirement shall be included as work incidental to paving operations.
6. Machine Spreading: All mixtures shall be deposited in an approved mechanical spreader and immediately spread thereby, and then struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness and shall conform to the grade and cross section contour specified.
7. Hand Spreading: Spreading by hand methods will be permitted only for particular locations in the work which because of irregularity, inaccessibility or other unavoidable obstacles do not allow mechanical spreading and finishing.

G. Placing and rolling of mixture shall be as nearly continuous as possible. Rolling shall begin as soon after placing as mixture will bear the operation without undue displacement. Delays in rolling freshly spread mixture will not be permitted. Rolling shall proceed longitudinally, starting at edge of newly placed material and proceeding toward previously rolled areas. Rolling overlap on successive strips shall be greater than or equal to 1/2 width of roller rear wheel. Alternate trips of roller shall be of slightly different lengths. Corrections required in surface shall be made by removing or adding materials before rolling is completed. Skin patching of areas where rolling has been completed will not be permitted. Course shall be subjected to diagonal rolling, crossing lines of the first rolling while mixture is hot and in compactable condition. Displacement of mixture or other fault shall be corrected at once by use of rakes and application of fresh mixture or removal of mixture, as required. Rolling of each course shall be continued until roller marks are eliminated. Roller shall pass over unprotected edge of course only when paving is to be discontinued for sufficient time to permit mixture to become cold.

H. In places not accessible to roller, mixture shall be compacted with hand tampers. Hand tampers shall weigh at least 50 pounds and shall have a tamping face less than or equal to 100 square inches. Mechanical tampers capable of equal compaction will be acceptable in areas in which they can be employed effectively.

I. Portions of pavement courses which become mixed with foreign material or are in any way defective shall be removed, replaced with fresh mixture, and compacted to density of surrounding areas. Bituminous material spilled outside lines of finished pavement shall be immediately and completely removed. Such material shall not be employed in the work.

J. Joints shall present same texture, density, and smoothness as other sections of the course. Continuous bond shall be obtained between portions of existing and new pavements and between successive placements of new pavement. New material at joints shall be thick enough to allow for compaction when rolling. Compaction of pavement, base, and subgrade at joints shall be such that there is no yielding of new pavement relative to existing pavement when subjected to traffic.

K. Contact surfaces of previously constructed pavement (if greater than or equal to two days since binder placed), poles, and similar structures shall be thoroughly cleaned and painted with a thin uniform coating of bitumen immediately before fresh mixture is placed. Tack coat shall be

applied at rate that will leave bituminous residue of 5 to 7 gallons/100 yd.^{2} after evaporation of vehicle. Base surface shall be dry and clean when tack coat is applied. Bituminous paving material shall not be placed until vehicle has completely evaporated from tack coat. Adjoining new paving shall be placed before tack coat has dried or dusted over.

L. Topsoil shall be placed along pavement edges in such quantity as will compact to thickness of course being constructed, allowing at least 12 inches of shoulder width to be rolled and compacted simultaneously with rolling and compacting surface.

M. Variations in pitch of finished surface shall be less than or equal to the following tolerances when tested with a 10 foot straightedge, applied both parallel to and at right angles to centerline of paved area.

1. For court pavement surface course - 1/4 inch in 10 feet.
2. At joints with existing pavement, and at other locations where an essentially flush transition is required, pavement elevation tolerance shall not exceed 0.01 feet.
3. At other areas pavement elevation tolerance shall not exceed $\pm$ 0.05 feet.
4. Irregularities exceeding these amounts or which retain water on surface shall be corrected by removing defective work and replacing with new material as specified and performed under this Section, BITUMINOUS CONCRETE PAVEMENT.

N. **No vehicular traffic of any kind shall be allowed to pass over the newly finished surface until it has had time to set. Seventy-two hours will be considered sufficient time for the pavement to set in most cases, but this period may be extended by the Owner's Representative as required by weather or other reasons. Under all circumstances, damage to the pavement caused by the Contractor's or public vehicles driving over the pavement before the pavement has fully cured shall be repaired as specified, performed and paid for under this Section, BITUMINOUS CONCRETE PAVEMENT, at no additional cost to the Owner.**

3.3 COLOR SEAL COAT

A. Application of color seal coat and line striping shall be in accordance with Section 44 of the Worcester DPW Special Conditions and Specifications, and as follows. The contractor shall furnish and apply to the approved bituminous pavement: two (2) applications to obtain a total quantity of not less than .16 nor more than .22 gallons per square yard. No application shall be covered by a succeeding application until thoroughly cured.

B. Prior to application of the filler coats, all dirt, sand, dust and other loose material shall be cleaned from the newly paved areas to be covered, by sweeping and pressure washing with water. All surfaces shall be dry prior to starting any color seal coating process. The Contractor shall take special precautions to assure that existing pavements are thoroughly cleaned. Limits of areas to be color coated shall be taped with minimum of two (2) inch wide tape true as to alignment prior to application of the color coating material.

C. Apply one (1) acrylic coating to the properly prepared surfaces with a uniform spread at the rate of .07 - .1 gallon per square yard of surface area. The coating shall be applied lengthwise on the court with a wide, rubber-faced squeegee.

D. The entire system of two (2) finish coats shall be applied with approved squeegees. The material shall be thoroughly mixed by mechanical agitation and all work shall be done in a thorough and workmanlike manner. The emulsion shall be thoroughly stirred in its container as received, by stationery bucket power mixer, so that a creamy, smooth consistency of all the

emulsion in the container is assured for ready application. The entire work of color coat surfacing shall be done in accordance with the recommendations of the manufacturer's representative. Special care shall be taken so that none of the coating material spatters or flows beyond the perimeter of areas to be covered. The acrylic coatings shall not be applied in foggy or rainy weather and shall be installed only when ambient temperature is fifty degrees F (50° F) and rising. Finish sealcoating and line striping shall be protected until dry.

E. The finished surface shall be smooth and uniform, true to required grade and cross section, and free of depressions, ridges, or other irregularities.

F. Colors A, B, C, D and E for the top coat shall be selected from the manufacturer's standard color options, as approved by the Owner's Representative during submittals.

G. GUARANTEE/WARRANTY

1. The pavement and coatings shall be guaranteed against defects in workmanship or quality for a period of one (1) year after final acceptance. The contractor shall replace, repair, recoat or otherwise make satisfactory to the Owner's Representative any unacceptable pavement and or coating at no additional cost to the Owner's Representative.

3.4 LINE STRIPING

A. Lay out court line markings as directed on approved Shop Drawing.

1. Allow Line Paint to dry for 4 hours between coating applications or as recommended by manufacturer.

2. Protect newly applied paint until cured, before allowing foot traffic over painted areas. This time period may vary depending upon weather.

3.5 TESTING LABORATORY

A. The testing laboratory shall make the following inspections and tests: Test aggregate materials for compliance with MassDOT or furnish accepted certificate of compliance from source of supply.

1. Test bituminous concrete in accordance with MassDOT, including:
   a. Penetration Tests.
   b. Marshall Stability Tests.
   c. Voids Test.
   d. Percent of Bitumen Test.
   e. Aggregate Gradations.
   f. Certifications required by MassDOT.

2. Verify thickness of the finished bituminous pavement construction obtained from specimens cut by the testing laboratory with a core drill. The diameter of the specimens shall in no case be less than 3-7/8 inches or more than 4 inches.

B. Testing laboratory will perform the following general services:

1. Determine maximum dry density and optimum moisture content of soils in accordance with standards herein before specified.
2. Provide optimum moisture - maximum density curves.
3. Test and approve all compacted aggregate layers before construction thereon.

C. Testing laboratory will perform the following field tests:

1. Determine frequency of field tests to assure densities required. Unless otherwise determined, minimum field testing shall include one (1) density test for each 1,000 square feet.

D. If any of the above tests indicate that the Specifications have not been met, the Contractor shall pay for such additional tests as may be required to assure that compliance has been attained.

3.6 PROTECTION

A. Properly protect existing pavement and landscaping against splashing and spattering from bituminous concrete products and color sealcoat during installation. Any materials so damaged shall be removed and replaced or satisfactorily cleaned with a pre-approved method no additional cost.

END OF SECTION

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SECTION 32 18 16 – BONDED RUBBER SURFACE

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Bonded Rubber Surface

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 10 - Site Concrete
C. Section 31 00 00 - Earthwork
D. Section 32 10 00 - Paving and Curbing
E. Section 32 90 00 - Lawns and Planting

1.4 REFERENCES

A. AASHTO: American Association of State Highway and Transportation Officials.
B. ASTM: American Society for Testing and Materials.
C. ASTM C1028: Slip Resistance.
D. ASTM C67: Freeze/Thaw.
E. ASTM D573: Aging Weathering
F. MassDOT: "Standard Specifications for Highways and Bridges", Massachusetts Department of Transportation, latest edition.

1.5 QUALITY ASSURANCE

A. Paving on public property shall comply with all laws, rules and regulations of governmental authorities having jurisdiction over such work.

B. It shall be the responsibility of the Contractor to render the site erosion free. Approval by Owner’s Representative of any method to accomplish this does not relieve the Contractor of full responsibility for controlling erosion and/or sedimentation throughout the construction process.

C. Construction Tolerances:

1. Variations from slope as indicated for finished surface of paving: 1/4 inch in 10 feet.

D. Qualifications: Utilize an installer approved and trained by the manufacturer of the resilient surfacing system, having experience with other projects of the scope and scale of the work described in this section.

E. Certifications: Certification by manufacturer that installer is an approved applicator of the bonded rubber surfacing system as described in this Section.

1.6 TESTING LABORATORY SERVICE

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.

1.7 SUBMITTALS

A. Product Data: Manufacturer's specifications and MSDS sheets for each product indicated including recommendations for their application and use. Include test reports and certifications substantiating that the products comply with requirements.

1. Submit physical samples of complete color selection for the bonded rubber surface materials for Owner's Representative's approval.

2. Supplier must provide complete installation instructions.

3. Bonded Rubber Surface Installer Qualifications: Minimum of five years of experience installing bonded resilient rubber surfacing. Installer must provide Owner with 3 local references where installation can be inspected.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Install the bonded rubber surfacing system when minimum ambient temperature is 40 degrees F (1 degree C) and rising, and maximum ambient temperature is 90 degrees F (32 degrees C). Do not install in steady or heavy rain.

1. Install bonded rubber surfacing only to clean, dry and properly prepared surfaces or as recommended by surfacing manufacturer. The more stringent requirement shall be followed.

1.9 GUARANTEE ON ACCEPTANCE/LIABILITY

A. Bonded rubber surface shall be guaranteed against failure or defect during normal use and operation for a period of one year.

B. Any defective elements or areas shall be replaced in part or whole by the Contractor at no cost to the Owner

C. The Contractor and the manufacturer shall hold the Owner's Representative harmless from any damages or liability resulting from negligent acts or omissions on the part of the Contractor or manufacturer or improperly installed material.

PART 2 - MATERIALS

2.1 BONDED RUBBER SURFACE

A. The bonded rubber surface shall be constructed from wire free, recycled rubber with polyurethane binder and pigmented colorant. The product is mixed on-site, poured in place and troweled.

1. Impact/Wear Course: composed of +4 SBR recycled rubber buffings which vary in size from 0.5 mm to 5.0 mm in thickness and 5.0 mm to 50.0 mm in length.

2. Binder is a 100% single component MDI based polyurethane binding agent. No polyoils or extenders are permitted.

3. Final Wear Course shall be coated with sealant.

B. Product shall meet ASTM F1292-04 and F1951-08.

C. The bonded rubber surface shall be provided by one of the following manufacturers:

1. “GT Impax Bonded Rubber” by Gametime, Williamsville NY, tel: 800-235-2440, website: www.gametime.com/playground-surfacing/recycled-bonded-rubber/.

2. ‘Vitriturf Bonded Rubber System’ by Vitriturf, tel: 631-231-1300.

3. ‘Duraturf Bonded’ by Sport Surface Specialties, East Aurora, NY, tel: 716-652-2039; website: www.sportsurface.net.

D. Colors shall be selected from the manufacturer’s full range of colors by Owner’s Representative.

2.2 BASE COURSE

A. CRUSHED STONE BASE: shall conform with all requirements for dense graded crushed stone in Section 31 00 00 - EARTHWORK, except the mix shall be of the following sizes:

Sieve Size	% Passing by Weight
1”	90 - 100
5/8”	50 - 80
1/4”	30 - 50
#4	15 - 35
#8	10 - 30
#30	3 - 5
#200	0 - 3

1. The crushed stone must be compacted to a 95% Standard Proctor Compaction. The crushed stone shall be a homogeneous mixture complying with the chart above.

PART 3 - EXECUTION

3.1 PLACEMENT OF AGGREGATE BASE COURSE FOR BONDED RUBBER SURFACING

A. Construct base course as detailed on the Drawings for all areas of bonded rubber surfacing in this Section. Do all necessary grading of the crushed stone subgrade in addition to that specified under Section 31 00 00 - Earthwork, of these Specifications to properly construct the Subgrade as detailed on the Drawings. Subgrade shall be compacted to 95% Proctor Density. Make any corrections necessary to base materials furnished and installed under Section 31 00 00 - Earthwork, to the sections and elevations shown on the Drawings.

B. Spread crushed stone from self-spreading vehicles, approved type of power grader or by hand upon prepared subgrade. Spread evenly in layers so as to avoid separation of aggregates. Layers shall not exceed 6 inches in depth after compaction. Remove stones larger than 3 inches. When spread, rolled and compacted on the prepared surface, it shall form a stable surface. All rolling shall be done with a roller weighing 8 to 10 tons. Compact any portion which is not accessible to a roller by mechanical or hand tamper. Compact to 90-95% Proctor Density.

1. Slope on the subgrade course shall be maintained at 1/4” per foot in any direction, and 1/8” per foot in any 3’ direction.

C. Spread finishing course aggregate smoothly over compacted base course from self-spreading vehicles, or by hand. Compact to 90-95% Proctor Density.

D. Final rolled surface shall be true to the lines and grades indicated on the Drawings or as directed by the Owner's Representative. Fill in any depression that may appear during and after rolling with aggregate and reroll until the surface is true and even.

E. Tolerance: 1/4 inch maximum above or below the cross-section grades and 1/4 inch maximum under a 10 foot line longitudinally.

F. Maintain the surface of any layer in its finished condition until succeeding layer is placed.

3.2 INSTALLATION OF BONDED RUBBER SURFACE

A. Installation shall be as recommended by the manufacturer and shall be to the depths and widths indicated on the Drawings.

B. Contractor shall coordinate the delivery and installation of the bonded rubber surface materials. Bonded rubber surface shall be installed following the installation of the new tree plantings.

C. Grading and Compaction of Subgrade

1. Do all necessary grading of the crushed stone base in addition to that specified under Section 31 00 00 - Earthwork, of these Specifications to properly construct the crushed stone base as detailed on the Drawings. Base shall be compacted to 90 to 95% Proctor.
2. Slope on the stone base course shall be maintained at 1/4" per foot in any direction, and 1/8" per foot in any 3' direction.

D. Installation of Bonded Rubber Surface shall be started when the crushed stone base course has been approved by the Owner's Representative. Prior to installation of the Bonded Rubber Surface, the entire subgrade surface shall be clean and dry and free of any foreign and loose material.

1. Wherever practical, the bonded rubber surface shall be installed in one continuous pour on the same day. When a second pour is required, fully coat the vertical edge of the previous work with polyurethane binder to ensure a 100 percent bond with the new work. Apply adhesive in small quantities so that new cushion layer can be placed before the adhesive dries.
2. The temperature should be 40 degrees and rising during installation of the rubber surface, or a maximum temperature of 95 degrees and falling.
3. The rubber granules and binder are blended together on site in a rotating tumbler to ensure that components are thoroughly mixed in accordance with manufacturer's recommendations. The blended material is then spread onto the compacted subgrade and leveled to the proper elevation using gauge bars equal to the required thickness.

E. During the curing period of the bonded rubber surface, the Contractor is responsible for overnight security for a minimum of 48 hours after installation.

3.3 PROTECTION

A. Properly protect new bituminous paving and court equipment against splashing and spattering from rubber surfacing material during installation. Any materials so damaged shall be removed and replaced or satisfactorily cleaned with a pre-approved method no additional cost.

B. The bonded rubber surface shall be allowed to fully cure in accordance with manufacturer's instructions. The surface shall be protected by the Contractor from all traffic during the curing period of 48 hours or as instructed by the manufacturer.

END OF SECTION

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SECTION 32 30 00 - SITE IMPROVEMENTS

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester 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. New Basketball Posts, Goals and Nets
2. New Trash Receptacles
3. New Benches
4. New Team Benches and Bleacher
5. New Concrete Filled Pipe Bollards
6. New Precast Concrete Light Pole Bases
7. Installation of Salvaged Granite Monument
8. New Signage
9. New Collapsible Bollard

B. Furnish and install all accessory items including hardware, connecting angles, clip angles, bolts, welds, bracing members, etc. necessary for a complete installation.

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 03 30 01 - Cast in Place Handball Wall Concrete
B. Section 03 30 10 - Site Concrete
C. Section 31 00 00 - Earthwork
D. Section 32 12 16 - Bituminous Concrete Paving

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

American Standards for Testing Materials, latest edition; Standards A-120, VA569, 1487-98 (S), and A-500 (ASTM).

Standard Steel Composition, Society of American Engineers

Standard Steel Composition, American Iron and Steel Institute
American Steel Institute (ASI), Standards for Structural Steel, latest edition.

Standards for Welding, American Welding Society, (AWS).

Specifications for Thermal Galvanizing

Structural Steel Painting Council SSPC-SP-5, SSPC-SP-10

American Society of Testing and Materials ASTM D-4417

City of Worcester Department of Public Works and Parks, Standard Specifications, latest edition.

1.7 QUALITY ASSURANCE

A. Engage a basketball goal installer who has successfully completed within the last 3 years at least 6 applications similar in type to that of this project and who will assign mechanics from these earlier applications to this project, of which one will serve as lead mechanic.

B. 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.
4. Variations from slope as indicated for finished surface of paving: 1/4 inch in 10 feet.
5. Variations from flush in unit to unit offset: 1/32 inch.

C. Precast Concrete Quality Control:

1. Fabricator must be designated a PCI Certified Plant for Group A1 - Architectural Concrete.
2. Quality Control Testing: test and inspect precast concrete as determined by Owner, according to MNL-117 requirements.
3. Strength of precast concrete units will be considered deficient when they fail to comply with ACI 318 [ACI 318M] requirements.
4. Defective Work: Discard precast concrete units that do not conform to requirements including strength, manufacturing tolerances and finishes. Replace with precast concrete units that meet requirements.
5. Precast concrete design modifications may be made only as necessary to meet field conditions and to insure proper fitting of the work and only as acceptable to Owner. Maintain general design concept shown without increasing or decreasing sizes of members or altering profiles and alignment shown.
6. Installer Qualifications: Engage an experienced Installer who has completed similar architectural precast concrete work similar in material, design and extent to that indicated for this project and with a record of successful in-service performance.
7. Do not change source of sources for precast concrete or setting materials during progress of work.

1.8 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. COLOR SAMPLES: Submit manufacturer's standard color samples for basketball equipment, site furnishings and paint finish for bollards.

C. Submittals for signs shall be submitted for approval prior to start of fabrication, and will include the following:

1. Manufacturer's technical data and installation instructions for each type of sign required.

2. Shop drawing for each sign required enumerating the various dimensions of all sign sections to be constructed as well as letter font and letter heights, 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 art work for a camera-ready graphic including sign layout with typography in PDF format.

D. Submittals for precast concrete foundations shall include:

1. Concrete design mix including report on design strength test.

2. Test reports on materials evidencing compliance with requirements:

a. Tests of materials, or review of test reports available from suppliers. Submit material certificates in lieu of agency test reports, when permitted by Owner's Representative, signed by fabricator certifying that each material item complies with requirements.

3. Shop drawings shall include sizes, shapes, finishes and location of materials, reinforcing, relations to adjacent construction and proposed light poles. Include locations and details of hoisting points and lifting devices for handling and erection.

E. Certificates of Compliance: Submit Certificates of Compliance from fabricator and coating manufacturer indicating compliance with requirements of specifications prior to application for payment.

F. Warranties: Submit written warranties from basketball court equipment, precast concrete light pole bases and site furnishing manufacturers to the Owner's Representative.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle and ship all items so as 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.

C. Locate storage piles, stacks or bins to avoid and be protected from heavy and unnecessary traffic.

1.10 MAINTENANCE MATERIALS

A. Provide Owner with not less than two sets of tools required for removing and replacing vandal resistant hardware.

B. Spare Parts:

1. Hardware: 2 of each type.

PART 2 - MATERIALS

2.1 BASKETBALL BACKBOARD, GOAL AND POST

A. New backboard shall be Model #XL7042, manufactured by True Bounce, Inc. 194 Riverside Avenue, New Bedford MA 02746, tel: 866-873-3715, or approved equal. Backboard shall be constructed from ½" thick clear polycarbonate, and measure 42" x 72" in size. Backboard will be framed with a heavy duty 2 ¼" solid aluminum extruded 'E' channel and attached with stainless steel hardware. An official sized target and trim color shall be chosen by the Owner's Representative from one of 12 stock standard colors, and silkscreened on the face of the backboard.

B. New goal shall be Model #RB7550 manufactured by True Bounce, Inc. 194 Riverside Avenue, New Bedford MA 02746, tel: 866-873-3715 or approved equal. Goal shall have an 18" dia. double ring, 3/16" wing plates and a 5/8" x 15" brace and nylon net. Metal components shall have a powder coat finish.

C. New galvanized gooseneck basketball posts shall be Model #PG-596, manufactured by True Bounce, Inc. 194 Riverside Avenue, New Bedford MA 02746, tel: 866-873-3715. Posts shall be 6-foot offset, 5 9/16 inch O.D. galvanized steel. Pole will be installed with the base of post 48" below finish grade into concrete footing as shown on Drawings.

2.2 SITE AND COURT FURNISHINGS

A. Benches with backs shall be Model #118-60 manufactured by Dumor, Mifflintown, PA or approved equal.

1. New bench shall be 6 feet in length. Bench shall be equipped with cast steel arm and legs, and steel bar strapping for seat and back.
2. Benches shall be furnished with the surface mount footing option, such that each bench is expansion bolted to the concrete pad in conformance with manufacturer's recommendations.

B. Trash Receptacles shall be #158-32-SH, provided by Dumor Inc, Mifflintown, PA or approved equal.

1. Note that all new receptacle installations shall be installed on a cement concrete pad as shown on Drawings.
2. Receptacles shall have vertical steel slats and 18 gallon steel shield. The units are 32 gallon receptacles fabricated with epoxy coated steel slats which are powdercoated. Receptacles shall come with anchor bolts for surface mounting and a 32 gallon plastic liner.

C. Team Bench shall be #129-1132 from The Park and Facilities Catalog, tel: 866-293-8528, or approved equal. Bench shall be 15' in length.

1. Bench shall be constructed with 2" x 10" clear anodized aluminum planks for bench seats, and 2" square PTS aluminum legs.
2. Legs shall be of a length to be inserted in concrete footings for an in-ground mount.

D. Bleacher shall be #LU-0321AD by GT Grandstands, 2819 Sydney Rd., Plant City, FL, tel: 813-305-1415, or approved equal. Bleachers shall be non-elevated, with 3 rows of seats. All materials used shall be anodized aluminum.

2.3 STEEL BOLLARDS

A. STEEL BOLLARDS shall be cut from 'XS' ferrous steel pipe conforming to ASTM A53, Schedule 80.

B. FINISH: Bollards shall be hot dip galvanized and shop painted after fabrication.

1. Galvanize bollards after cutting, on the interior and exterior, with a coat weight of 2.0 ounces of zinc per square foot.

C. CONCRETE INFILL for bollards shall meet the following:

1. Cement, coarse and fine aggregate shall comply with ACI 304. Coarse aggregate shall be no larger than 1 inch diameter, and together with fine aggregate, shall comply with ASTM C-33. Cement shall be Type 1, ASTM C-150.
2. Concrete shall be rated at a strength of 20.5 Mpa at 28 days with 5 percent air entrainment. Minimum slump is 2 inches and maximum slump is 4 inches.
3. Mixing and placing of concrete shall comply with ACI 304 and ASTM C-94. Consolidation by vibration shall comply with ACI 318.
4. Slump tests shall conform to ASTM C-143 and will be conducted by the Contractor to confirm the workability and to control the water content of the concrete mix during placement. Maximum water-cement ratio (be weight) shall be 0.46 for air-entrained concrete.

D. GALVANIZED FINISH

1. All ferrous metal items shall be hot dip galvanized unless otherwise noted herein. Galvanizing process shall be Colorgalv by Duncan Galvanizing, or approved equal. Provide dry film thickness specified in referenced standards.

E. SHOP COATING MATERIALS

1. PAINT for galvanized steel surfaces: provide 2 coats of Metalatex semi-gloss coating, Series B42 as manufactured by Sherwin Williams, Cleveland OH, compatible with galvanizing repair paint selected.

2. Colors to be selected by Owner's Representative. Application to be in conformance with paint manufacturer's written recommendations.

2.4 PRECAST CONCRETE LIGHT POLE BASES

A. Precast light pole bases shall be fabricated from air-entrained concrete conforming to the requirements and applicable provisions of M4.02.0 of MassDOT Standard Specifications. Minimum 28 day compressive strength is 4,000 psi.

1. Cracked, broken, spalled, stained or otherwise defective precast units are not acceptable.
2. Bases shall be reinforced with twelve (12) - #5 rebars placed vertically, equally spaced, and #3 ties at 8" on center.
3. Air entrainment is 6 – 7% minimum with a 2 – 4" maximum slump.

B. Acceptable manufacturers of new light pole bases are: E. F. Shea New England Concrete Products, Inc., Wilmington MA, tel: 978-658-2645; Precast Specialties Corp., Abington MA, tel: 781-878-7220; Scituate Companies, Marshfield MA, tel: 800-440-0009; or approved equal.

C. Fabricate precast concrete units complying with manufacturing and testing procedures, quality control recommendations and following dimensional tolerances unless otherwise indicated.

1. Fabricate precast concrete units according to the approved Shop Drawings. Exposed edges and corners shall be precise, square and true unless otherwise indicated. Provide uniformly chamfered edge and corner treatment. Bases shall be smooth and true to size and shape.
2. Exposed surfaces: Steel trowel or polished top surface and sandblast finish other surfaces with a light sugar cube finish, all free of pockets, sand streaks and honeycomb with uniform color and texture.

2.5 SIGNAGE

A. ENTRANCE SIGNS shall be constructed of two .21 mm aluminum panels bonded to a solid polyethylene core. Sign shall be mounted between two tubular square steel posts as supplied by FastSigns of Worcester MA, tel: 508-841-5800, or approved equal. Signs shall be printed with graphics and will have a 5 year warranty.

1. Sign shall be mounted with inside an anodized aluminum frame that encases all sides of the sign.
2. Aluminum frame shall be connected to steel posts with stainless steel brackets.
3. Overall thickness of ACM panel is 6 mm.
4. Graphics for the sign shall be provided by the Owner's Representative. Sign shall be a full color digital print with a UV laminate for color protection.
5. Steel posts shall be galvanized and painted black. Posts shall be anchored in the ground in concrete footings. Posts shall be fitted with a cast iron finial sphere cap for 5" square posts.
6. Color for the back of sign and frame shall be selected by the Owner's Representative.

2.6 COLLAPSIBLE BOLLARD

A. COLLAPSIBLE BOLLARD shall be Model #2636 – 36" ht., manufactured by Bollard Warehouse, Inc., PO Box 298, Batavia, IL 60510, Tel: 888-290-6420. Website: www.bollardwarehouse.com, or approved equal.

1. Bollards supplied should be free from surface blemishes and defects where exposed to view in the finished installation.
2. Steel tube, ASTM A500. Steel plate, ASTM A36. Steel pins, ¾" x 8" galvanized pins or ¾" x 6".

2.7 MISCELLANEOUS MATERIALS

A. CONCRETE FOR FOOTINGS shall conform to ASTM C94 using 3/4 inch maximum size aggregate and have a minimum compressive strength of 3,000 psi at 28 days.

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, or approved equal.

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. Install epoxy and sealants in strict accordance with manufacturer's written instructions.

D. Repair damaged surfaces and finishes after completion of installation, or replace damaged members as directed where damage is beyond satisfactory repair.

E. Perform all excavation of every description and through whatever materials encountered to the depths indicated on the Drawings. In all other respects excavation shall conform to the requirements of Section 31 00 00 – Earthwork of these Specifications.

F. 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 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, plumb and true to line and grade. Secure in place. Install furnishings with the top of benches and trash receptacles horizontal and square to paving unless otherwise shown on the Drawings.

B. Site furnishings shall be either cast into below grade concrete footings, or firmly secured to new concrete walk slab with stainless steel expansion anchors.

1. Neatly drill or core into paving and set anchor in epoxy grout.
2. 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.

D. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment, elevation, level, true and free of rack, measured from established lines and levels.

E. Provide all temporary bracing, guy wires, turnbuckles, horizontal struts, etc., as may be required to plumb and hold the metal fabrications in place and aligned at all times during assembly and to take care of all lateral and vertical loads to which the work may be subjected. Provide temporary bracing or anchors in formwork for items which are built into concrete, masonry or similar construction.

F. Do not field modify any shop assembly unless approved by Owner's Representative.

3.3 CLEANING AND INSTALLATION OF EXISTING MONUMENT

A. Existing granite monument shall be cleaned of all dirt and grime with the use of a mild liquid detergent and warm water. Use soft bristle brush as needed to remove difficult areas of dirt. Rinse off soap with clean water, and dry with soft, lint free cloth.

B. Salvaged monument shall be installed as shown on Drawings. Monument shall be installed with a new concrete footing to anchor the base. New cork expansion joint material shall be wrapped around monument to provide protection between new concrete paving and the monument.

3.4 APPLICATION OF GALVANIZING

A. Galvanizing Application: Galvanize materials in accordance with specified requirements. Galvanizing shall provide a visually acceptable substrate for applied coatings, and be free of lumps, globules, or heavy deposits which will interfere with intended use or esthetic appearance of materials.

B. Finish Metal Coating Application: Apply finish metal coatings over hot-dip galvanizing within 12 hours after galvanizing in the galvanizer's facility in accordance with specified requirements and recommendations of galvanizer and coating manufacturer. Metal coatings shall be free of lumps, runs, or sags which will interfere with intended use or aesthetic appearance of materials.

3.5 CONCRETE FOUNDATIONS

A. FOOTING EXCAVATION: Drill holes for footings in firm, undisturbed or compacted soil of diameters and spacings shown. Excavate holes to the minimum diameters or at least 3 times the diameter of the post. Excavate hole depths approximately 6" lower than the post bottom, with bottom of bollards set not less than 48" below the surface when in firm, undisturbed soil. Remove excess excavated material from the site. Where ledge is encountered, the Contractor shall notify the Owner's Representative to determine method of installation.

B. SETTING BOLLARDS AND POSTS: Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete. Center and align posts in holes 3" below bottom of excavation. Place concrete around bollards and posts in a continuous pour, and vibrate or tamp for consolidation. Check each bollard and post for horizontal, vertical and top alignment, and hold in position during placement and finishing operations.

1. Trowel finish tops of footings, and slope or dome to direct water away from posts. Keep top of concrete 6" minimum below finish grade. Set keeps, stops, sleeves and other accessories into concrete as required. Keep exposed concrete surfaces moist for at least 7 days after placement, or cure with membrane curing materials, or other acceptable curing method.

C. CONCRETE STRENGTH: Allow concrete to attain at least 75% of its minimum 28 day compressive strength, but in no case sooner than 7 days after placement, before additional weight is installed.

3.6 CONCRETE INFILL FOR BOLLARDS

A. After installation of galvanized steel piping for bollards in footings, Contractor shall infill concrete compactly into interior of pipe, from bottom to top of pipe. Vibrate concrete infill to reduce air pockets. Neatly form top of concrete into smooth dome taking care not to leave concrete on outside of finished bollard.

1. Immediately clean away any concrete prior to it setting that may find its way on the outside of the bollard.

3.7 SIGN INSTALLATION

A. The installer shall examine conditions under which this work is to be performed and notify the Contractor in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning the work means that installer accepts substrates, and conditions.

1. Posts for all signs shall be set plumb in new concrete footings when viewed from all directions.

3.8 COLLAPSIBLE BOLLARD INSTALLATION

A. The installer shall comply with the Drawings and the manufacturer provided instructions.

B. Install base true and level on concrete footing.

3.9 TOUCH-UP AND REPAIR

A. Touch Up Painting: Immediately after erection of steel components, clean field welds, bolted connections, abraded areas and surfaces to which paint was omitted for field welding and paint exposed areas with same material as used for shop painting to comply with SSPC-PA1 requirements for touch up of field painted surfaces.

1. Apply by brush or spray to provide the required minimum dry film thickness.

3.10 CLEANING AND PROTECTION

A. Protect materials, fabrications, and assemblies with metal coatings from damage during construction using methods approved by fabricator and coating manufacturer.

B. Protect work in progress and after completion. Keep the premises neat and clean at all times.

C. Remove all debris and refuse at the completion of work and dispose of in a legal manner.

END OF SECTION

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SECTION 32 90 00 – LAWNS AND PLANTING

PART 1 - GENERAL

1.1 REFERENCE

A. Attention is directed to the printed form of the Contract of the City of Worcester and Division 1 of which these specifications are hereby made a part.

1.2 SECTION INCLUDES

A. Preparation of final subgrades in planting areas; furnishing planting soil; finish grading; planting; maintenance; and planting guarantee.

B. For all items regarding seeded lawns, soil testing, application of soil conditioners and guarantee refer to: Article 40 ‘General Lawn Areas, Loam and Seeding’, City of Worcester Special Conditions and Specifications.

1.3 RELATED WORK

A. Section 02 41 13 - Site Preparation
B. Section 31 00 00 - Earthwork
C. Section 32 18 16 - Bonded Rubber Surface
D. Section 32 30 00 - Site Improvements

1.4 REFERENCES

A. ASNS: "American Standard for Nursery Stock", American Association of Nurserymen, 1973 Edition.
B. ASTM: American Society for Testing and Materials.
C. Federal Specification O-F-241c(1), Fertilizers, Mixed, Commercial.
D. SPN: "Standardized Plant Names", American Joint Committee on Horticultural Nomenclature, 1942 Edition.

1.5 CERTIFICATES, INSPECTIONS, TESTS AND SUBMITTALS

A. 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 is not available for inspection.

B. Plants shall comply with all applicable State and Federal laws in respect to inspection for plant diseases and infestation. Certificates of inspection shall accompany the invoice for each shipment as may be required by laws for transportation. File certificates with the 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.

C. Furnish full and complete written instructions for maintenance of plantings to the Owner’s Representative at least 30 days prior to the end of the contractual maintenance period in order

to familiarize the Owner with the maintenance requirements for the proper care and development of lawn areas and plantings.

D. Submit samples of the following materials in the quantities indicated for approval prior to use.

1. Mulch for planting: .5 cubic foot.

E. SAMPLES:

1. Planting Soil, imported and amended Loam Borrow, and Organic Compost proposed for use, complete with any necessary amendments and additives. Provide two 2-pound representative samples from each proposed source for testing and analysis. Provide a 2-pound sample for the Owner’s Representative's inspection, to be retained by the Owner’s Representative for comparison with delivered soil. The Owner’s Representative may examine each planting soil delivery to the site, and may request further testing. No planting soil 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.

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 and WOOD CELLULOSE FIBER MULCH 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. 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. 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.

5. 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, 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.

PART 2 - MATERIALS

2.1 TOPSOIL

A. TOPSOIL stripped and stockpiled as required by Section 31 00 00 of these Specifications shall be used for part of this work. It shall be free of any admixture of subsoil, stones larger than one (1) inch, clods of hard earth, plant roots, sticks or other extraneous materials.

1. If additional topsoil is required it shall be imported to the site and 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:

Sieve Size	% Retained
1 inch	0
1/2 inch	0-3
No. 100	40-60

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. The Contractor shall be responsible for estimating the quantity of topsoil stockpiled.

2.2 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. Percentages of Nitrogen,

Available Phosphoric Acid and Water-soluble Potash in the fertilizer mix shall be based on laboratory test recommendations as approved by the Owner's Representative.

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. 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 inform. 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.
2. 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 Tree Saver' manufactured by Plant Health Care, Inc. or approved equal.

2.3 PLANTING SOIL

A. PLANTING SOIL for use as backfill at the tree plantings shall consist of eight (8) parts topsoil and one (1) part compost by volume. It shall have a pH value between 6.0 and 6.

2.4 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.

2.5 PLANT MATERIALS

A. TREES 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. Trees 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. Trees shall be freshly dug at time of delivery. No heeled-in plants or plants from cold storage will be accepted.
3. Trees 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. Trees 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. Trees 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. Trees 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.

2.6 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%.

2.7 GUYING AND STAKING

A. Wood Stakes: Straight, sound, rough sawn lumber 2 in. x 2 in., if square, or 2-1/2 in. diameter, if round. Provide 3/4 in. wide flat polypropylene fabric material as manufactured by Deep Root, or approved equal. Fabric shall be knotted and nailed to the stake.

2.8 WATER

A. WATER shall be free of substances harmful to plant growth. It shall be provided by the Contractor. Furnish all necessary hose, hose connections and watering equipment.

PART 3 - INSTALLATION

3.1 PREPARATION OF SITE

A. After the subgrade of the areas required to be planted 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.

3.2 SCHEDULE FOR PLANTING

A. The actual planting work 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 seeding 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. Planting shall be done within the following dates:

1.	Trees:	Spring:	April 1 to May 15
		Fall:	Oct. 1 to November 30

3.3 EROSION CONTROL

A. It shall be the responsibility of the Contractor to render all lawn areas and plant beds erosion free. The Contractor may accomplish this by any of several alternate methods, any of which may be used provided such method is acceptable to the Owner's Representative. Approval of method by Owner's Representative does not free Contractor of responsibility for controlling erosion.

3.4 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 PLANT PITS:

1. Stake out on the ground locations for plants and obtain approval of Owner's Representative before excavation is begun. Make adjustments in locations as directed.
2. Establish finish grades for plant beds and 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 pits and beds 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. Do not backfill beds with planting soil until the exact location of all plants is approved by the Owner's Representative.
2. Set plants 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. Leave burlap wrapping intact around ball. Turn under and bury portions of burlap exposed at top of ball.

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 and shrubs planted in lawn areas.
4. After plants have been installed and prior to placement of mulch, place 1 packet of “PHC Tree Saver” around in the top ½” of planting soil. Work into planting soil so that the material is incorporated.
5. Staking and Guying: Stake or guy trees immediately following planting:

    a. Plants shall stand vertical and plumb after staking or guying. Set vertical stakes and space to avoid penetrating root balls or root masses. Allow enough slack to avoid rigid restraint of tree.
    b. Stakes and guys shall be installed as indicated on the Drawings. Staked planting shall have polypropylene fabric tied to stakes with fabric knotted and nailed to the stake.

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. Place fertilizer for other plant material over planting area and work into upper soil layer. 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.

3.5 MAINTENANCE AND PROTECTION

A. Maintenance and protection shall begin immediately upon completion of seeding operations and after each plant is planted and shall continue until acceptance or for at least 30 days or as much longer as necessary to establish a uniform stand of the specified grasses 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.
2. 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.

3. Provide temporary protection fences, barriers and signs, where deemed necessary and all other work incidental to proper maintenance. Remove temporary protection devices at the completion of maintenance period.
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.

3.6 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 planting upon acceptance of the work, and continuing through the guarantee period.

3.7 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. 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.

C. 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.

D. 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.

3.8 FINAL INSPECTION AND ACCEPTANCE

A. At the end of the guarantee period, submit a written request to the Owner's Representative to inspect all guaranteed work for final acceptance at least 10 calendar days before the anticipated date for final inspection.

END OF SECTION
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APPENDIX A

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OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Tel (508) 339 – 3929
Fax (508) 339 - 3140

June 27, 2022

Ray Dunetz, RLA
Ray Dunetz Landscape Architecture, Inc.
179 Green Street
Boston, MA 02130

Re: Subsurface Evaluation
South Worcester Playground
37 Camp Street
Worcester, MA 01603
OHI Project # 22-2221

Dear Mr. Dunetz:

OHI Engineering Inc (OHI) is pleased to submit this Preliminary Geotechnical Evaluation for the South Worcester Playground in Worcester, Massachusetts (the "Site"). The Site is located off of Camp Street in Worcester (see **Figure 1 – Locus**). The evaluation was conducted in accordance with our agreement.

1.0 INTRODUCTION

The Site consists of a baseball field, playground equipment, basketball court, and two handball courts surrounded by a chain-link fence. The proposed work will involve the installation of several new light poles and associated footing structures.

2.0 SUBSURFACE EVALUATION

The subsurface evaluation consisted of four GeoProbe soil borings completed at the Site at locations approved by a City of Worcester Park representative. Prior to conducting the soil borings, the Site was pre-marked and Dig-Safe was contacted for utility mark out. Also, applicable access permits were obtained from the city to accomplish the subsurface campaign.

Four soil borings were completed on Thursday, May 26, 2022. A City of Worcester representative was on-site to provide access to water and observe a portion of the soil boring campaign. The four soil borings, numbered SB-1 to SB-4, were advanced at the Site by Geologic Earth Exploration from Norfolk, MA using a 54DT GeoProbe rig. At all locations the probes were advanced to depths of 16 feet below surface grade (bsg); bedrock refusal was

encountered at 14 feet bsg in SB-3. Refusal was not encountered in any of the other test probes. The test probe locations are shown on **Figure 2 – Site Plan**. Test probe logs are provided in **Appendix A**. All test probes were completed within the boundaries of the playground as approved by the City of Worcester.

Soils at SB-1 were described as loose in the top three feet then medium dense to dense fine to medium SAND and SILT with fine to medium gravel from approximately three to sixteen feet bsg. At approximately fourteen feet below surface grade, medium dense, saturated, tan and grey SAND and SILT with fine gravel and cobbles was observed.

Soils at SB-2 were similar to those in SB-1 and were described as loose in the top 3 feet then medium dense fine to coarse SAND and fine to medium gravel with some silt and cobbles from approximately four to sixteen feet bsg.

Soils at SB-3 were described as very loose fill from grade to approximately seven feet bgs. At approximately seven feet and extending down to 14 feet bsg, medium dense to dense, tan, fine SAND and SILT with a trace of fine to medium gravel was observed. Cobbles and boulders were encountered at an approximate depth of nine to 11 feet bsg. Refusal on fractured bedrock or a possible boulder was encountered in the boring at a depth of approximately 14 feet bsg.

Soils at SB-4 were described as medium dense fill with brick and asphalt in the top four feet then medium dense to dense for the remainder of the test boring. Soils consist of fine to medium, tan-gray SAND and SILT with fine to medium gravel and some cobbles from approximately four to sixteen feet bsg.

The natural soils are defined as Material Class 7, Granular Ablation Till, on Table 1806.2a of the Massachusetts Building Code. Net allowable bearing pressure of four tons per square foot should be used in design.

Groundwater was measured between nine and eleven feet below grade. It is anticipated that the depth to groundwater will fluctuate due to season, temperature, precipitation, and construction activity in the area; therefore, water levels during and following construction will vary from those observed in the subsurface explorations.

3.0 FOUNDATION EVALUATION

Fill soils encountered in borings SB-3 and SB-4 should be removed and replaced with structural fill described below. The undisturbed naturally deposited till soils and gravelly-sands at the Site are considered suitable for support of light base supports. The subsurface soils encountered in the borings are medium-dense to dense ablation till meeting Material Class 7, Table 1806.2a of the *Massachusetts Amendments to the International Building Code 2009, Eight Edition* (Massachusetts Building Code).

3.1 Support Foundation Qualifiers

1. The Massachusetts Building Code, Table 1806.2a *Presumptive Allowable Vertical Bearing Pressures* provides a net bearing pressure of four (4) tons per square foot for Material Class 7.

2. For purposes of seismic design and in accordance with the *Massachusetts Amendments to the International Building Code 2009 (Basic/Commercial) Eighth Edition*, the profile at the project site is classified as Site Class D, with Site Coefficients F_a (short period) of 1.6 and F_v (1-second period) of 2.4. The soils are not considered susceptible to liquefaction.

The work should be done in dry conditions. Dewatering requirements will vary across the Site based on groundwater levels encountered during construction and local soil conditions. In general, it should be practicable to accomplish construction dewatering from within excavations by open pumping methods to depths of about one foot below free water levels encountered in excavations. Dewatering to greater depths below groundwater will likely require the use of deep sumps or wells. Surface runoff and infiltration of groundwater should be controlled so that excavation, construction and backfilling can be completed in the dry.

Dense graded crushed stone for use as backfill should be a clean, well-graded sand and gravel mixture meeting the following gradation.

Dense graded crushed stone Gradation

Screen or Sieve Size	Percent Passing
3 inches	90-100
No. 4	35 - 70
No. 40	10 - 35
No. 200	0 - 10

Note: Maximum particle size limited to 3 inches.

In confined areas, structural fill should be placed in lifts not exceeding 6 inches in uncompacted thickness and compacted with hand-operated compaction equipment. Fill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft3 (2,700 kN-m/m3)].

Visual classifications of the on-Site soils from the probe logs provided indicate the on-site soils are not likely to be suitable as structural fill, but may be acceptable for use as general fill in landscaped areas, if needed. On-site soils should be segregated and stockpiled during construction. Laboratory testing will be needed to determine if the on-Site soils are suitable for use as fill, or if special handling will be required for off-Site disposal.

Since the above recommendations are based on limited numbers of observations and tests, the Owner and the project Contractor should be particularly sensitive to the potential need for adjustments in the field.

4.0 SUMMARY

The evaluations and recommendations presented in this Geotechnical Evaluation are based on the results of eight subsurface boring explorations. The nature of variations between the explorations may not become evident until construction has begun. If variations are encountered, it may be necessary for OHI to re-evaluate the recommendations presented in this report.

We appreciate the opportunity to work with you on this project. Please do not hesitate to contact us should you have questions or comments regarding this matter.

Very truly yours,

OHI ENGINEERING, INC.

Douglas C. Morrison
Senior Project Manager

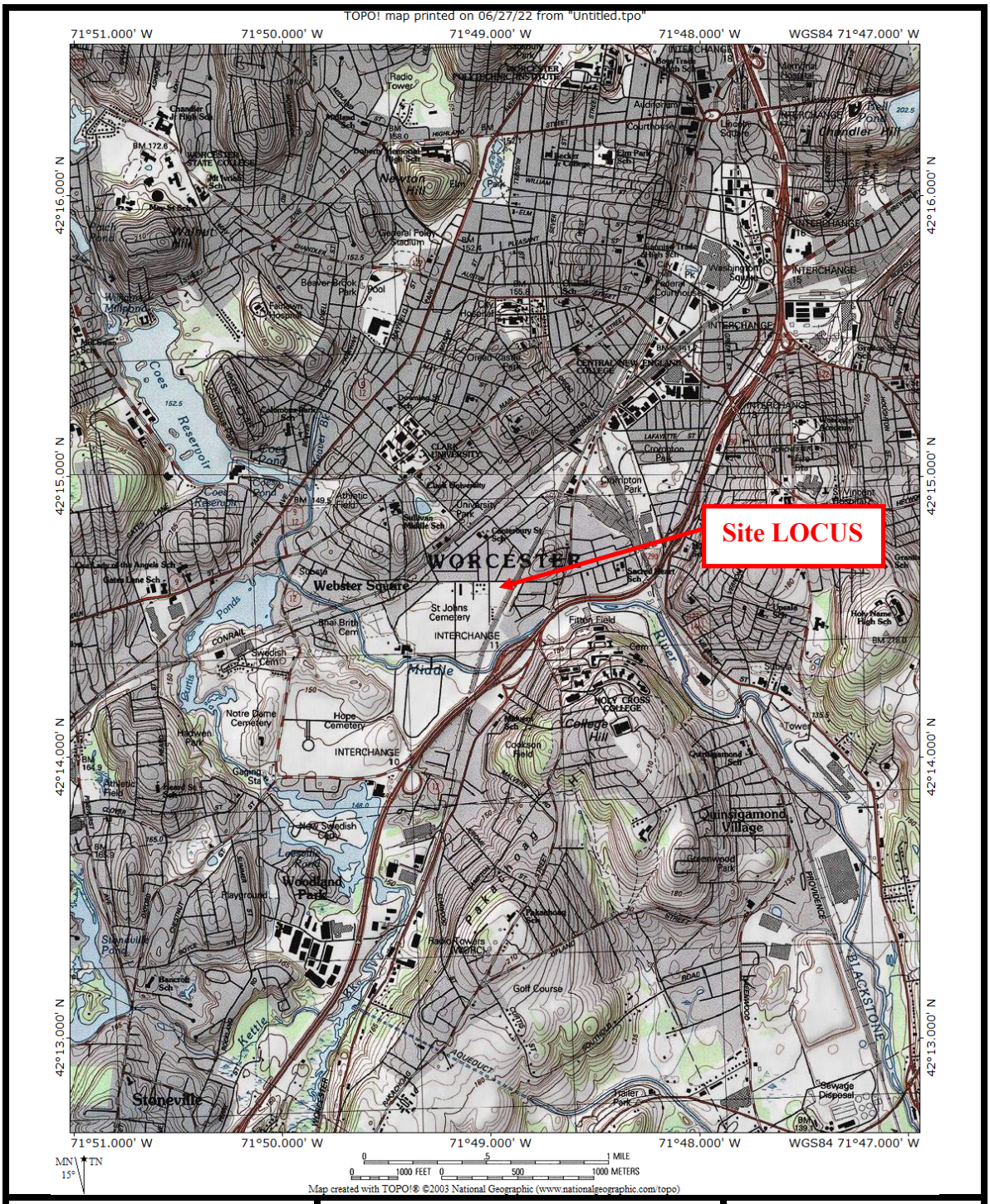
Jared J. Kelly
Project Engineer

James R. Borrebach, P.E., L.S.P.
Principal

Attachments

OHI Engineering, Inc.
Engineers & Environmental Scientists

FIGURES



Site LOCUS

Figure 1

South Worcester Playground
37 Camp Street
Worcester, Massachusetts

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue · Mansfield, MA

N
W E
S

Site Locus – Boring Locations

Figure 2

South Worcester Playground
37 Camp Street
Worcester, Massachusetts

OHI Engineering, Inc.
Engineers & Environmental Scientists
44 Wood Avenue · Mansfield, MA

N
W E
S

OHI Engineering, Inc.
Engineers & Environmental Scientists

APPENDIX A

Boring Logs

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	***South Worcester Playground***	**BORING:**	**SB-1**
	37 Camp Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	5/26/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	5/26/2022
DRILL RIG:	Track Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		5	5	6	5	63%		15" Loam	
2									
3		6	12	15	18	50%		Loam. Dry. Tan Fine to Medium SAND and SILT w/ Cobbles	
4									
5		25	36	36	26	58%		Tan-Gray F-M SAND/SILT w/ F-M GRAVEL	
6									
7									
8									
9									
10		46	50	46	36	50%		Tan-Gray F-M SAND/SILT w/ F-M GRAVEL	
11									
12									
13									
14									
15		18	19	25	19	42%		Wet. Tan-Gray F-M SAND/SILT w/ F-M GRAVEL and Cobbles	
16									
17								End of Exploration @ ~ 16' bgs	
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
5 - 9	loose	3 - 4	soft
10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	***South Worcester Playground***	**BORING:**	**SB-2**
	37 Camp Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	5/26/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	5/26/2022
DRILL RIG:	Track Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		4	6	11	6	50%		12" Loam	
2									
3		5	7	7	6	0%		Rock in Tip of Spoon	
4									
5		19	22	29	28	50%		Tan-Gray F-C SAND w/ F-M GRAVEL and Some Silt w/ Some Cobbles	
6									
7									
8									
9									
10		26	25	21	54	50%		Wet. Tan-Gray F-C SAND w/ F-M GRAVEL and Some Silt w/ Some Cobbles	
11									
12									
13									
14									
15		20	16	14	10	42%		Wet. Tan F-C SAND w/ F-M GRAVEL and Some Silt w/ Some Cobbles	
16									
17								End of Exploration @ ~ 16' bgs	
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
5 - 9	loose	3 - 4	soft
10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	***South Worcester Playground***	**BORING:**	**SB-3**
	37 Camp Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	5/26/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	5/26/2022
DRILL RIG:	Track Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		3	2	2	1	75%		12" Loam Dk Brwn Loamy, F-C SAND and SILT w/ Some Asphalt (Possible Fill)	
2									
3		1	1	1	2	17%		Dk Brwn Loamy, F-C SAND and SILT w/ Some Asphalt (Possible Fill)	
4									
5		2	1	1	1	34%		Dk Brwn Loamy, F-C SAND and SILT w/ Trace F Gravel (Possible Fill)	
6									
7		1	1	12	10	50%		Tan F-C SAND w/ Some Silt and Some F-M Gravel	
8									
9									
10		60	40	40	50	50%		Cobbles and Boulders w/ Tan F-M Sand/Silt and F Gravel Fractured Bedrock	
11									
12									
13									
14									
15		100/3"	--	--	--	0%		Spoon Refusal (Bedrock in Tip of Spoon)	
16									
17								End of Exploration @ ~ 14' bgs	
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
5 - 9	loose	3 - 4	soft
10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

SOIL TEST BORING LOG & MONITORING WELL COMPLETION REPORT

OHI Engineering, Inc.
Engineers & Environmental Scientists

44 Wood Avenue
Mansfield, MA 02048
Voice: (508) 339-3929
Fax: (508) 339-2893

PROJECT:	***South Worcester Playground***	**BORING:**	**SB-4**
	37 Camp Street	**WELL:**	**NA**
	Worcester, Massachusetts	**SHEET:**	**1 of 1**

CONTRACTOR:	Geologic Earth Exploration, Inc.	**SIZE:**	2"	**SAMPLER:**	**START DATE:**	5/26/2022
GEOLOGIST/ENG.:	JJK	**WEIGHT:**	140 lb	Split Spoon	**FINISH DATE:**	5/26/2022
DRILL RIG:	Track Mounted (Drive n'Wash)	**FALL:**	30"		**SURFACE GRADE:**	N/A

DEPTH (FT)	PID (ppmv)	BLOW COUNTS 0 - 6"	6" - 12"	12" - 18"	18" - 24"	REC		DESCRIPTION	DIAGRAM
+1	N/A					%			
1		--	25	17	11	42%		6" Asphalt (Cut Out) Fill: Brick	
2									
3		6	5	3	9	42%		Fill: Blk-Dk Brwn Sand/Silt/Gravel Above Tan-Brwn F Sand and Silt	
4									
5		6	27	48	50	50%		Tan-Gray F-M SAND and SILT w/ F-M GRAVEL and Cobbles	
6									
7									
8									
9									
10		20	35	24	26	63%		Tan-Gray F-M SAND and SILT w/ F-M GRAVEL and Cobbles	
11									
12									
13									
14									
15		17	26	23	12	42%		Tan-Gray F-M SAND and SILT w/ F-M GRAVEL and Cobbles	
16									
17								End of Exploration @ ~ 16' bgs	
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									

Penetration Resistance

Cohesionless Density		Cohesive Consistency	
0 - 4	very loose	0 - 2	very soft
5 - 9	loose	3 - 4	soft
10 - 29	med. dense	5 - 8	med. stiff
30 - 49	dense	9 - 15	stiff
50+	very dense	16 - 30	very stiff
		31+	hard

Terms

Proportion Definition	
trace	0% - 10%
little	10% - 20%
some	20% - 35%
and	35% - 50%

Groundwater Observations

@ _____ ft.

@ _____ ft. after _____ hours

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END OF REPORT

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